A STUDY OF SERIOUS AND FATAL ACCIDENT RECORDS DURING 1939 AND 1940

by

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and

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A report on research conducted under the auspices of the National Research Council Committee on Aviation Psychology, from funds provided by the Civil Aeronautics Administration.

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LETTER OF TRANSMITTAL

NATIONAL RESEARCH COUNCIL

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

Committee on Aviation Psychology

May 15, 1948

Dr. Dean R. Brimhall
Assistant to the Administrator
for Research
Civil Aeronautics Administration
Room 5217, Commerce Building
Washington 25, D. C.

Dear Dr. Brimhall:

Attached is a report entitled A Study of Serious and Fatal Accident Records During 1939 and 1940, by Raymond Franzen and Dean R. Brimhall. This report is submitted by the Committee on Aviation Psychology with the recommendation that it be included in the series of Technical Reports issued by the Division of Research, Civil Aeronautics Administration.

The study described in this report has practical implications for the maintenance of accident records and for their use in furthering flight safety. In addition, as indicated in the Editorial Foreword, the study has stimulated research on the recognition and avoidance of the inadvertent stall, leading to specific recommendations with respect to the use of stall warning devices on private airplanes. Flight safety is the major consideration in a number of other current studies which are being conducted by the Committee on Aviation Psychology.

Cordially yours,

M S Viteles

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

MSV:rm

EDITORIAL FOREWORD

The analysis of accident records described in this report represents one of a series of studies, conducted under the auspices of the Committee on Aviation Psychology, concerned with problems of increasing flight safety. The findings of the study are of significance in relation (a) to the development of improved methods for recording and analyzing accident data and (b) to the isolation of factors pertinent to accident causation.

The study has also led directly to a number of investigations of major significance for the reduction of aircraft accidents. Data on the incidence of light plane accidents associated with the inadvertent stall led to a study of accuracy of recognition of the incipient stall. The findings of this study resulted in the recommendation that efficient stall warning devices be included as standard light plane equipment.[1] Other studies growing out of the analysis of accident data presented in this report include an investigation of the relative importance of various sensory cues in stall perception; an investigation of the consistency of stall recognition from maneuver to maneuver and its relation to other pilot characteristics, and an investigation of the basic factors in the recognition and avoidance of the stall by expert pilots. It is anticipated that findings from such studies will lead to recommendations for revisions in the pilot training curriculum with the view of reducing the incidence of accidents arising from inadvertent stalls.

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[1] Rulon, P. J. A study of the accuracy of recognition of the incipient stall in familiar and unfamiliar planes. Washington, D. C. CAA Division of Research, Report No. 74, November 1947.

CONTENTS

SUMMARY

The official records indicating the causes of non-carrier accidents, and related elements of information pertaining to such accidents, represent a valuable source of data for analysis as a basis for suggesting steps to be taken in initiating an accident prevention program. However, the value of this source of information is greatly reduced by inadequacies in present non-air-carrier accident recording procedures.

The major purpose of this investigation has been the evaluation of accident record files covering 1163 accidents occurring during 1939 and 1940. The requisite elements of information which are available in the present files, which are available to a limited degree only, and which are not available, are indicated. Suggestions are made for improving accident record procedures in order that a complete description of the background of the accident may be obtained.

The major need is for development of procedures which will result in the collection of comparable information on all accidents, particularly in terms of the nature of maneuvers immediately preceding the accident (lead maneuvers), and in terms of other pertinent conditions surrounding the accident (environments). The inadequacy of procedures in which the specific elements of accident data to be collected are left to the discretion of the investigator is noted. This inadequacy often results in restriction of information to those elements which are most immediately available, and, moreover, may lead to uncertainty as to whether certain important background elements did not apply to the accident in question, or were merely overlooked by the investigator

In the course of the analysis, the high incidence of stalls, particularly from turns, immediately preceding the crash, became evident. In the records analyzed, approximately 65 per cent of the private plane accidents resulting in fatalities involved a stall; and more than half of such stalls followed improper execution of a turn at low altitude. The implication of this fact with respect to revisions of the pilot training curriculum is discussed. As another by-product of the principal study, comparisons were made between the sample of pilots in the CAA accident records and a sample of pilots obtained during other research in California. Differences among pilots having accidents, and accident-free pilots, are discussed, in terms of elements of information pertaining to pilot history, such as experience and age.

as nearly as practicable to that presented by the National Advisory Committee for Aeronautics in their report #576. The Safety Bureau method follows the basic principles outlined in this report and these basic principles include a separation of the functions of investigation and analysis. Investigators are left almost entirely free in the accumulation of materials and objectivity of classification entries in the process of analysis. Though this brings about a consistency and uniformity of basic breakdowns from which statistical data are derived, the validity and the pertinence of the final results are left doubtful.

The best substantiation of the sterility of tabulations arising from this procedure may be found in an examination of a release on accidents. For example, it was apparent from inspection of the figures in a release, dated March 15, 1943, covering accidents which occurred during 1941 that the tables devote themselves mainly to an analysis of age in relation to certain other objective factors appearing in the investigation reports, such as "total number of hours flown at time of last accident," "number of previous accidents in pilot's experience," "certification," "type of flying," "amount of injury," etc. No attention is devoted to the more subtle considerations of maneuvers which lead to an accident, experiences which surrounded the pilot apart from flying at the time of accident, original intent of pilot at time of take-off, medical history, important moral history, and the like.

The reason for such omission is, of course, obvious because when elements of this type occur in the files they are sporadic. They are not directly required and the investigator may use his own judgment if and when to use them. Weather conditions, lead maneuvers[1] and elements of the environment[2] are present in only limited form. Separation of elements in the code developed in this investigation into elements which are usually available in the files, elements which are available in limited form only, and elements which are not available at all, is made later in this report.

A succinct exhibit of the type of investigation made and the analytic factors which grow from it may be found in Appendix B. This appendix contains the Non-Air-Carrier Aircraft Accident Report and the Non-Air-Carrier Accident Analysis Sheet. It is clear from a comparison of these that such consistency as is obtained in reporting is a function of arbitrary rules developed by the analyst. Reference to the accident reports regularly issued makes it clear that the result usually is to leave matters out of the analysis which are not objectively stated in the investigation.

A quotation from a manual describing the method of aircraft accident analysis may be in order to indicate that this unfortunate result has its

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[1]Defined here as being the maneuvers nearest to the accident.

[2]"Elements of the environment" is defined as concomitant circumstances which have a bearing on the accident and which are not included under "weather," "attitude of plane," or "pilot." Examples of elements of the environment are "instrument flying," "running into mountain," "engine failure," etc.

A STUDY OF SERIOUS AND FATAL ACCIDENT RECORDS DURING 1939 and 1940

INTRODUCTION

The accident study investigated materials on file with the Civil Aeronautics Board regarding accident cases in 1939, 1940, and a very small number of cases at the early beginning of 1941. The purposes of the study when it was undertaken were:

1. To develop suggestions for revision of the pilot training curriculum.

2. To establish definitions of types of accident and reliable frequencies of these types together with their relation to other conditions on record.

3. To provide a practical, validated routine for accumulating and maintaining accident records.

In the development of the first of these purposes difficulties were encountered which occurred because insufficient progress had been made in the past in respect to the other two. The manner of investigation and analysis employed by the Safety Bureau were such that original materials were neither complete nor objective.

The 1163 files which were examined contained a miscellaneous arrangement of materials. These included such items as newspaper reports, letters from witnesses, reported testimony by witnesses, statements by friends and relatives of the victims, examination by accredited agents, statement of the pilot when the accident was not fatal, and summaries made by the Civil Aeronautics Board authorities. The evidence was often vague and sometimes conflicting. The most satisfactory files, from the point of view of statistical analysis were those where witnesses who are themselves pilots were available. These, however, are mainly the accidents which occur at or near airfields.

HISTORY OF METHODS CURRENTLY USED

The history of the methods used, in itself, accounts for their present status and implies the need for revision which should be implemented by this report. Since the main conclusions netted by the investigation were in respect to the kinds of revision which are needed in accident reports, in order to make true statistical analysis possible, it becomes necessary to describe in general the background and the present status of procedures used.

The method of aircraft accident analysis used by the Accident Analysis Division of the Civil Aeronautics Board's Safety Bureau is patterned

The procedures in classifying and coding the material in the accident record files were as follows: the personnel engaged in coding and classifying the accident records were thoroughly indoctrinated in the procedures to be employed. The codes as used are presented in Appendix C and the coding instructions are presented in Appendix D. The scoring agents worked in teams of two. After the training period, the teams of scoring agents began work on coding the accident records from the files. Each individual on a team examined and coded a series of records. The codings accomplished were reviewed by a supervisor, and then the series of files were exchanged between the two members of the teams.[3]

Any disagreements which occurred in the independent coding of the same file were discussed by the members of the team in conference with the supervisor. In the course of these conferences decisions were made as to the proper coding of various elements in the records and full agreement between the individual coding agents was therefore attained through collusion. The purpose of this procedure was to arrive at a single determination through a cooperative process.

Accident Record Needs. One of the principal problems was to make the code elements mutually exclusive and collectively exhaustive. Another important problem was to select codes and train operators so that objectivity could be established. These two problems were attacked simultaneously and a finished code accepted only after agreement between operators working independently had been established. There was not perfect objectivity for all items in the accepted code, but the limitations of each element were ascertained. Constant changes were made in procedure, and final validation of the personal elements depend mainly upon differences between accident cases and a normal sampling evaluated in terms of probability. Those aspects of the code which deal with maneuvers which precede an accident (called Lead Maneuvers) were the most difficult elements in this respect.

Constant comparison between coders show independence of coding from the individual talents of observers and indicate that segments of the materials lead to the same conclusions which were reached from other segments. However, changes in procedure and some infrequent occurrence of important elements make satisfactory statistical proof impossible. New double application to another thousand cases would be necessary.[4] It is believed that comparisons to normal, using the code as developed, are a better justification of the procedure.

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[3]During the training procedures each file was coded by at least two examiners and conferences were always held. After the training period, which lasted until the first 200 files had been coded, double coding continued but conferences were not held unless there was disagreement, and then only on the points of disagreement.

[4]The term "double application" refers to the procedure just described which involves independent coding of records by two "agents" followed by consultation between the "agents" on points of disagreement.

origin in a clear, methodological concept. This is the concept that the investigator should be free to find whatever he can and that objective classification of items enter into the picture only when the analyst reviews the data submitted to him:

> "Experience has shown that the work of accident study and prevention can be handled most effectively and efficiently when the functions of investigation and analysis are separated. This leaves investigators free to devote their highly specialized training and background to investigation. Their material is turned over to a group of trained accident analysts (all pilots) who utilize it to the greatest advantage by virtue of their knowledge of classifications, rules, interpretations, and policy. This brings about a consistency and uniformity of basic breakdowns from which statistical data are derived and special studies are made. Thus accuracy and validity of final results are assured."

It must be admitted that there is a clear acceptance of an obligation to represent causal factors. Space is provided in the forms for a brief description of the accident. This description is important to the Safety Bureau since theoretically it permits the development of specialized studies which focus upon particular situations. However, in actual practice the procedure employed results in confining the listed factors to a minimum and it does not gain the additional detail which is contemplated in the general description. In practical application the listed factors are the only ones which are sufficiently objective and uniform to be used for purposes of statistical treatment. The description of the accident is often highly subjective in character. One serious limitation is that the types of evidence used are always those that are most immediately available and the forms do not even provide a record of why certain types of evidence are not available, i.e., whether they are missing because they are not pertinent or because they could not be obtained.

AN ANALYSIS OF ACCIDENT RECORD PROCEDURES

Coding Problems

Obviously, the limitations of the material which make it difficult for the analysts in the Safety Bureau were encountered by this study also. To meet, as far as possible, the objective of providing a practical and validated routine for accident records, it became important first to classify aspects of investigation materials which should be available into those that are usually available, those that are available only to a limited extent, and those that are not available at all. On the basis of this analysis, the development of a series of principles which follow from the shortcomings in the material will guide a reconstruction of the investigation schedule. Obviously this reconstructed schedule can only be accepted by the Safety Bureau when the fundamental philosophy of freedom on the investigation side is discarded.

Classification of Materials in Accident Records

As stated at the beginning of this report, the study had three purposes. The first of these is intended to reflect upon the training curriculum and the other two are intended to promote the reliability and usefulness of records. In the interests of the two latter, close scrutiny was given to the elements available and conclusions were drawn in respect to elements which were entirely missing from the files. The purpose was to develop aspects which can be used immediately after an accident in obtaining pertinent information surrounding the accident. When these aspects obtain, the following values accrue:

1. They will operate as a check list so that each aspect is given consideration in respect to each accident. This is necessary to force investigators' attention to each detail.

2. They will be so formulated that they force an objective judgment (by objective is meant a judgment which would be the same independent of which investigator makes it).

3. They will include the possibility of registering the fact that the information is not available or that it has doubtful validity and by so doing will make the record more complete since absence of a factor now must be interpreted as either that the information was not available or that it was overlooked.

4. Possible sources of evidence will be listed and the investigator will check sources used.

5. Because the records will all have the same information, gathered in the same manner, statistical tabulation will be greatly facilitated.

6. Personal involvement will be crystalized in terms of its minutiae and not as a vague percentage assigned as an unobjective rating.

The first step towards outlining revisions in the accident record procedures in accordance with these desirable objectives was to classify the materials which have been objectified by means of the code (Appendix C) together with its detailed instructions (Appendix D). The available elements have been grouped into four classes of accuracy.

Table 1 includes elements in the code which seem to be readily available and can be used as they are found in the files. These, therefore, are elements which may be used on the record in very much the same form as they now are. Number of undetermined cases is given in the table. They are obviously negligible except perhaps for "visibility" and "ceiling" and they certainly can be easily improved through development of check-sheet procedures.

Coding instructions which were developed and which may be found in Appendix D, represent important elements contributing to objectivity and should be a basis for the development of a better form of record since they can be used much better at source than in the process of evaluation of files.

Procedure in the Accident Study

1. Development of a coding method by the experimental consideration of 200 accidents. The coding procedures chosen by double applications provided grounds to expect objectivity. The goals in the construction of these codes were first, to obtain meaningful aspects of accident which might have a bearing upon curriculum revision, and, second, to define these in such a manner that the same results would be secured from any given accident folder, no matter which of our operatives was evaluating it.

2. Double application of this coding to other sets of 100 accident folders. This double application was made in order to provide the necessary evidence for determination of objectivity. Calculation of objectivities showed, in general, satisfactory coding but left insufficient evidence on infrequent but important elements.

3. Consultation with experts in respect to the code. This step was required in order to provide the necessary revisions both in terms of usefulness of the coding items and improvement of objectivity, when necessary. It is to be noted that these revisions must be made in the light of possible interrelations and it has been found advisable to consult in respect to these revisions only when defined materials were on hand to illustrate the types of interrelation which will be available. This provided another reason for trial and error objectivity determinations.

4. Application of the code to 1163 accidents obtaining two separate codings for all items which have not been shown to be entirely objective. This is, of course, the main evaluation of materials toward which the previous steps were directed. At this stage conferences were held on all disagreements (two coders and one supervisor) so that the final results may be considered single determination. The true objectivity of the code still needs to be evaluated. Examples of forms employed in the coding procedure are presented in Appendix E.

5. Calculation of the frequencies of personal characteristics, setting of the accident, maneuvers preceding the accident, environmental complications and outcome. These have been punched and sorts have been made. All elements have been distributed. It was considered particularly desirable to state the relative frequency of the maneuvers leading to stalls and spins and these are reported in another section of this report.

6. Study of the importance of factors of the accident complex. This involves the comparison of characteristics of the pilots having accidents with a random sample. The Civil Aeronautics Administration has conducted a survey among a random sample of California pilots and these furnish the necessary comparative data.

Table 2 includes elements in the code which are sometimes available and sometimes not, and which can be greatly improved. Number undetermined is given and it is evident that the number of elements in the code, under the several categories which remain "undetermined," is too large. These undetermined cases mean literally that the file is uncommunicative in this respect.

Table 3 includes elements in the code which are now available but are of doubtful value in the form they now have and must be improved even though this involves some experimental practices. The table gives reasons for rejection.

Table 4 includes elements which are not now available in the files but which should be considered since a true analysis of accidents can never be made without them.

Interpretation of Elements in the Code. In Table 1 is presented a list of elements which now seem satisfactory. The degree of satisfaction, however, must be judged in terms of Tables 1a-13a, inclusive, in Appendix A, since the individual differences registered are indicated in these tables. (Place of accident and date of accident have not been so tabled because these distributions are obviously objective and depend upon a large number of cases for statistical meaning.)

Table 2 lists the elements which can be greatly improved. It is apparent by viewing the number of records which were undetermined in respect to each of the aspects as listed in this table why improvement in most of the elements would be merited.

For example, in the case of pilot hours in the last 90 days, there is the additional limitation that reliance is placed on the pilot's own record and there is evidence that such records are not always trustworthy. Some method of obtaining hours within the last 90 days should be devised which has more creditability.

In the case of altitude the difficulty is that in most cases the estimates are frankly guesses. It seems possible that some method can be devised for estimating the altitude in terms of the results of the accident and in terms of objectified evaluation of comment. Just how this shall be done is not clear, but certainly an improvement is essential.

In the case of both lead maneuvers and environment, the results should be interpreted with the full knowledge that at least three maneuvers and two environments are necessary in order to gain creditable results, as explained in a later section of this report.

It is recommended that all elements in Table 2 be revised in such a manner that full records will be obtained. This, of course, includes the opportunity for registering the impossibility of getting information. It cannot be too often repeated, however, that the possibility of such a registration is a different matter from leaving it to the alertness of the inves-

TABLE 1

ELEMENTS IN THE CODE WHICH NOW ARE AVAILABLE IN THE FILES

(Total files examined 1163)

		Number Undetermined
Personal		
	Place of accident	0
	Date of accident	0
	Age of pilot	5
	Registered defect	0
	Previous accident	0
	Extent of injury to pilot	0
	Extent of injury to passenger	0
Plane		
	Horse-power	15
	Age	20
	Condition of plane	0
Conditions		
	Visibility	36
	Ceiling	41
	Setting	2
	Outcome	1
	Kind of flying	7

tigators whether or not to consider a given aspect. The list of elements should operate as a check list and in every case some response should be registered, even though this only is an assurance that no evidence is available.

Table 3 presents the elements which are usually recorded but where the manner of recording is such as to throw considerable doubt upon the value of the records. Examination of this table indicates that:

1. "Total hours of the pilot" seems to be untrustworthy.

2. Class of pilot is very confusing for three reasons. Shifts back and forth between private and commercial or even student and private are frequent. "Commercial" and "limited commercial" mean different things at different times. "Solo" and "student" have changed their meaning within recent years. In general novices are inadequately described.

3. Time of day is not described in enough detail. This can be seen from the limitations of the code where only three classes were objectively possible. It may be that no greater refinement is necessary, in which case this element would revert from Table 3 to Table 1.

In Table 4 is presented a list of elements which are not available in the files but which seem to be candidates for consideration in isolating factors important in accident causation.

As a result of the analysis discussed in this section the specific elements of information necessary for an accurate description of the pertinent factors surrounding an accident situation have been outlined. The inadequacies of the present record procedures also have been presented. One element, however, has not been discussed in detail, namely, "lead maneuvers." This problem will be discussed in the following section.

ANALYSIS OF IMPORTANCE OF LEAD MANEUVERS

This section deals with one particular difficulty (in addition to those treated in the previous section) which must be overcome before it is possible to develop an objective and validated statistical routine to be employed in accident control, namely, description of what the pilot and the plane are doing just previous to the accident.

If current accident statistics, received during the past five years or so, are examined it is found that they deal mostly with evaluations of what has happened in the accident as such. They give a fairly clear picture of the trend in degree of fatality, amount of injury, damage to plane, and the like, but they do not characterize the particular ways in which the accident happens. They do not give any hint as to the frequency, either changing or static, of type of performance which precedes an accident.

TABLE 2

ELEMENTS IN THE CODE WHICH NOW ARE AVAILABLE
BUT IN VERY LIMITED FORM

(Total files examined 1163)

		Number Undetermined
Personal		
	Hours last 90 days (pilot)	202
Plane		
	Hours since overhauled	307
	Total hours	113
Conditions		
	Wind	123
	Other limiting conditions	920
	Altitude	44
Lead Maneuvers*		
	First	42
	Second	429
	Third	649
	Fourth	991
Environment		
	First	314
	Second	871
	Third	1099
	Bank angle	534

*First is nearest to accident.

Competent safety control and useful change of educational procedures can only be inaugurated if it is first known just what initiates the accident. Of course this does not mean knowing this in the sense of aerodynamic theory or the exact procedures that are involved, but rather, knowing it statistically so that quantitative evaluations may be made of provocative factors.

As previously noted, the files which were examined in this study contained a miscellany of materials, newspaper reports, letters from witnesses, reported testimony by witnesses, statements by friends and relatives of the victim, examinations by accredited agents, statement of the pilot when the accident was not fatal, and summaries made by the Civil Aeronautics Board authorities.

A description of the intent of the pilot and the attitude of the plane is rarely found. Evidence on these points, when it does appear, is often vague and sometimes conflicting. However, the files do vary in terms of their adaptability to statistical evaluation. There may be merely a statement that the pilot was flying straight and level, and then a description of the crash, with nothing intervening between those two statements anywhere in the file, and, again, there may be a very complete and accurate record of just what happened in sequence, so that, for instance, a complete story is available from the time the pilot was waving goodbye over a house which he had visited, to his climb, to the stall, and to the crash into a water tower.

The method employed to study possible solutions of this problem was that of obtaining judgments of what are referred to as "lead maneuvers." This term is intended to describe maneuvers which precede an accident. One of the first experimental problems was to determine how many such lead maneuvers should be obtained or how far before the accident there should be information. From the point of view of recording, it was desirable that a form be developed by which there would be an opportunity to register a given number of lead maneuvers and to register also where information in respect to them is not available.

In 214 cases out of 1,124 studied in this respect, the accident occurred during taxiing before take-off. For these, obviously, one lead maneuver is the complete picture. Excluding these, the following results were obtained:

Evidence on:		#	%
	One maneuver only	180	20
	Two maneuvers	218	24
	Three maneuvers	341	36
	Four maneuvers	172	20
	Total	911	100

The importance of these figures depends upon the belief that most accidents are not really described until three or more maneuvers which preceded the crash are known. This belief arises from the differences in accident

TABLE 3

ELEMENTS IN THE CODE WHICH ARE AVAILABLE BUT OF DOUBTFUL VALUE IN PRESENT FORM

(Total files examined 1163)

		Number Undetermined	Reason
Personal			
	Total hours (pilot)	40	Untrustworthy
	Class of pilot	4	Novices differently described
Conditions			
	Time of day	1	Not available except day, evening, and night

TABLE 4

ELEMENTS NOT AVAILABLE IN THE FILES

Medical history

Immediate moral history (defined as insurance companies define it)

Insurance data

Insurance policies

Fatigue, worry, anxiety, disappointment and anger

Training (school, type and time)

CPT and WTS training

War experience

Principal kind of flying

Previous violations

Annual flying time

Ownership of plane flown

Types of plane flown

It is apparent that the unidentified accidents were reduced from 56 per cent to 9 per cent where three maneuvers were used instead of two, and that the turn stalls, as a proportion of all serious accidents, increased from 9 per cent to 54 per cent. It does not seem reasonable to assume that turn stalls are easier to describe. Therefore noted presence must be due to additional clarity of description. There is very little change between the three-maneuver descriptions and the four-maneuver ones. The conclusion from these figures is that the forms must be drawn in such a manner that observers will record at least three maneuvers preceding the accident, whenever possible and explain why it is not possible when that is the case. It would be possible then to identify types, make better judgments about personnel responsibility, take preventive measures, and effect educational procedures.

COMPARISON OF SERIOUS AND FATAL ACCIDENTS IN 1939 AND 1940 WITH A RANDOM SAMPLE OF LISTED PILOTS IN CALIFORNIA

In the interests of the research division of the Civil Aeronautics Administration a survey was conducted during the spring of 1947 among 1,481 pilots located and interviewed from a list of 3,000 selected at random from the total list of California pilots.[5] Three hundred and eighty-five of the total list were eliminated for legitimate reasons, such as Armed Services, death, hospitalization, etc., and the other 1,134 could not be located. For various reasons the bias, though present, is judged to be in the direction of pilots who have terminated their flying experience. However this may be, the 1,481 do represent at present the best random sample of current certificated pilots.

Among the questionnaire materials were various aspects of experience believed to have a relation to accident proneness. In the report on the California study comparison is made between pilots having had accidents with those who have not had accidents. (In so far as the California sample is concerned these, of course, are not fatal accidents and rarely are serious accidents.) Relationships are determined in respect to the following characteristics:

Amount of flying experience
Flying for business reasons
Having a certificate higher in grade than private
Length of time since first receiving civilian pilot rating
Owning a plane
Furthest distance from home airport (civilian flying only)
Total distance from home airport in trips 100 miles or over
Having sometime made an emergency landing.

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[5]Actually the list was taken from all pilots whose names begin with the letters A to L, inclusive.

description when there are data on two, three, and four maneuvers, respectively. For the purpose of this analysis the one-maneuver description may be neglected entirely since, apart from take-off taxiing, over half of these are collisions and, obviously, when it is a collision, the one-maneuver description is often entirely adequate. The "outcome" code, usually, clears up such one-maneuver listings.

In the remainder, however, the following proportions show a marked difference in character as the descriptions become more complete. When only a two-maneuver description was available, 41 per cent were unidentified; that is, there was entire agreement in these 41 per cent among independent examiners that the file did not allow a description of what happened. The accident was not objectively defined. When three and four-maneuver descriptions were available, however, only 6 per cent and 5 per cent, respectively, were entirely unidentified. This is, of course, a great reduction, and it means that the accuracy has tremendously improved.

In the two-maneuver descriptions again, 15 per cent of the stalls were unidentified. That is, it was clear that it was a stall, and that is all that was clear. There was no description of what happened before the stall. The examiners did not know whether it was a turn stall or not. In the three-maneuver descriptions only 3 per cent were unidentified in terms of conditions immediately preceding the stall. It is true, however, that 12 per cent in the four-maneuver cases were of that type, prompting the conclusion that there is not a very marked difference in respect to identification of stalls which are unidentified as to type.

It is important to note, however, that when there is a large amount of material, unidentified for primary classification, it makes a difference in the conclusion regarding the percentage of accidents -- fatal and serious accidents -- that are turn stalls. In the two-maneuver data, 9 per cent were recorded as turn stalls and 22 per cent were recorded as other stalls; in the three-maneuver materials, 54 per cent were recorded as turn stalls, and 28 per cent as other stalls; and in the four-maneuver data, 45 per cent were recorded as turn stalls and 20 per cent as other stalls. It follows that conclusions as to the type of accidents that occur depend upon how many maneuvers are recorded.

It is admitted that no matter what is done in the way of a recording device, there still will be two-maneuver recordings that are insufficient because there still will be occasions where there is not adequate evidence, but this state of affairs should be clearly recorded. From the point of view of statistical handling it would clarify the questions if only the data where enough lead maneuvers are known are analyzed.

An examination of the data does show that in many cases evidence was available but not recorded. It was clear from the way that the evidence was presented that the information was known but not included in the findings.

TABLE 5

AGE DISTRIBUTION OF SERIOUS AND FATAL ACCIDENTS AND OF FATAL ACCIDENTS COMPARED WITH CALIFORNIA SAMPLE

	CAA Sample		
Age	Serious and Fatal Accidents (1163) %	Fatal Accidents (347) %	Total Civilian Pilots in California Study (1274) %
Under 20	11	10	3
21-25	30	27	20
26-30	21	24	34
31-39	30	31	31
40 and above	8	8	12
Unknown	*	0	*
Total	100	100	100

*Less than .5 per cent

the younger group than in the older one. In addition to the other limitations it was assumed that the age distribution of pilots in 1939 and 1940 was like the age distribution in California at the time of the sample.

The reason that no age comparison between those having accidents and those not having accidents was made in the California study was because the exposure of the younger group is so much less than the exposure of the older one that any frequency of minor accidents becomes unimportant. This makes the youth of the pilots having serious and fatal accidents more important than it would otherwise be.

Comparison, in terms of flight experience, between the sample from the CAA record files and the California sample proved difficult. This difficulty resulted from the fact that for the CAA sample records were available in terms of hours flown during the last 90 days; whereas for the California sample data were available only in terms of hours flown during the last 30 days, and in terms of an estimate of the average number of hours flown per month. (These figures were obtained through interviews with pilots.) Therefore, in comparing the California sample with the CAA record sample the "average monthly hours" for subjects in the California sample was multiplied by 3 in order that a figure comparable to the "number of hours in the last 90 days" available from the CAA record sample could be obtained. The figures for the California sample given in Table 6 are based on three times the average monthly hours.

A comparison of hours in the last 90 days of cases having serious and fatal accidents with three times the average monthly flying of those pilots

The results of the analysis of data collected in the California study cannot be covered in this report.[6] However, certain comparisons can be made between data collected from the CAA files and some of the data from the California study. It was felt that such comparison might give some conception of how pilots having such accidents are different from pilots in general. It is true that these pilots are California pilots only and that that may make them distinct in certain ways and it is true also that the unavoidable sample bias may have had some limiting effect. It is felt, however, that a comparison merits attention.[7]

Unfortunately many of the elements cited above are not available in the study of accident records because the files were inadequate. It is possible, however, to compare the group of records from the CAA files with the California sample in respect to experience, class of pilot, and age. In the case of age, a comparison is made with the total California civilian sample. This is reduced from 1,471 to 1,274 because the remainder have done military flying only, except for the period of instruction. In the case of experience and class of pilots, separate comparison is made with those in the California study who have had some accidents and those who have not. The accident cases in the California study are, of course, nearly all cases of pilots with minor and not major accident experience.

The comparison of age (Table 5) shows that the California study has significantly fewer younger pilots and significantly more older ones than do the records investigated here. Forty-one per cent of the serious and fatal accidents together and 37 per cent of the fatal accidents alone were with pilots 25 and under. Only 23 per cent of the total California sample includes pilots 25 and under. These differences are significant at the 1 per cent level of confidence and the average age differences are also significant at the 1 per cent level.[8] Materials in the report on the California study indicate that if pilots who fly often are used for comparison, and if the group who have discontinued flying is subtracted, this percentage of young pilots in the California sample goes even lower. It was concluded, therefore, that the liability to serious and fatal accidents is greater in

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[6]This California study was not conducted under the auspices of the Committee on Aviation Psychology.

[7]Comparison of the California sample and the sample from the CAA records could be considered particularly suspect in terms of "age"; since the effect of the war and the training of a great number of young men as pilots might be expected to lower the age level of the California sample, collected in 1947, as compared to the sample from the CAA records, which covered 1939 to 1941. However, for purposes of the comparisons in this report, the 207 pilots in the California sample with civilian licenses who had armed service flying only, were excluded from the distributions. It is concluded, therefore, that the age of the California sample is not significantly affected by the inclusion of veterans.

[8]Actually the probability of the groups belonging to the same universe is less than .000.#

TABLE 7

TOTAL HOURS OF CASES HAVING SERIOUS AND FATAL ACCIDENTS COMPARED WITH CALIFORNIA SAMPLE

	CAA Sample	California Sample	
	Serious and Fatal Accidents (1163)	No Accidents (989)	Minor Accidents (240)
Hours*	%	%	%
1-100	32	31	21
101-200	20	21	16
201-300	10	11	11
301-400	5	7	6
401 and over	16	28	43
No experience	17	2	3
Total	100	100	100

*For the CAA sample, "Hours" refer to number of hours during last 90 days. For the California sample, the comparable figure is based on three times the average hours flown per month.

ious and fatal accidents, and 31 per cent of the California no-accident group are accredited with between 1 and 100 hours. Only 21 per cent of the minor-accident group in California have so little experience.

As noted previously the no-experience category is not likely to occur when licensed pilots only are questioned. Nevertheless it must be taken into consideration for the other group since it adds to the toll from inexperienced fliers. The percentages having 400 or more hours to their credit are 16, 28, and 43 when the groups are arranged from the serious and fatal accidents through the normal to the minor accidents. All of these differences in distribution are, of course, significant to the 1 per cent level of confidence. Average differences have been tested also and these are significant to a 1 per cent level of confidence.[9] The conclusion can be drawn that inexperienced pilots are more likely to have serious and fatal accidents and less likely to have minor accidents. The reason they are less likely to have minor accidents is, of course, because they have not accumulated enough exposure to encounter what may be considered an inevitable result.

Comparison of the same groups in respect to class of pilot indicates a correlated finding (Table 8). Serious and fatal accident cases are much

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[9]Actually the probability of the groups belonging to the same universe is less than .000.

TABLE 6

HOURS IN LAST NINETY DAYS OF CASES HAVING SERIOUS AND FATAL ACCIDENTS COMPARED WITH A COMPARABLE MEASURE ON CALIFORNIA SAMPLE EXCLUDING ALL CASES WHO HAVE CEASED FLYING

	CAA Sample	California Sample	
	Serious and Fatal Accidents (1163)	No Accidents (735)	Minor Accidents (192)
Hours*	%	%	%
1-15	29	39	37
16-30	18	24	21
31-75	18	15	16
76 and over	18	21	22
No experience	17	1	4
Total	100	100	100

*For the CAA sample, "Hours" refer to number of hours during last 90 days. For the California sample, the comparable figure is based on three times the average hours flown per month.

in the California study who have had minor accidents and those in the California study who are free from accidents (Table 6) indicates that very slight exposure (1-15 hours) is less for the CAA group than in either of the other two California groups but that "no experience at all" is very much greater. Only 47 per cent of the group who had serious or fatal accidents show in the records that they have flown 30 hours or less in the last 90 days, whereas calculating the same figure from the average monthly experience, it was found that in the two California groups 63 and 68 per cent, respectively, fly as little as this. On the other hand, 17 per cent of the group having serious or fatal accidents (from the CAA records) have had no experience whatsoever, whereas there was a negligible number of "no experience" subjects in the two California groups, since all terminated cases were excluded. It is apparent that in combining the two classes in Table 6 (no experience and 1-15 hours) there is no significant difference in exposure. It is probable that the no-experience group, as reported on the accident records, is concealed in the face-to-face interview results.

A comparison of the total hours, however, shows significant differences at the inexperienced level and also in the number of cases having 400 hours or more of flying (Table 7). The serious and fatal accidents, as transcribed from the records, show 17 per cent no experience, whereas the other two groups show 2 per cent and 3 per cent, respectively. In this case, even when no experience is combined with the claimants of 1 to 100 hours, a significant difference remains. Thirty-two per cent of the serencountered in pleasure flying. Again the serious and fatal accident cases seem to be different from the minor accident cases and the direction of this difference is again toward the younger group, with lower grade of certificate, who are flying for pleasure only. Serious and fatal accidents seem to occur more frequently to inexperienced pilots. Minor accidents, on the other hand are reserved for pilots who amass more experience, have a higher grade of certificate, and fly in conjunction with their business interests.

FATAL ACCIDENTS AND THE STALL

This section of the report concerns 1,016 records, of which 306 resulted in a fatality.[11] These cover accidents in 1939 and most of 1940. When accidents, obviously due to structural defect, and fatal accidents in which the setting and the lead maneuvers are unknown, are deleted from the material, 257 accidents resulting in a fatality remain. Of these, 81 are cases where there was no passenger and the accident was fatal to the pilot; 94 are cases where there was a passenger and the accident was fatal to the pilot and passenger; and 82 are cases where there was a passenger and the accident was fatal to one or the other, but not to both.

These fatal accidents were divided into two classes: 168 or 65 per cent were fatal accidents involving stalls, 89 or 35 per cent were fatal accidents not involving stalls. One hundred and thirty-five of the 257 fatal accidents were cases where the maneuver immediately preceding the accident behavior was a turn. Eighty-one per cent of these accidents following turns were due to a stall. The materials were distributed as follows:[11]

	#	% making stalls	% not making stalls
Turns	135	81	19
Glides	42	35	65
Climbs	32	71	29
Slips or skids	17	35	65
Precision spins	11	100	0
All others	20	21	79
Total	257	65	35

[11]The total number in this analysis is kept at 1,016 instead of the final number of 1,163, so that results may be exactly as they were in material already published. Addition of the other 147 cases, less than one-third of which were fatal, will not change conclusions.

more likely to be private licensees and minor accident cases are less likely to be private licensees. Higher grade of license and number of hours of experience being related, this is to be expected. Sixty-two per cent of the serious and fatal accident cases held private licenses,[10] whereas only 44 per cent of the normal non-accident group in California had a private license and only 32 per cent of the cases in the sample who had a minor accident were of this grade. Similarly, none of the serious and fatal accidents are instructors, 6 per cent of the normal non-accident group and 10 per cent of those having minor accidents have instructor licenses. Again the differences quoted here are significant at the 1 per cent level of confidence.

A direct comparison of the kind of flying was not possible because of the way that the question was asked in the California survey. However, it was determined that 52 per cent of the cases reporting no accident flew for pleasure alone and 39 per cent of the cases reporting a minor accident flew for pleasure alone. This may be noted in relation to a figure (see Table 13c, Appendix A) showing that 47 per cent of the serious and fatal accidents were

TABLE 8

CLASS OF PILOT OF CASES HAVING SERIOUS AND FATAL ACCIDENTS COMPARED WITH CALIFORNIA SAMPLE

	CAA Sample	California Sample	
	Serious and Fatal Accidents (1163) %	No Accidents (989) %	Minor Accidents (240) %
Private**	62	44	32
Commercial and limited commercial	32	36	50
Airline	1	4	3
Instructor	-	6	10
Uncertificated	5	6	3
Unknown	*	4	2
Total	100	100	100

*Less than .5 per cent

**Includes student and solo

10 Includes "student," "solo" and the like.

The fatal accidents which were found by going through all the files must have explanations other than physical defect. Only 9 cases out of the 257 had records of any other defects whatsoever. Three of these were among the 110 turn-stall cases, two were among the other stall cases, and four were among the non-stall cases.

It is concluded that proper instruction could greatly reduce fatalities.

Proper instruction in this case means abandoning dependence on the conventional pattern of teaching stalled spins. After all, teaching pilots how to spin and recover may be considered not as important as finding out how to avoid a stall at a low altitude. These are quite different objectives. One manner of teaching this important preventive skill would be to use inadvertent stalls after turns at a high altitude.

It should be noted that recent revisions in the approved pilot training curriculum represent steps towards the development of more realistic instruction in stalls.

PREVIOUS ACCIDENTS OF CASES HAVING SERIOUS AND FATAL ACCIDENTS

Table 9 shows the distribution of previous accidents of the 1,163 cases studied. The mean number of previous accidents for this group is

TABLE 9

PREVIOUS ACCIDENTS OF CASES HAVING SERIOUS AND FATAL ACCIDENTS

(1939 and 1940)**

Previous Accidents	#	%
0	900	77
1	178	15
2	39	3
3	20	2
4	17	2
5	6	1
6	1	*
7	2	*
Total	1163	100

$M = .37$

$\sigma^2 = .79$

*Less than .5 per cent

**Includes a small portion of early 1941

It is quite apparent from these figures that a large majority of the fatal accidents are due to stalls -- about two-thirds -- and that more than half of these stalls are due to improper execution of turns at a low altitude. The 135 turns identified as such were distributed in the following manner:

	#	% making stalls	% not making stalls
Level turns	74	73	27
Climbing turns	32	97	3
Gliding turns	30	82	18
Total turns	135	81	19

In examining these stalls in relation to other conditions it was noted that: forty-four per cent of the fatalities which followed stalls due to improperly executed turns happened to pilots who had less than 100 hours in the air. Another one-third happened to pilots who had less than 400 hours in the air. In contrast to this the fatal accidents which did not follow stalls happened to pilots, 48 per cent of whom had more than 400 hours in the air. In further contrast, in a normal group of pilots taken at random in California, only 31 per cent had less than 100 hours in the air.

Sixty-seven per cent of the pilots in fatal accidents due to a stall following an improperly executed turn, were inexperienced -- students, private license, solo, and a small number uncertificated. Sixty-four per cent of pilots having fatal accidents due to other stalls, not those following an improperly executed turn, were in these classifications of license. In contrast to this only 49 per cent of the pilots in other fatal accidents were so classified and only 42 per cent of the California sample are of this grade of certification.

Eighty-three per cent of the fatal accidents due to stalls following an improperly executed turn were initiated at an altitude lower than 500 feet. In contrast with this only 57 per cent of fatal accidents involving a stall but not after turn, happened at an altitude of under 500 feet, and 67 per cent of the accidents not involving a stall happened at an altitude under 500 feet.

Of the 110 pilots in fatal accidents following a stall due to an improperly executed turn, only 13 had any registered visual defect. Of the 58 pilots in fatal accidents involving a stall but not following a turn, 11 had a registered visual defect. Of the 89 accidents not involving a stall 10 were registered as having a visual defect. These small proportions are a very poignant reminder that one cannot look here for explanations of accidents.

.37 and the variance is .79. Since the square of the standard deviation is equal to the average in Poisson distributions, when the events are distributed among the individuals purely by chance it may be concluded that the individuals at risk have varying degrees of accident proneness.

This conclusion is not surprising since it duplicates accident statistics in other fields. It is important, however, to know that many of the serious and fatal accidents, namely, 85 out of 1,163 had two or more previous accidents, and that this is more than chance will allow even for a chance distribution of the accidents among this selected group.

APPENDIX A

DISTRIBUTION OF THE SERIOUS AND FATAL ACCIDENTS FOR ELEMENTS OF THE CODE

Tables 1a to 13a, inclusive, show distribution of cases for coded and punched items. Hollerith cards are available which are basic to these distributions and any cross-relations desired may be run. These Hollerith cards are on file in the Civil Aeronautics Administration's statistics division.

TABLE 1a

AGE DISTRIBUTION OF SERIOUS AND FATAL ACCIDENTS AND OF FATAL ACCIDENTS
(1939 and 1940)**

Age	Serious and Fatal Accidents #	Serious and Fatal Accidents %	Fatal Accidents #	Fatal Accidents %
Under 20	127	11	34	10
21-25	344	30	95	27
26-30	247	21	83	24
31-39	349	30	108	31
40 and above	91	8	27	8
Unknown	5	*	0	0
Total	1163	100	347	100

TABLE 2a

VISUAL DEFECTS OF CASES HAVING SERIOUS AND FATAL ACCIDENTS
(1939 and 1940)**

Visual Defect	#	%
None	1040	90
Acuity	28	2
Acuity corrected	57	5
Acuity partly corrected	10	1
Depth perception	5	*
Muscle imbalance	8	1
Color	5	*
Multiple defect	10	1
Total	1163	100

*Less than .5 per cent

**Includes a small portion of early 1941

TABLE 3a

DEFECTS OTHER THAN VISUAL OF CASES HAVING SERIOUS AND FATAL ACCIDENTS
(1939 and 1940)**

	#	%
No defect	1142	90
Hearing	3	*
Structural	9	1
Hernia	3	*
General system	3	*
Cardiovascular	2	*
Syphillis	1	*
Psychiatric	0	0
Epilepsy	0	0
Total	1163	100

*Less than .5 per cent

**Includes a small portion of early 1941

TABLE 4a

EXTENT OF INJURY TO PILOT

Code	#	%
Fatal	288	25
Severe	145	12
Minor	81	7
Uninjured	649	56
Total	1163	100

TABLE 5a

EXTENT OF INJURY TO PASSENGER

Code	#	%
Fatal	192	17
Severe	87	7
Minor	57	5
Uninjured	282	24
No passenger	545	47
Total	1163	100

TABLE 6a

HORSEPOWER (Plane)

Code	#	%
Up to 50	432	37
51-100	403	35
101-219	136	12
220-500	154	13
Over 500	10	1
Multi-motor	13	1
Unknown	15	1
Total	1163	100

TABLE 7a

AGE OF PLANE

Code in Years	#	%
Less than 1	498	43
1	129	11
2	103	9
3	63	6
4	36	3
5	26	2
6	13	1
7	28	2
8	49	4
9	198	17
Not known	20	2
Total	1163	100

TABLE 8a

CONDITION OF PLANE

Code	#	%
Good	478	41
Poor	122	11
Not known	563	48
Total	1163	100

TABLE 9a

VISIBILITY

Code	#	%
Non-limiting condition - more than 3 miles, good, excellent, clear, absolute, contact, unlimited, not involved	1024	88
Doubtful - 3 miles to more than 2	10	1
3 miles to more than 1	10	1
1 mile	1	*
Fair visibility	3	*
Haze, dusk, smoke, light rain	14	1
Limiting - less than 1 mile, bad, zero, solid, overcast, fog and cloud, storm, snow, sleet, heavy rain	65	6
Not mentioned	36	3
Total	1163	100

TABLE 10a

CEILING

Code	#	%
Non-limiting condition - 3000 or more, good, excellent, unlimited, absolute, clear, contact	988	85
Doubtful - 2000 to less than 3000	21	2
1000 to less than 2000	26	2
Fair	3	*
Cloudy	2	*
Overcast	13	1
Limiting - less than 1000, bad, zero, solid, overcast, fog and cloud, storm, snow, sleet	69	6
Not mentioned	41	4
Total	1163	100

*Less than .5 per cent

[illegible]

Code	#	%
Take-off (norm. est. airport)	70	6
Take-off (norm. priv. airport)	23	2
Take-off (norm. unimp. field)	47	4
Take-off (forced)	8	1
Landing (norm. est. airport)	210	18
Landing (norm. priv. airport)	67	6
Landing (norm. unimp. field)	51	4
Landing (forced est. airport)	30	2
Landing (forced priv. airport)	6	1
Landing (forced unimp. field)	200	17
In flight	333	29
Ground	114	10
Parachute (practice)	2	*
Unknown	2	*
Total	1163	100

TABLE 12a

OUTCOME

Code	#	%
Crash	455	39
Collision	300	26
Nose-up, etc. on ground, ground-loop, nose-over	196	17
Crash landing	127	11
Safe landing	47	4
Severe injury or death to bystander	13	1
Took to parachute	13	1
Parachute and safety belt fatality	11	1
Unknown	1	*
Total	1163	100

*Less than .5 per cent

TABLE 13a

KINDS OF FLYING IN SERIOUS AND FATAL ACCIDENTS
(1939 and 1940)*

Kind of Flying	#	%
Airline	7	1
Instructional	400	34
Experimental	31	3
Industrial	174	15
Pleasure	551	47
Total	1163	100

Kind of Industrial Flying		
Sight-seeing	54	31
In connection with business	26	15
Crop dusting	14	8
Cross country taxi	14	8
Demonstration	9	5
Ferrying	9	5
Dept. of Commerce Test Flight	9	5
Exhibition	7	4
Racing and endurance	5	3
Aerial advertising	5	3
Photography and mapping	4	2
Other	18	11
Total Industrial	174	100

*Includes a small portion of early 1941

APPENDIX B

NON-AIR-CARRIER AIRCRAFT ACCIDENT REPORT

and

NON-AIR-CARRIER ACCIDENT ANALYSIS SHEET

CIVIL AERONAUTICS BOARD
SAFETY BUREAU
WASHINGTON 25, D. C.

NON-AIR-CARRIER AIRCRAFT ACCIDENT REPORT

(To Be Submitted in Duplicate)

This form (453) to be used in reporting all civil aircraft accidents in NON-AIR-CARRIER operations. AIR-CARRIER acci- should be reported on a different form (454) which covers scheduled, nonscheduled, and intrastate airlines whether carrying ssengers or cargo.

The Civil Air Regulations require that all aircraft accidents be reported on the form provided. Fill out immediately and deliver mail to the nearest Civil Aeronautics Board investigator or the nearest Civil Aeronautics Administration inspector. Items I through II will be completed by the pilot if able. There should be no delay in forwarding this form even though the pilot is incapacitated. such case item XII should be made as a supplement to this form and forwarded at earliest possible date. Fill out only pertinent rts in any item. Ignore item XI if malfunctioning or failure in aircraft, power plant, accessories, etc., did not occur prior to impact th ground or other objects.

. LOCATION AND TIME OF ACCIDENT:
1. City or place ______ State ______ Date ______ Hour ______
2. If on airport, name same ______
3. If off airport, state approximate distance and direction to nearest airport ______ miles ______
North ☐ South ☐ East ☐ West ☐

I. PILOT, INSTRUCTOR, OR SOLO STUDENT:
1. Full name ______ Address ______
2. Age ______ Male ☐ Female ☐ Injuries ______
3. CAA certificate, kind and number ______
4. Ratings ______
5. Total flying time ______ Night flying time ______ Time in type involved ______
6. Instrument time ______ Approved school graduate. Yes ☐ No ☐
7. If yes, give name and location of school ______
8. Was pilot flight-checked for certificate by designated flight examiner? Yes ☐ No ☐
9. If yes, give examiner's name ______
10. Name and certificate number of last flight instructor in past 6 months ______

. CREW OTHER THAN PILOT (copilot, dual student, other—denote which):
1. Full names, addresses, CAA certificate numbers, ratings, injuries ______

. PASSENGERS (denote whether revenue or nonrevenue):
1. Names, addresses, injuries ______

. INJURY TO GROUND CREW, SPECTATORS, ETC.:
1. Names, addresses, injuries ______

AIRCRAFT:
1. Trade name ______ Model ______ Identification No. ______
2. Age of aircraft ______ Mfr's serial No. ______ Total flying time ______
3. Present owner (name and address) ______
4. Purchased from (name and address) ______
5. Engine make ______ Model ______ Horsepower ______
6. Aircraft damage ______
7. Does owner intend to rebuild aircraft? Yes ☐ No ☐

16—0021-8

II. **Property Damage** (structures, power lines, crops, livestock, etc.):

1. Describe damage in detail (dollar estimate not necessary) ....

II. **Type of Flying Engaged in at Time of Accident** (check each item applicable):

Day ☐	Student dual	☐	Commercial	☐	Other special program (describe)	
Night ☐	Student solo	☐	Noncommercial	☐	....	
Local ☐	Advanced training	☐	GI program	☐	....	
X-C ☐	Pilot check	☐	....			

Describe purpose of flight ....

Were pilot and passengers equipped with parachutes? ....

X. **Weather Conditions** (check items applicable):

		HEAVY	LIGHT
Clear			
Rain			
Sleet			
Snow			
Hail			
Fog			

Ceiling (feet) .... Dew point ....

Visibility (miles) .... Temperature ....

Wind velocity and direction ....

Were icing conditions encountered? ....

X. **Collision Accidents** (if accident involved collision with other aircraft complete following information pertaining to other aircraft):

1. CAA number .... Make .... Model ....
2. Damage ....
3. Pilot's name and address ....
4. Owner's name and address ....
5. Attach sketch showing flight paths and point of collision ....

I. **Mechanical Failure Report:**

To be completed *ONLY* if accident involves malfunctioning or failure in the aircraft structure, power plant, accessories, instruments, etc. Complete item (*a*) in all such cases. Complete item (*b*), (*c*), or (*d*) only if such item is directly involved.

1.

Item	Make and Model	Serial and Part No.	Hours Since Overhaul	Total Time (Hours)
(*a*) Aircraft				
(*b*) Engine				
(*c*) Propeller				
(*d*) Accessories				

2. Describe specific parts involved in sufficient detail to identify positively (make sketch of failed parts and supply photographs, if practicable):
3. Are failed parts held for examination? Yes ☐ No ☐
4. If yes, where may they be examined? ....
5. Do you have any suggestions for the prevention of a recurrence of this or similar failures? ....

II. Pilot's Description of Accident. (Give detailed account including flight or maneuvers immediately preceding the accident, nature of difficulty, speed, altitude, etc. Draw diagram if necessary for clarity.):

e of this statement: Signature of pilot ______

______ Type or print name ______

alling address for next 30 days ______

III. Owner's or Operator's Statement. (If you do not agree with the pilot's statements, please set forth your version of the accident. Also supply any additional information which may assist in the analysis of this accident and the prevention of similar ones.):

of this statement: Signature of owner or operator ______

______ Type or print name ______

address for next 30 days ______

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Crash—Injury Details:

To be completed *WHEN APPLICABLE* by CAB investigator or CAA inspector.

1.

Names	Seating Position at Time of Accident	Injury (see key below)				Part or Structure Causing Injury
		Location	Type	Degree	Treatment	

2. KEY—Location: hd=head, tr=trunk, a=arm, lg=leg. Type: sp=sprain, fr=fracture, bn=burn, lac=laceration. Degree: ml=mild, sv=severe, ft=fatal. Treatment: O=none, 1st=first aid, hos=hospital.

3. If autopsy performed, state in what town.

4. If mental or physical condition of pilot appeared to be a factor in the accident, describe:

XV. Investigator's or Inspector's Statement (additional information, comments, and recommendations. If violation involved, describe and give CAR number.):

Date report forwarded: ______

Signature ______

Title ______

APPENDIX C

CODING FOR ACCIDENT CARDS

<u>Original Codes</u> are the codes on the work sheets and in the files.

<u>Revised Codes</u> are the codes punched on the cards.

CODING FOR ACCIDENT FATALITIES CARDS AND SERIOUS INJURY CARDS

Case Number

State Code

Region

Date of Accident

	Original Codes	Revised Codes	
Time of Day	0	1	Night
	1	2	Up to 4 P.M.
	2	3	4 P.M. to night
Age of Pilot	Numerical		
Class of Pilot	0	1	CPT
	1	2	Student
	2	3	Private
	3	4	Solo
	4	5	Amateur
	5	6	Commercial
	6	7	Lim. Commercial
	7	8	Industrial
	8	9	Airline
	9	10	Glider
	X	11	Uncertificated
	Y	Alpha X	Unknown or not inv.
Total Hours Pilot	1	1	1-50
	2	2	51-100
	3	3	101-150
	4	4	151-200
	5	5	201-250
	6	6	251-300
	7	7	301-350
	8	8	351-400
	9	9	401-1000
	0	10	1001 or more
	X	Alpha X	No experience
Hours Last 90 Days	1	1	1-15
	2	2	16-30
	3	3	31-45
	4	4	46-60
	5	5	61-75
	6	6	76-90
	7	7	91-105
	8	8	106 or more
	X	Alpha X	No experience

	Original Codes	Revised Codes	
Visual Defect	0	Alpha X	No visual defect
	1	1	Visual acuity
	2	2	Visual acuity corrected
	3	3	Visual acuity partially corrected
	4	4	Depth perception
	5	5	Eye muscle balance
	6	6	Color vision
		7	Double codes 3 and 4
		8	" " 2 and 4
		9	" " 3, 4, and 5
		1	" " 1 and 6 (1 case)
		4	" " 2, 4, and 6 (1 case)
Other Defect	0	Alpha X	No defect
	1	1	Hearing
	2	2	Structural
	3	3	Hernia
	4	4	General System
	5	5	Cardiovascular
	6	6	Syphilis
	7	7	Psychiatric
	8	8	Epileptic
Previous Accidents	0	Alpha X	None or not known
	1	1	1 accident
	2	2	2 accidents
	3	3	3 accidents
	4	4	4 accidents, etc. through 9
Extent Injury to Pilot	1	1	Fatal
	2	2	Severe
	3	3	Minor
	4	4	Uninjured
Injury to Passenger	0	Alpha X	No passenger
	1	1	Fatal
	2	2	Severe
	3	3	Minor
	4	4	Uninjured
Horse-Power (Plane)	Y	Alpha X	Unknown
	0	9	Glider
	1	1	Up to 50
	2	2	51-100
	3	3	101-219
	4	4	220-500
	5	5	Over 500
	6	6	Multi-Motor

	Original Codes	Revised Codes	
Age of Plane (Years)		Alpha X	Not known
	1	1	Less than 1 year
			One year, etc.
Total Hours (Plane)	Y	X	Unknown
	0	1	0-100
	1	2	101-500
	2	3	501-1000
	3	4	1001 or more
Hours Since Overhaul	Y	X	Unknown
	0	1	0-50
	1	2	51-150
	2	3	151-500
	3	4	501-or more
Condition of Plane		G	Good
		P	Poor
		X	Not known
Visibility	Y	Alpha X	Not mentioned
	0	1	Non-limiting condition -- more than 3 miles, good, excellent, clear, absolute, contact, unlimited, not involved.
	1	2	Doubtful -- 3 miles to more than 2
	2	3	2 miles to more than 1
	3	4	1 mile
	4	5	Fair visibility
	5	6	Haze
	6	7	Dusk
	7	8	Smoke
	8	9	Light rain
	Y1	10	Limiting -- less than 1 mile, bad, zero, solid, overcast, fog and cloud, storm, snow, sleet, heavy rain
Ceiling	Y	Alpha X	Not mentioned
	0	1	Non-limiting condition -- 3000 or more, good, excellent, unlimited, absolute, clear, contact.
	1	2	Doubtful -- 2000 to less than 3000
	2	3	1000 to less than 2000
	3	4	Fair
	4	5	Cloudy
	5	6	Overcast
	Y1	7	Limiting -- less than 1000, bad, zero, solid, overcast, fog and cloud, storm, snow, sleet

	Original Codes	Revised Codes	
Wind	Y	Alpha X	Not mentioned
	0	1	Non-limiting condition -- less than 15 mph., light, calm, moderate
	1	2	Doubtful -- 15-24 mph.
	2	3	Strong
	3	4	Variable
	Y1	5	Limiting -- 25 mph. or more, gale, storm, bad, violent
Other Limiting Conditions	Y	Alpha X	Not mentioned
	1	1	Bumpy, gusty, cross-winds, down or up-drafts, variable
	2	2	Fog, cloud
	3	3	Rain
	4	4	Snow
		5	Double codes 1 and 3
		6	" " 2 and 3
		7	" " 2 and 4
		8	" " 1 and 4
		9	Triple codes 1, 2, and 3
		1	Double codes 1 and 2 (2 cases)
Altitude	0	1	0
	1	2	1-100
	2	3	101-500
	3	4	Over 500, not specified
	4	5	501-1000
	5	6	1001-2000
	6	7	2001 or more
	Y	Alpha X	Unknown
A. Setting	0	1	Take-off (norm. est. airport)
	1	2	Take-off (norm. priv. airport)
	2	3	Take-off (norm. unimp. field)
	3	4	Take-off (forced)
	4	5	Landing (norm. est. airport)
	5	6	Landing (norm. priv. airport)
	6	7	Landing (norm. unimp. field)
	7	8	Landing (forced est. airport)
	8	9	Landing (forced priv. airport)
	9	10	Landing (forced unimp. field)
	X1	11	In flight
	X2	12	Ground
	X3	13	Glider
	X4	14	Parachute (practice)
	Y	Alpha X	Unknown

	Original Codes	Revised Codes	
B. Preceding Maneuvers			
First Maneuvers	0	Alpha X	None recorded
	1	1	Taxiing
	2	2	Undershot
	3	3	Overshot
	4	4	Straight and level
	5	5	Climb
	6	6	Glide
	7	7	Level turn
	8	8	Climbing turn
	9	9	Gliding turn
	X2	10	Wingover
	X3	11	Gl. spiral (descent)
	X4	12	Power-on spiral (descent)
	X5	13	Power dive
	X6	14	Stall
	X7	15	Spin
	X8	16	Slip or skid
	X9	17	Recov. from dive
	X0	18	Climb after dive
	Y1	19	Other descent
	Y2	20	Loops, rolls, etc.
		21	Inverted stall
Second Maneuver	Same as first maneuver		
Third Maneuver	Same as first maneuver		
Fourth Maneuver	Same as first maneuver		
C. First Environment	0	Alpha X	None
	1	1	Visibility or ceiling
	2	2	Wind
	3	3	Ice
	4	4	Light-blind
	5	5	Instrument conditions
	6	6	Instrument flying
	7	7	Ground factors
	8	8	Traffic conditions
	9	9	Obstruction
	X1	10	Mountains
	X2	11	Contact with ground, water, ice (in flight)
	X3	12	Contact with aircraft
	X4	13	Fuel exhaustion
	X5	14	Engine failure
	X6	15	Structural
	X7	16	Excess load
	X8	17	Airsick

	Original Codes	Revised Codes	
First Environment (Cont.)	X9	18	Unconscious
	X0	19	Parachute failed to open
	Y1	20	Fire
	Y2	21	Passenger
Second Environment	Same as first environment		
Third Environment	Same as first environment		
D. Outcome	1	1	Collision
	2	2	Crash
	3	3	Crash landing
	4	4	Took to parachute
	5	5	Nose-up, etc. on ground, ground-loop, nose-over
	6	6	Parachute and safety belt fatality
	7	7	Safe landing
	8	8	Death to bystander
		9	Severe injury to bystander
E. Bank Angle	0	1	No turn
	1	2	Shallow power on
	2	3	Shallow power off
	3	4	Medium power on
	4	5	Medium power off
	5	6	Steep power on
	6	7	Steep power off
	7	8	Not spec. power on
	8	9	Not spec. power off
	Y	Alpha X	Unknown or not mentioned
Kind of Flying:	3A	3A	Airline Flight (est. airways) - Mail
	3B	3B	Airline Flight (est. airways) - Passenger
	3C	3C	Airline Flight (est. airways) - Express
	3D	3D	Airline Flight (est. airways) - Instrument Flying
	3E	3E	Airline Flight (est. airways) - Familiarization with Run
Instructional - Student dual	4A	4A	Instructional - Student dual, airport
Instructional - Student solo	4B	4B	Instructional - Student solo, airport
Instructional - Airport	4C	4C	Instructional - Student dual, X-country
Instructional - X-country	4D	4D	Instructional - Student solo, X-country

Original Codes	Revised Codes	
5A	5A	Experimental - Test flights
5B	5B	Experimental - Other
6A	6A	Commercial or Industrial (for hire) - Aerial advertising
6B	6B	Commercial or Industrial (for hire) - Crop dusting
6C	6C	Commercial or Industrial (for hire) - Cross-country taxi flying for hire (not scheduled)
6D	6D	Commercial or Industrial (for hire) - Exhibition
6E	6E	Commercial or Industrial (for hire) - Photography, mapping or surveying
6F	6F	Commercial or Industrial (for hire) - Flying in connection with a business (not scheduled)
6G	6G	Commercial or Industrial (for hire) - Competitive flying (racing, distance, endurance, etc.)
6H	6H	Commercial or Industrial (for hire) - Sight-seeing, airport flying
6I	6I	Commercial or Industrial (for hire) - Demonstration
6J	6J	Commercial or Industrial (for hire) - Ferrying
6K	6K	Commercial or Industrial (for hire) - Dept. of Commerce test flight
6L	6L	Commercial or Industrial (for hire) - Other
7A	7A	Non-commercial or Pleasure (not for hire) - Airport flying
7B	7B	Non-commercial or Pleasure (not for hire) - Cross-country flight

APPENDIX D

CODING INSTRUCTIONS

These are the final instructions incorporating all advantages gained by final use.

CODING INSTRUCTIONS

General

1. For all factual data (date, time, hours, age, etc.) use Aircraft Accident Report (AAR) which has been corrected in red, wherever available. Where there is no entry use any information obtainable from competent sources in supplementary material.

2. Use investigator's report as precedence to AAR, except where latter is checked in red.

3. Where information is "estimated" or "about" take figure given.

4. Where there is no entry or no credible information available in supporting evidence, always code Y (unknown) never 0.

Specific

1. Time of Day: Night or day is determined by entry on AAR under XVI (kind of flying 1 or 2).

2. Location of Accident: Give as nearest urban center or town, not nearest airport.

3. Class of Pilot: Student permit is class "student" (1) when checked in red on AAR. Otherwise, code Y, unless investigator states pilot was a student pilot. If pilot has held certificate, but is now uncertificated code as, e.g., "X (formerly stud.)"

4. Visual Defect: a. Give worst eye.
   b. Partial correction is worst eye corrected to less than 20/20.

5. Injuries: Serious is differentiated from minor by definition that serious is hospitalization of more than 3 days.
   Broken arm or leg alone is "minor."
   Uninjured includes all cases (not "serious" or "fatal") without broken bones, unstitched cuts, etc.

6. Flying time since overhaul: If no major overhaul or rebuild, or listed as "new," repeat total flying hours of plane.
   Do not use engine time.
   If no entry and date of rebuilding is also blank code Y.

7. Condition of plane: Investigator's report is final.
   Code G - excellent, o.k.-good, satisfactory, P-fair, poor.

8. Altitude: This is altitude from terrain not from sea-level.
   Use as source Air Safety Board Report.
   Use altitude of plane at first maneuver to be recorded under events.
   Where there are equally credible sources giving conflicting altitude estimates, average the two.
   For a collision with a mountain, the altitude is zero.

9. Kind of flying: Only one type of the 5 possible under XVI, AAR (3, 4, 5, 6, or 7) may be taken. Where there are entries under more than one, the kind of flying should be classified according to information supplied elsewhere, e.g., Air Safety Board Report. This is especially true of 4c "Instructional Airport" and 7a. "Non-commercial Airport," in most cases the former will be adequate, if a student is in the plane. The AAR has several different forms employing different coding. Standardize according to the usual form (printed) by using correct form from another folder.

A "practice" flight is instructional if pilot is student, solo or private. This is usually a choice between 4a or 7a. This is coded "4c."

Under H "Instructional," four entries are possible, e.g., 4a Oc "Instructional Dual Other (school) Airport." Elsewhere only two may be used, e.g., 7b. "Noncommercial Cross-Country." If more than one sub-entry in 3, 5, 6, or 7, select most appropriate.

10. Weather: Doubtful categories should be used only if conditions do not warrant coding as "Y1," i.e., Y1 takes precedence over 1-8 and actual figures (such as 2 miles visibility) take precedence over "haze," "light rain," etc., if such figures are reliable and known to be true at scene of accident.

Code "Y" where no information is available. This applies principally to wind velocity, where wind must be specifically mentioned. Do not code gusty, etc., wind "Y1," which refers only to velocity, but as "1" under "Other Limiting Conditions."

Accident Events

Code only those accidents when pilot is in the plane. Do not code glider accidents.

a. Setting: 1. Take-off begins when plane is in take-off position, and ends when an altitude of 300 ft. has been reached after leaving the ground.

2. A landing begins when the plane is circling to approach or is making an approach at not over 1000' altitude. A landing is completed when the plane is on the ground and comes to a stop, or changes from deceleration to acceleration.

3. Forced landing is a landing outside the plan of flight (which may be changed in flight).

4. Forced take-off is a take-off after a forced landing on an unimproved field or private airport.

5. Glider, fire in hangar, and other accidents with no pilot in the plane, are to be recorded with written-in notation, and no coding.

b. <u>Maneuvers</u>: 1. Maneuvers to be coded are those in general given in Air Safety Board Report and this is final authority if it contradicts any witness. Additional information from credible and consistent accounts of eye-witnesses (particularly air-field employees) should be coded.

2. In cases of structural failure, collision or unconsciousness, (unless there is recovery of consciousness prior to landing) list events leading up to failure, etc. only. Write-in any other data, such as whether pilot could have (or did) compensate for lack of control.

3. "None" applies only to plane not in motion.

4. A turn that is part of a spin is coded spin.

5. "Undershot" or "overshot" apply only to landing.

6. A "stall" is a situation (other than collision) where the plane has insufficient forward speed, or loses forward speed, such that a climb, turn, or forward motion cannot be continued.

7. Wherever "stall" is recorded for non-precision spin, the preceding maneuver <u>must</u> be recorded.

7a. "Spin" is regarded as precision only where it is known that the pilot was practicing spins.

8. If there is "spin," there is always "stall."

9. Always include a "spin" if it occurs in the sequence of events.

10. "Slip" or "skid" is always included if subsequent to any maneuver recorded, or if it is possibly a causal influence.

11. Distinguish between "slip" used by naive witness to describe descent or fall of plane (not coded "slip") and "slip" as a fairly technical term to describe loss of altitude in turn, or in glide, where it is beyond normal. "Skid" is included under "slip" coding.

12. "Power dive" is a deliberate dive or with controls in a position of deliberate dive (i.e., pilot being unconscious).

13. "Recovery from dive" refers to dive completed but plane still at approximate low point of dive.

14. "Climb after dive" is when plane is clearly ascending after termination of dive.

15. "Other descent" refers to any case other than "spin," "power dive," "glide," "spiral" (descent) where plane falls or drops to ground. Thus the use of "dive" in accident report usually comes in this category (see item 12) except for landing stall at very low altitude where outcome is crash landing. Code enough maneuvers to get plane to ground, except as noted in item 2.

16. Bank Angle

1. (a) Shallow - up to 30°
   (b) Medium - up to 45°
   (c) Steep - over 45°

2. (a) "Power on" means developing power
   (b) "Power off" means not developing power, including "engine throttled down."
   (c) Doubtful cases go in former
      Shallow up to 30°
      Medium - 30-45°
      Steep - over 45°

c. Environment: 1. Describe no environmental factors subsequent to final maneuver coded, or described by final outcome code.

2. "Instrument flying" is use of instruments (in bad weather). "Instrument conditions" is a statement of instruments needed with no instruments used.

3. "Engine failure" due to obvious structural defects is included under "structural" code.

4. "Obstruction" includes all obstacles other than mountain.

5. "Mountain" refers to running into mountain.

6. "Excess load" refers to pounds carried.

7. For "asleep" code as "X9 (slee)."

Implications: Include suggested causes not demonstrated.

APPENDIX E

ILLUSTRATIVE EXAMPLES OF THE FORMS EMPLOYED IN CODING PROCEDURE

[illegible] Date 3-7-40 Time 0 Location **Newark, New Jersey**

Pilot		Plane	
Name	Matthew A. Seckinger	H.P.	3
Age	31	Age	9
Class	5	Hrs.	2
Hrs. T. 5	Last 90 days Y	Since overhaul	Y
Vis. Defect 2	Defect 0	Condition	G
Prev. Acc.	[illegible]		
Injury	2 - 3		

Weather

Vis. 0 Ceil. 0 Wind 0 Lim. Cond. Y

Accident

Altitude 4 Kind of Fly. 6c Events a 9

b 6, 9

c X2, 1, 5, 7

d 2

e 8

Indications

Inexperience of the pilot in type of airplane involved
Airplane not equipped for night flying
Inexperienced pilot, during a night flight, tried to land at a strange airport, no landing lights, no radio, no flood lights and no flares

Probable Cause

Failure of the pilot to maintain sufficient altitude while maneuvering for a landing.

#2594 Date [illegible] Time [illegible] Location Lake Henshaw, Cal.

Pilot				Plane	
Name	Newton W. Collins			H.P.	4
Age	33			Age	0
Class	5			Hrs.	0
Hrs. T.	0	Last 90 days	8	Since overhaul	1
Vis. Defect	Y	Defect	Y	Condition	Y
Prev. Acc.	1				
Injury	4 - 0				

Weather

Vis. Y 1 Ceil. Y 1 Wind 0 Lim. Cond. 2

Accident

Altitude 5 Kind of Fly. 6f

Events
- a 9
- b 6
- c 1, X4, 5, 6, X2
- d 3
- e 0

Implications

Pilot had no excuse for the lack of judgment displayed in not returning to an area of known favorable weather along a lighted airway upon encountering fog condition at his destination, particularly with an unoperative radio receiver. Ignorance of the terrain and fog conditions in So. Cal. is the only plausible excuse. Pilot does not hold an instrument rating.

Probable Cause

Action of the pilot in continuing flight above an overcast, in approaching darkness and with defective radio equipment.

#4159 Date 9-30-40 Time 0 Location Wilman, Calif.

Pilot

Name William J. Stahly

Age 40

Class 2

Hrs. T. 9 Last 90 days Y

Vis. Defect 0 Defect 0

Prev. Acc. 0

Injury 1 - 1

Plane

H.P. 2

Age 10

Hrs. 2

Since overhaul 1

Condition G

Weather

Vis. Y 1 Ceil. Y 1 Wind 0 Lim. Cond. 2

Accident

Altitude 2 Kind of Fly. 7b Events a X 1

b 4 - Y 1

c 5, X5 (part.) 1, Y 1

d 2

e 0

Implications

Passenger was fatally injured upon impact with the ground when she resorted to her parachute at an altitude insufficient to permit the parachute to fully open. The aircraft carried no radio equipment and was not equipped for instrument flight. Pilot and passenger wore regulation Irvin seat-pack parachutes.

Probable Cause

Malfunctioning of engine followed by fire of undetermined cause.