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PRELIMINARY ANALYSIS OF ACCIDENTS IN SCHEDULED AIR COMMERCE

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The views expressed in this report are those of the authors and not necessarily of the Bureau of Air Commerce or the Department of Commerce.

TABLE OF CONTENTS

	Page
SUMMARY	1
INTRODUCTION	2
PERTINENT DATA	3
Flight Crews	4
Dispatchers	6
Maintenance Crews	6
Aircraft	6
Weather	7
Air Navigation Facilities	7
Terrain	7
Night Flying	8
Collision	8
DISCUSSION	8
Flight Crews	8
Dispatchers	18
Maintenance Crews	20
Aircraft	20
Weather	24
Air Navigation Facilities	25
Terrain	26
Night Flying	26
Collision	27
CONCLUSIONS	28
TABLES	35 - 63

PRELIMINARY ANALYSIS
OF
ACCIDENTS IN SCHEDULED AIR COMMERCE

SUMMARY

An analysis of accidents which have occurred in scheduled air commerce between January 1, 1934 and February 28, 1938 indicates that a majority of them have occurred by reason of causes other than failures in the mechanical factors involved in aviation. It has been the authors' purpose to develop, where possible, not only the direct but the underlying causes of these accidents to the end that proper remedial measures may be adopted.

Tabulated and analyzed herein are the following factors involved in the accidents: personnel, aircraft (including accessories), weather, air navigation facilities, terrain (including airports), night flying, and collision. Pertinent data are presented with reference to these factors followed by discussion, opinions and, in some instances, the recommendations of the authors.

It is concluded that aviation materiel and the attending complexities of its operation have progressed so rapidly within the past few years that personnel, particularly flight crews, have found it exceedingly difficult and on occasions have been unable to adjust themselves to such complexities. This has been aggravated by the many added duties imposed upon flight crews and the more difficult kinds of flying attempted which have contributed to their physical fatigue or emotional stress.

Numerous tables are appended in support of the data, discussion and conclusions.

INTRODUCTION

The period chosen for this analysis begins January 1, 1934 and ends February 28, 1938. This is regarded as a critical period in aviation history in view of the cancellations of air mail contracts which occurred early in 1934, immediately followed by reorganization of all the domestic air lines. Also, during this period, important and startling changes in the design, size, and performance of aircraft were initiated.

During these 50 months there occurred 112 accidents in scheduled airline operations (not including accidents involving ferry trips or test flights) within the continental limits of the United States which, in the opinion of the authors, were of sufficient importance to be used as the basis of this analysis. Many minor accidents involving no injuries and insignificant damage to the aircraft have been omitted from this analysis.

These 112 accidents may be classified as follows:

(a)	Accidents involving fatalities	28
(b)	Accidents involving injuries only	24
(c)	Accidents involving no fatalities or injuries	60
	Total	112

Another breakdown of the same total which is considered important is as follows:

(d)	Accidents involving fatalities	28
(e)	Accidents involving no fatalities but which were potentially serious	34
(f)	Minor accidents, some of which involved personal injuries; all of which involved various degrees of damage to aircraft	50
	Total	112

Fatalities resulting from group (e) above were distributed as follows:

(g)	Passengers	122*
(h)	Pilots	45*
(i)	Stewardesses	10
	Total	177

Accident Boards selected from within the Bureau of Air Commerce and augmented, on occasions, by technical advisors from without the Bureau rendered conscientious opinions as to the probable causes of these accidents and their findings are available to the public. In view of the obvious value of an analysis of the entire situation in the light of present knowledge these 112 accidents have been reviewed.

PERTINENT DATA

The factors involved in the causes of these accidents divide themselves into seven groups, as follows:

*Pilots and co-pilots who met with fatal accidents while riding as passengers are included in group (g) above.

(a) Personnel

(b) Aircraft (including accessories)

(c) Weather

(d) Air Navigation Facilities

(e) Terrain (including airports)

(f) Night flying

(g) Collision

In this subject there is presented factual information and data not subject to discussion.

Personnel

Reference to table A emphasizes the relative importance of this factor which divides itself into the following sub-groups:

I. Flight crews

II. Dispatchers

III. Maintenance crews

Flight Crews

The average number of flying hours accumulated by first pilots involved in the accidents was 6,203, (co-pilots, when involved, 2,075). This roughly represents three quarters of a million miles of flying. Breaking this down further by separating fatal accidents, 28, from non-fatal accidents, 84, the flying time of first pilots in the first group was 6,443 hours and in the second groups, 6,108 hours. Average with reference to all airline first pilots compiled late in 1937 was 6,710 hours; co-pilots 2,200 hours. Table F shows the ratio

of accident frequency to pilots' experience.

The average age of first pilots involved in 112 accidents was 33.3 years, (co-pilots, when involved, 29). Breaking this down further by separating 28 fatal accidents from 84 non-fatal accidents, the average age of the first pilots in the first group was 35 years and in the second group, 33.3 years. Average with reference to all airline first pilots compiled late in 1937 was 34 years; co-pilots, 29 years. Table G shows the ratio of accident frequency to pilots' ages.

In 112 accidents 63 flights were manned with co-pilots and in 28 fatal accidents 18 flights were manned with co-pilots. In four instances the co-pilot was the senior from the standpoint of age.

Table J shows the ratio of accident frequency to the number of flying hours accumulated by the first pilots within the 90 day period preceding the accident in which they were involved. It will be noted that 50 out of 112 accidents occurred to aircraft operated by first pilots who had logged from 230 to 260 hours within the 90 day period.

Fourteen of the first pilots involved in 112 accidents had been granted waivers covering slight physical defects. Thirteen of these waivers covered minor eye defects.

In 112 accidents, 65 occurred when the pilot in command of the flight was returning to his base as against 47, "outbound". In 28 fatal accidents, 18 occurred "inbound" as against 10 "outbound".

Dispatchers

Discussed on page 18.

Maintenance Crews

Discussed on page 20.

Aircraft

Table A shows that failure of aircraft and aircraft parts including engines, accessories, and radio have accounted for at least 35 of 112 accidents. Charged to "weather" rather than "aircraft" are the occasions when severe static conditions rendered radios unintelligible.

Foremost among aircraft failures are engine and propeller failures, 21, and landing gears and brakes, 8*. In 28 fatal accidents aircraft failures accounted for at least 3: (a) propeller breakage; (b) faulty aileron design; (c) faulty structural design which caused sufficient flutter to detach parts of the tail surfaces while in flight.

The average age of aircraft involved in 112 accidents was 25.3 months. The average age of those in 28 fatal accidents was 22.2 months and in this group, nine were less than a year old. Table L shows the ratio of accident frequency to age of aircraft. Table K shows the make and model of the 112 aircraft involved. Table P shows the make and model of aircraft involved in each accident.

*The master table from which these figures are taken is not appended since it duplicates much information contained in other tables.

Weather

Table M shows weather conditions which prevailed at the scene of 118 accidents.

This factor is discussed on page 24.

Air Navigation Facilities

Discussed on page 35.

Terrain

Table N shows the type of terrain involved in 110 accidents. Two accidents occurred without the aircraft making contact with the ground or water. Both met unusually turbulent air conditions which resulted in injuries to some of the occupants before the pilots could proceed to an area of safety.

No fatal accidents have occurred on airports. Seven occurred in the vicinity of or immediately contiguous to airports but were in no way attributable to the airport or the condition thereof. In the 12 that occurred in mountainous terrain, 10 involved the element of weather.

In 34 serious accidents involving no fatalities 10 occurred on airports and in 50 minor accidents, 27 occurred on airports.

In 34 serious accidents involving no fatalities 3 occurred in mountainous terrain and in 50 minor accidents, 5 occurred in mountainous terrain.

Night Flying

In 38 fatal accidents 19 occurred at night. In 34 serious accidents involving no fatalities, 21 occurred at night. In 50 minor accidents, 25 occurred at night. In the 112 accidents 65 occurred at night.

Collision

No aircraft collisions aloft have been experienced but one aircraft flew into three wild swans over a water-way during a migration season. This occurred at night over rough country and in view of the damage done to the aircraft could easily have proven more serious.

DISCUSSION

In this section the authors express their views concerning the factors reported on in the previous section. These views reflect composite opinions reached through individual, detailed study.

Personnel

Flight Crews

Table A shows a distribution of the direct causes of 112 accidents of which 64 are attributed to pilots.

It is well recognized that airline pilots as a group represent a high standard of American manhood, physically and mentally. In technical efficiency and aeronautical knowledge

they excel average pilots by a wide margin. From past performance records they are well qualified and they possess a high degree of physical courage. But mistakes made by them include poor judgment and, on occasions, faulty technique. This might indicate that present methods of evaluating their capabilities and limitations are inadequate. Superior aircraft, and air navigation facilities are but of questionable value in the absence of properly qualified personnel capable of operating such facilities. The inability of some pilots to cope with unusual and difficult situations may mean that the alteration of design and the increase in the complexities surrounding the operation of modern aircraft has not been satisfactorily coordinated with the capabilities of many of the pilots and further that insufficient consideration has been given to the proper selection, development, evaluation and maintenance of the men who have flown the aircraft and used the airways.

The authors believe that emotional instability influencing judgment which in turn effects performance is the foremost cause of pilots' mistakes; that fatigue, mental and/or physical, is a contributing factor and that complexities of the aircraft coupled with the growing demands made upon pilots with reference to various kinds of calculations to be made and records to be kept during flights have a decided bearing on the problem.

In addition to the actual handling of the aircraft while in the air pilots' duties include:*

Radio

1. Test all three radio receivers and transmitter prior to start of trip.
2. Work field control tower on 278 kc for testing and to secure orders concerning departure.
3. Maintain constant watch on company frequency.
4. Maintain constant watch on Department of Commerce radio range stations.
5. Report to company over all check points.
6. Contact Department of Commerce stations when passing over their markers.
7. Report to Airways Control when over inner marker.
8. Report to company when over inner marker.
9. Report weather for each 1000 ft. level during ascent.
10. Report to company estimated time over next check point.
11. Report time, altitude, weather over check point.
12. Receive and record weather for next station on route.
13. Change radio receiver frequency for cross range fixes.
14. Report to company any change in flight plan.

*The list which follows enumerates actual duties imposed upon the pilot and co-pilot. Definite allocations of duties cannot be made. The list was compiled by an airline pilot with more than 12,000 hours of flying experience.

15. Relay messages to assist other aircraft in making radio contacts.

16. Change company frequency to work traffic control through field control tower.

17. Change Department of Commerce receiver frequency to work field control.

18. Handle miscellaneous messages.

Calculations

19. Calculate true airspeed.

20. Calculate ground speed.

21. Calculate wind direction.

22. Calculate wind velocity.

23. Check wind direction and velocity with drift.

24. Estimate time over next check point.

25. Calculate course for next leg of flight.

26. Calculate horse power required on next leg of course.

27. Calculate fuel consumption per hour.

28. Check airspeed point to point.

29. Estimate fuel required at next refueling stop.

Recordings in Flight

30. Enter time of departure.

31. Enter time off ground.

32. Enter time between check points.

33. Enter airspeed between check points.

34. Enter wind direction and velocity between points.

35. Enter ground speed between check points.

36. Enter altitude flown between check points.

37. Enter time over check points.

38. Enter true course flown between check points.

39. Enter manifold pressure used.

40. Enter fuel consumption per hour.

41. Enter horse power used each leg of flight.

42. Enter outside air temperature.

43. Enter carburetor air temperature.

44. Enter distance from last check.

45. Enter magnetic course.

46. Enter amount of crab from course.

47. Enter corrected airspeed.

48. Enter carburetor manifold pressure between check points.

49. Enter engine RPM between check points.

50. Enter cloud formations and levels between check points.

Recordings in Airplane & Engine Log

51. Enter departure time.

52. Enter time off ground.

53. Enter air time.

54. Enter arrival time.

55. Enter fuel on board at place of departure.

56. Enter oil on board at place of departure.

57. Enter fuel taken on board at each refueling point.

58. Enter oil taken on board at each refueling point.

59. Enter average head temperature.

60. Enter average oil temperatures.

61. Enter average oil pressure.

62. Enter average gasoline pressure.

63. Enter average carburetor intake temperature.

64. Enter average cruising manifold pressure.

65. Enter average cruising engine R.P.M.

66. Enter average vacuum pump readings.

67. Enter airplane structure remarks.

68. Enter any malfunctioning of controls.

69. Enter any malfunctioning of instruments.

70. Enter any malfunctioning of engines.

71. Enter any malfunctioning of radio.

Other Clerical Duties

72. Enter time and pouches on P. O. form No. 2702.

73. Check all P. O. forms No. 2715.

74. Balance No. 2702 before arrival each stop showing arrival - departure, pouches on and off.

75. Check express waybills on and off against airplanes manifest.

76. Check company material.

77. Keep airplanes cargo manifest in balance.

78. Prepare company form for station agent showing cargo off.

79. Prepare weather summary for trip.

80. Fill out trip discrepancy report.

Miscellaneous

81. Check de-icer equipment at intervals.

82. Check slinger ring operation.

83. Check windshield de-icer.

84. Regulate ventilation.

85. Regulate heat supply for cabin.

86. Make frequent checks on hydraulic gear.

87. Keep radios tuned.

Many of the airlines do not supply the services of stewardesses or stewards. When such is the case a generous share of the co-pilot's time, during flight, is required in the passengers' compartment. Not infrequently it is necessary for a co-pilot to absent himself from the pilots' compartment for several minutes at a time. When his duties involve the serving of meals aloft, as is often the case, such periods are necessarily longer.

It should be remembered that these added duties are not performed while comfortably seated at a desk in an office. Pilots' compartments do not lend themselves as places where clerical work may be done to the best advantage. Sometimes the windows leak rain; sometimes they are open for ventilating

purposes; and frequently the temperature is not conducive to writing. And somebody must fly the aircraft! Automatic pilots mitigate actual flight duties but they do not "take over" as is assumed by some.

Considerable stress has been laid on the probability of fatigue contributing both directly and indirectly to many of these accidents. To just what extent physical fatigue influences mental fatigue and vice versa is not known. The study is a profound one which requires meticulous and consistent investigation.

An experimental station, under the direction of an experienced flight surgeon, is being established by the Bureau of Air Commerce in Kansas City. Studies will be conducted in aviation medicine and fatigue as well as experimental performance flight tests. This project includes study with reference to ground personnel involved in dispatching and maintenance.

Lack of experience from the standpoint of accumulated hours can scarcely be assigned as causes for these accidents (refer to pages 4 and 5 and tables F & G). The spreads between 6,710 hours, the average of all airline pilots, 6,203 hours, the average of first pilots in 113 accidents and 6,443 hours, the average of first pilots involved in the 38 fatal accidents, do not seem to be wide enough to be conclusive. Opinions expressed by some (not the authors) are that many years and

many hours of experience sometimes contribute to an element of danger rather than of safety. These claimants state that some pilots who have been successful in avoiding accidents for a long period of time occasionally evolve an attitude of contempt for the fundamental hazards of flying. This is not definitely supported in tables F and G.

It is felt that the "age of pilots" element fails to indicate any significant trends. Reference is made to Table G.

More than half of the first pilots involved in 112 accidents had accumulated upwards of 220 hours in the 90 day period immediately preceding the accident; the average for this group being 243 hours. Since this figure is appreciably in excess of 194 hours which is the time accumulated by average airline pilots within 90 day periods it is indicated that fatigue may have contributed as a cause of the 57 accidents used in arriving at this 243 hour average. Table J provides a breakdown of hours accumulated in 90 day periods.

Careful investigation fails to show that any of the 14 pilots who had been granted waivers suffered accidents by reason of the physical defect which had been waived.

Prior to April 30, 1938, co-pilots were not required to hold instrument ratings. Reference to table H shows that in 41 of the 67 accidents in which co-pilots were involved the

accumulated time of these co-pilots was below the average of all co-pilots. This may or may not be significant but it is well known that in the past many co-pilots have been employed who not only failed to possess instrument ratings but who were actually unable to safely take-off and land the type of aircraft in which they served. Under Civil Air Regulations, effective April 30, these potential deficiencies are corrected.

The position of first pilot and co-pilot with respect to age or hours has, on occasions, been reversed. This generally is due to an older first pilot having been placed on the status of co-pilot, either temporarily or permanently. No significance is attached to this.

On at least three occasions, and perhaps more, accidents have occurred as a result of confusion between pilots as to their respective duties. The emotional stress engendered during trying situations has been the cause. Contributing to this has, no doubt, been the many added duties required of both pilots due to the complexities of modern aircraft.

Opinions have been advanced that a contributing cause of accidents may be the desire on the part of pilots to terminate a homeward bound trip as quickly as possible and, consequently to assume greater risks when proceeding toward their home ports than when departing therefrom. In 28 fatal accidents, 18 occurred "inbound" against 10 "outbound". This ratio of

9:5 might support the contention although the ratio of 11:8 which prevailed in 112 accidents does not seem so serious. Should the trend continue as above some significance should necessarily be attached thereto. Pilots' schedules are frequently arranged to permit them to terminate their trip at their home and at night. The fact that the majority of fatal and serious accidents have occurred at night may have influenced the above ratios. The subject of night flying is further discussed on page 26.

Dispatchers

Mistakes made by dispatchers ordinarily consist of giving permission to flights to proceed in the face of too uncertain weather or in cases when the condition of the air navigation facilities or flight personnel involved in the flight is questionable.

In distributing causes of 112 accidents none have been directly charged to dispatchers since in no instances have they had the final authority to order a flight to proceed when the pilot elected otherwise. In at least 23 out of 112 accidents poor judgment on the part of dispatchers has contributed to these accidents.

It may be that lack of sufficient information with reference to meteorological conditions is not the only cause of their errors. Complaints have been made by pilots that

sometimes dispatchers have unduly influenced flight crews to originate or to proceed when conditions were questionable, for the purpose of getting a particular flight past a particular station, for the purpose of conveniently placing the aircraft along the company's route with a view to subsequent operations or in order to avoid the additional work and expense of "training" passengers. If such practice exists it is obvious that some dispatchers have been employed without proper consideration being given to their judgment, experience, or character.

On the other hand conscientious dispatchers have on many occasions erred, not through carelessness or ignorance, but because inaccurate or inadequate meteorological information has influenced their judgment. Many flights have been cleared on the basis of inaccurate weather information which have carried through successfully because the error was offset by exceptional ability or courage on the part of the flight crews involved.

Experts in this field are none too numerous. Some of the airlines are filling these important positions with old pilots with successful piloting careers behind them. There has been just criticism in the past that on too many occasions these posts were manned by personnel with insufficient aeronautical experience. The authors urge that all available steps be taken to the end that only competent dispatchers

participate in the clearance and movement of aircraft and that operators establish procedures which will provide for complete understanding between dispatchers and flight crews.

Maintenance Crews

Mistakes made by maintenance crews are due, ordinarily, to poor supervision, imperfect or careless inspection and sometimes to inexperience.

It is suggested, in the interest of safety, that servicing stops enroute be of sufficient duration to permit servicing crews to adequately inspect and refuel the aircraft. Facts concerning some of the reviewed accidents suggest that errors were committed because ground crews were in too much of a hurry to accomplish their work.

Careful selection and training of maintenance crews by the company employing them is of paramount importance. It is the opinion of the authors that inefficient mechanics have not only been the direct cause of at least 4 accidents; that they have contributed to not less than 10; and that on many more occasions accidents as a result of their mistakes have been avoided only by the excellent technique of pilots.

Aircraft

With the exception of those accidents mentioned on page 6, only five other structural failures occurred; (a) one in which a

gas tank support gave way in the air; (b) one in which the ply wood wing covering cracked and opened from spar to spar due to turbulent air, (both of these involved non-metal aircraft not now in use as passenger carriers); (c) one which suffered an accident because of breakage of stops on upper quadrants of landing gear making it impossible to lower the gear; (d) one which resulted in considerable damage to the aircraft by reason of landing gear breakage, and (e) one which suffered extreme damage due to failure of tail wheel assembly in normal landing and which caused the aircraft to ground loop.

In addition to 21 power plant (including propeller) failures distributed as direct causes (see page 6) there were 18 other occasions when they contributed to the accidents. In these 39 cases propeller breakage occurred 8 times. This specific propeller deficiency has been corrected and considerable progress has been made with reference to the complex fundamentals of propeller vibration.

Ice in carburetors which in the early portion of the period accounted for several engine failures has been overcome.

Aircraft accessories, including instruments, have made substantial advancement to the point where they no longer contribute materially to danger in flying. No instrument failures seem to have caused any of the accidents reviewed. It is true that as they have increased in number the complexities of operating and interpreting

them have likewise increased. Experiments are under way which should improve this situation. Relief from undue complexity by means of instrument simplification is badly needed and the work progressing along that line should be accelerated if possible.

Although phenomenal strides have been made in radio there remains much to be desired in this field. Operations are so dependent upon reliable radio that the importance of utilizing all resources in the further development of this aid cannot be overestimated. Inability to receive radio signals under conditions of precipitation static have not only contributed to accidents but on numerous occasions have placed the flight in precarious positions. Work is progressing in this specific field and all resources are being marshalled in solving this important problem. The application of ultra high frequency promises a great deal. Experiments are being conducted almost daily looking to its general application.

Of particular interest is the inverse ratio of accident frequency to "age of aircraft". (See table L). This goes far in supporting the contention of those who hold that older aircraft well tested by time and in connection with which the operating and maintenance problems have been more nearly solved, offer less of a hazard than newer equipment with which the flight and maintenance crews are not so familiar. It may be that the policy generally and voluntarily employed by some operators of retiring their aircraft at a relatively early age by reason of supposed obsolescence not only militates against

economy but, to a degree, against safety. Or, it may mean that longer test periods are needed before new aircraft are placed in line operation.

The type of aircraft alters, of course, as progress is made in the industry. A preponderance of "twin engine" accidents in the past four years has undoubtedly occurred because there has been a preponderance of "twin engine" aircraft in popular use. Distribution is as follows:

	1 engine	2 engines	3 engines	Total
1934	11	7	7	25
1935	11	13	5	29
1936	6	25	6	37
1937) 1938)	2	19	0	21
Total ..	30	64	18	112

For further breakdown reference is made to table K.

The authors believe that the trend of aircraft design has resulted in equipment that requires much more technical skill, concentration, and aeronautical knowledge on the part of the pilots than were required of them a few years ago. As against this factor speed and pay-load have increased in ratio to operations cost. The flying characteristics of currently popular airline aircraft, particularly when operating under adverse meteorological conditions do not appear to be as satisfactory, from the standpoint of safety, as those characteristics found in aircraft of less spectacular performance. The opinion is held by many in the industry that possibly the traveling public and the operators are paying too high a price for speed and luxury. There is evidence available from accidents reviewed herein and from numerous

experiences not resulting in accidents but reported by pilots and others to support this.

Weather

The accurate and consistent forecasting of weather is a problem not yet satisfactorily solved. Progress in this field has been good but much is to be desired. Since this element plays such an important part in airline activities it is impossible to anticipate the day when flight cancellations and interruptions will not be the major consideration insofar as operations are concerned.

Weather has been a factor in many accidents and many bitter experiences have been forced upon aviation by reason of it. The inevitable conclusion has been reached by most operators that an ultra-conservative policy in this regard is necessary.

During the years 1936 and 1937, thirteen fatal accidents occurred in which 117 persons lost their lives. Then of these 13 occurred in bad weather. In the entire 28 fatal accidents involving 177 deaths, bad weather prevailed on 31 occasions. Over the entire period reviewed but 7 accidents (with resultant fatalities of 46) occurred in which weather was not a factor.

Available de-icing equipment has not completely solved the problem of icing while in flight and this is a matter for major consideration.

The Weather Bureau and other agencies are conducting constructive experiments by means of radiotelemeters suspended to free

balloons. These flights usually reach altitudes of more than 50,000 ft. and automatically transmit by high frequency radio signals, pressure, temperature and humidity readings, at thirty second intervals. During the current year several additional Weather Bureau stations will begin daily flights of this kind and it is believed that the data so secured will be of great benefit in permitting more accurate forecasts.

Additional means of disseminating available weather information should be encouraged.

Air Navigation Facilities

Failure of aids have been assigned as contributory causes in 7 accidents. There is reason to believe that on many more occasions only luck or skill have prevented accidents because of such failures. Two accidents, not included above, which occurred on the same route might have been avoided had not the teletype weather reporting facility been discontinued on that particular airway, presumably as an economy measure. This facility was again requisitioned and is now operative.

It is recognized that occasional interruptions of any mechanical device is to be expected and due allowances made therefor, but improvement in the airways which includes additions and modernization of existing aids is needed. It is hoped that the application of ultra high radio frequencies will materially improve conditions.

Progress in this field is being made as additional funds are available.

It should be remembered, however, that the absence of aids in certain locations, no matter how badly needed, cannot be reasonably assigned as a cause for any accident in view of the futility of placing dependence on aids which are nonexistent.

One pilot who survived a serious accident, complained that when he switched to the airport localizer, expecting to receive the range signal, he heard voice. This cannot be assigned as a facility failure.

Terrain (Including Airports)

Conclusions on page 33.

Night Flying

Air transport appears to be relatively less subject to the vicissitudes of night operation than other forms of transportation. This may be due to the mathematical improbability of collision accidents in the air as opposed to surface transportation which generally flows over predetermined, narrow lanes. A ratio of 65:47, night accidents vs. day accidents, does not seem to be higher than could be normally expected in view of the fact that night flying is admittedly more exacting than day flying.

In 65 accidents that occurred at night, 43 involved bad weather. In 47 accidents that occurred during daylight, 25 involved bad weather. If it can be assumed for a moment that weather, rather than time of day was the more important contributing factor the

following brief table is of interest.

	Night		Day
Total	65		47
Less weather	43	Less weather	25
Remainder	22	:	22

Such an assumption might also indicate (a) bad weather is more frequently encountered at night, (b) flying from the pilots' standpoint becomes more difficult when bad weather is encountered at night, or (c) weather reporting and dispatching is less efficient at night as compared to daylight.

No accurate figures are immediately available as to the ratio of night flying to day flying, but estimates lead the authors to believe that such ratio is about 40:60.

Collision

On a few occasions slight damage to aircraft has resulted by reason of collision with birds. The problem appears to some to be trivial but the authors do not feel so and a project is under way looking to means of safeguarding against this hazard. The accident involving wild swans, mentioned on page 8, took place at an altitude more than 8,000 ft. above sea level and more than 4,000 ft. above the terrain, much higher than was generally believed possible.

CONCLUSIONS

The authors feel that this preliminary analysis, covering a period of more than 4 years and 112 accidents constitutes a basis for intelligent findings from which conclusions may be drawn with reasonable accuracy.

Conclusions both positive and negative have, therefore, been reached with reference to the several factors discussed in the preceding section of this analysis and are presented below in corresponding order. In some cases recommendations are made which involve, in the opinion of the authors, desirable changes in existing Civil Air Regulations.

Personnel

Flight Crews

1. Pilots' accumulated hours of flying time does not appear to be an important factor in the review of these accidents.
2. Pilots' ages in 112 accidents fail to indicate any significant trend in view of the general age average.
3. The average hours (243) accumulated by pilots within the 90 day period preceding a majority of these accidents may have contributed to the fatigue element. Flight Time Limitations (CAR 61.513) takes no cognizance of the type of flying conducted. Since there is considerably more than a mathematical

difference between 40 hours of flying under entirely favorable conditions and 30 hours of flying under unfavorable conditions, it is recommended that this factor be made the subject of a specific study with the view of revising CAR 61.513 to more adequately provide precautionary limitations under varying conditions.

4. Since the waivers granted to pilots involved in accidents have in no wise contributed to the accidents, it seems plausible that present minimum requirements may be higher than necessary. It is recommended that this factor be made the subject of a specific study with the view of revising pilots' physical requirements, particularly with reference to vision.

5. Efforts should continue to progress in the establishing of procedures which will eliminate the possibility of confusion between pilots with reference to individual and respective duties.

6. Further and consistent analyses should be made with the view of ascertaining if the accident trend indicates a greater number of them occurring while pilots are "inbound".

7. Accidents sometimes hinge on obscure events the perception of which requires mental alertness. Pilots

busily engaged with tedious and exacting clerical duties, subject to audit, are obviously handicapped in the performance of flight duties. Such duties should be simplified.

8. The practice of constantly introducing unnecessary changes in the familiar arrangement of instruments and controls definitely militates against pilot efficiency.

9. It is not known to what extent anoxia (oxygen deprivation) contributes to fatigue and accidents. The pilot medical study being conducted in Kansas City by the Bureau should, therefore, be vigorously supported.

10. It is recommended that operating companies undertake a more complete and detailed study of the avocational and social environments of flight personnel.

Dispatchers

1. Lack of proper and sufficient weather information has, on occasions, influenced dispatchers in clearing flights under conditions which were actually hazardous and these errors have been contributing causes of several accidents.

2. It is felt that some dispatchers have had too much regard for the economics rather than the safety of air transport and that at times the "crowding" of pilots has been the indirect causes of some accidents. Greater care in the selection of men for these positions is necessary as is

the establishment of procedures looking to better coordination between flight crews and ground crews.

Maintenance Crews

1. Servicing stops should be established which will permit mechanics to adequately perform their duties without too much haste.
2. More efficient, better trained and better supervised maintenance crews will tend to reduce aircraft failures with attending accidents.

Aircraft

1. Structural failure resulting in fatal or serious accidents occur only on rare occasions.
2. Engine and accessories failures constitute the principal mechanical hazard. The general application of "feathering propellers" should be made the subject of special study. The need for this improvement is pressing.
3. Presently existing instrument complexities militates against efficiency and contributes to fatigue. Every effort should be made toward simplification.
4. The problem of radio ineffectiveness under certain meteorological conditions is of major concern.
5. Age and use of aircraft within reasonable limitations do not appear to contribute to accidents. The fact that

so many accidents involve comparatively new equipment indicates the desirability of longer test periods before such aircraft are placed in line service.

6. Presently popular airline aircraft require better technique and aeronautical knowledge on the part of flight crews than was required a few years ago.
7. When operating under certain unfavorable meteorological conditions modern aircraft do not seem to possess as favorable flying characteristics as is found in aircraft of less speed and less load carrying ability.
8. De-icing equipment has not been perfected.
9. Manufacturers should give more consideration to the item of "pilot comfort" in designing aircraft. This bears directly on efficiency. Elimination of glare, noise, the elements, etc.; visibility and comfortable seating arrangement are important.

Weather

1. A substantial majority of accidents occur under conditions of bad or questionable weather.
2. More accurate weather forecasting and additional aids for disseminating weather information are needed.
3. The experiments under way employing the use of radio-telemeters should be encouraged.

Air Navigation Facilities

1. Failures of these aids occur but rarely and have been assigned as contributory causes only in 7 accidents.
2. Additional aids are needed and should be installed as rapidly as funds will permit.
3. The development of ultra-high frequency radio transmission may materially improve the utilization of such facilities. This project should be fostered in every way.
4. Inability of pilots to identify their positions is a frequent contributing cause of accidents. The perfecting of a procedure whereby accurate fixes may be had by means of radio-triangulation, both from ground and aircraft, should serve a useful purpose.

Terrain

Operations over mountainous or hilly terrain entail some additional hazard and require a continued policy of conservatism particularly in bad or questionable weather.

Night Flying

1. Night operations, if conducted with full consideration as to weather, appear to involve only slightly more risk than day operations.
2. Fifty-eight percent of the reviewed accidents occurred at night and 66⅔ of these involved bad or questionable weather.

Collision

No collisions have occurred between air transports in flight and the probability of such can be minimized through proper application of presently operating Air Traffic Control.

TABLE A

ACCIDENT SYNOPSIS

Accident Number	PROBABLE ACCIDENT CAUSES: Personnel: Pilots	PROBABLE ACCIDENT CAUSES: Personnel: Maintenance	PROBABLE ACCIDENT CAUSES: Other Causes: Aircraft	PROBABLE ACCIDENT CAUSES: Other Causes: Miscl.	FATALITIES RESULTING: Passengers	FATALITIES RESULTING: Pilots	FATALITIES RESULTING: Stewardesses
401	X				5	2	1
402			X		0	0	0
403	X				0	0	0
404	X				0	0	0
405	X				4	2	1
406	X				0	0	0
407	X				0	0	0
408	X				0	0	0
409			X		0	0	0
410	X				4	1	0
411	X				0	0	0
412			X		0	0	0
413				X	0	0	0
414			X		0	0	0
415	X				0	0	0
416			X		0	0	0
417	X				0	0	0
418	X				1	1	0
419			X		0	0	0
420			X		0	0	0
421	X				0	1	0
422				X	0	0	0
423	X				0	1	0
424				X	0	0	0
425	X				0	0	0
	15		7	3	14	8	2

TABLE A

TABLE A-2

Accident Number	Pilots	Maintenance	Air-craft	Miscl.	Passen-gers	Pilots	Steward-esses
Carried fwd.	15		7	3	14	8	2
501			X		0	0	0
502	X				0	1	0
503	X				0	0	0
504	X				0	0	0
505	X				0	0	0
506	X				0	0	0
507	X				0	0	0
508			X		0	0	0
509			X		0	0	0
510	X				0	1	0
511	X				3	2	0
512	X				0	1	0
513	X				1	1	0
514				X	0	0	0
515	X				0	0	0
516	X				0	0	0
517		X			0	0	0
518			X		2	2	0
519	X				0	0	0
520	X				0	2	1
521			X		0	0	0
522	X				9	2	1
523			X		0	0	0
524	X				0	0	0
525			X		0	0	0
526			X		0	0	0
527		X			0	0	0
528			X		0	0	0
529			X		0	0	0
	31	2	17	4	29	20	4

TABLE A-3

Accident Number	Pilots	Maintenance	Air-craft	Miscl.	Passen-gers	Pilots	Steward-esses
Carried fwd.	31	2	17	4	29	20	4
601	X				0	0	0
602	X				0	0	0
603	X				14	2	1
604	X				0	0	0
605		X			0	0	0
606	X				0	1	0
607	X				0	0	0
608				X	0	0	0
609	X				0	0	0
610	X				0	0	0
611	X				0	0	0
612	X				0	0	0
613	X				0	0	0
614	X				0	0	0
615	X				0	0	0
616	X				1	1	0
617			X		0	0	0
618	X				10	2	0
619			X		0	0	0
620			X		0	0	0
621			X		0	0	0
622		X			0	0	0
623	X				0	0	0
624			X		0	0	0
625			X		0	0	0
626	X				6	2	0
627	X				0	0	0
628			X		0	0	0
629			X		0	0	0
	49	4	25	5	60	28	5

TABLE A-4

Accident Number	Pilots	Maintenance	Air-craft	Miscl.	Passen-gers	Pilots	Steward-esses
Carried fwd.	49	4	25	5	60	28	5
630			X		0	0	0
631			X		0	0	0
632	X				0	0	0
633	X				0	0	0
634	X				4	2	1
635	X				0	2	0
636	X				0	0	0
637	X				9	2	1
701	X				5	1	0
702	X				0	0	0
703	X				0	0	0
704			X		0	0	0
705		X			8	2	1
706	X				0	0	0
707			X		10	2	1
708				X	0	0	0
709			X		0	0	0
710	X				0	0	0
711			X		0	0	0
712				X	0	0	0
713			X		0	0	0
714			X		0	0	0
715				X	2	2	0
716	X				0	0	0
717			X		0	0	0
718	X				16	2	1
719	X				0	0	0
801			X		8	2	0
802	X				0	0	0
Grand Totals	64	5	35	8	122	45	10 = 177

TABLE A-4

TABLE D

TOTAL ACCIDENTS

Accident Number	PROBABLE ACCIDENT CAUSES: Personnel: Pilots	PROBABLE ACCIDENT CAUSES: Personnel: Maintenance	PROBABLE ACCIDENT CAUSES: Other Causes: Aircraft	PROBABLE ACCIDENT CAUSES: Other Causes: Miscl.	FATALITIES RESULTING: Passengers	FATALITIES RESULTING: Pilots	FATALITIES RESULTING: Stewardesses
401	X				5	2	1
405	X				4	2	1
410	X				4	1	0
416	X				1	1	0
421	X				0	1	0
423	X				0	1	0
502	X				0	1	0
510	X				0	1	0
511	X				3	2	0
512	X				0	1	0
513	X				1	1	0
514	X				2	2	0
520	X				0	2	1
522	X				9	2	1
603	X				14	2	1
606	X				0	1	0
616	X				1	1	0
618	X				10	2	0
626	X				3	2	0
634	X				4	2	1
635	X				0	2	0
637	X				9	2	1
701	X				5	1	0
	22		1		78	35	7

TABLE 1-2

Accident Number	Pilots	Maintenance	Aircraft	Miscl.	Passengers	Pilots	Stewardesses
Carried fwd.	22		1		78	35	7
705		X			8	2	1
707			X		10	2	1
715				X	2	2	0
716	X				16	2	1
801			X		8	2	0
Grand Totals 28	23	1	3	1	122	45	10 = 177

TABLE C

SERIOUS ACCIDENTS

Accident Number	PROBABLE ACCIDENT CAUSES: Personnel: Pilots	PROBABLE ACCIDENT CAUSES: Personnel: Maintenance	PROBABLE ACCIDENT CAUSES: Other Causes: Aircraft	PROBABLE ACCIDENT CAUSES: Other Causes: Miscl.	FATALITIES RESULTING: Passengers	FATALITIES RESULTING: Pilots	FATALITIES RESULTING: Stewardesses
406	X				0	1	0
408	X				2	2	0
411	X				0	2	0
412			X		0	1	0
413	X				0	1	0
415	X				0	1	0
417	X				0	1	0
419			X		0	1	0
422				X	0	2	0
424				X	0	0	0
506	X				0	0	0
508			X		0	2	1
516	X				3	0	0
517		X			0	0	0
519	X				0	0	0
524	X				0	0	0
526			X		0	0	0
527		X			0	0	0
528			X		0	0	0
529			X		0	1	0
601	X				0	0	0
602	X				0	0	0
604	X				0	0	0
607	X				0	1	0
611	X				0	0	0
	15	2	6	2	5	16	1

TABLE C-2.

Accident Number	Pilots	Maintenance	Air-craft	Miscl.	Passen-gers	Pilots	Steward-esses
Carried fwd.	15	2	3	2	5	16	1
622		X			2	1	0
629	X				12	2	1
629			X		0	1	0
632	X				0	1	0
636	X				1	2	0
706	X				0	0	0
710	X				0	0	0
711			X		0	0	0
712				X	2	0	0
Grand Totals 34	20	3	3	3	22	23	2 = 47

TABLE D

MINOR ACCIDENTS

Accident Number	PROBABLE CAUSES				FATALITIES RESULTING		
	Personnel		Other Causes				
	Pilots	Maintenance	Air-craft	Miscl.	Passen-gers	Pilots	Steward-esses
402			X		0	0	0
403	X				0	1	0
404	X				0	2	1
407	X				0	0	0
409			X		0	0	0
414			X		0	0	0
416			X		0	0	0
420			X		0	1	0
425	X				0	0	0
501			X		0	0	0
502	X				0	0	0
504	X				0	0	0
505	X				2	1	0
507	X				0	0	0
509			X		0	0	0
514				X	3	0	0
515	X				0	0	0
521			X		0	0	0
523			X		0	0	0
525			X		0	0	0
	9		10	1	5	5	1

TABLE D

TABLE D-2

Accident Number	Pilots	Maintenance	Aircraft	Misc.	Passengers	Pilots	Stewardesses
Carried fwd.	9		10	1	5	5	1
605		X			0	0	0
608				X	0	0	0
609	X				0	0	0
610	X				0	0	0
612	X				0	0	0
613	X				0	0	0
614	X				0	0	0
615	X				0	0	0
617			X		0	0	0
619			X		0	0	0
620			X		0	0	0
621			X		0	0	0
624			X		0	0	0
625			X		0	0	0
627	X				0	0	0
629			X		0	0	0
630			X		0	0	0
631			X		0	0	0
632	X				0	0	0
702	X				0	0	0
703	X				0	0	0
704			X		0	0	0
708				X	0	0	0
709			X		0	0	0
	19	1	21	3	5	5	1

TABLE D-3

Accident Number	Pilots	Maintenance	Air-craft	Miscl.	Passen-gers	Pilots	Steward-esses
Carried fwd.	19	1	21	3	5	5	1
713			X		0	0	0
714			X		0	0	0
716	X				0	0	0
717			X		0	0	0
719	X				0	0	0
602	X				0	0	0
Grand Totals 50	22	1	24	3	5	5	1 = 11

TABLE D-3

TABLE E

ACCIDENT SUMMARIZATION

1.	Accidents	112
2.	Accidents involving no injuries or fatalities	60
2(a)	Accidents involving fatalities or injuries, passengers or crew	52
3.	Accidents - Fatal	28
4.	Accidents - Fatal, passengers only	None
5.	Accidents - Fatal, crew only	8
6.	Accidents - Fatal, passengers and crew	20
7.	Accidents - Injuries only	24
8.	Accidents - Injuries, passengers only	3
9.	Accidents - Injuries, crew only	16
10.	Accidents - Injuries, passengers and crew .	5

TABLE F

ACCIDENT FREQUENCY VS. PILOT HOURS

Pilot Experience Groups of 500 hrs.	Number of Accidents	Number of Accidents	Pilot Experience Groups of 500 hrs.
1,500 - 2,000	2	11	3,500 - 4,000
2,000 - 2,500	1	9	5,500 - 6,000
2,500 - 3,000	4	9	7,000 - 7,500
3,000 - 3,500	7	8	5,000 - 5,500
3,500 - 4,000	11	8	6,000 - 6,500
4,000 - 4,500	7	8	8,500 - 9,000
4,500 - 5,000	6	7	3,000 - 3,500
5,000 - 5,500	8	7	4,000 - 4,500
5,500 - 6,000	9	7	6,500 - 7,000
6,000 - 6,500	8	6	4,500 - 5,000
6,500 - 7,000	7	6	8,000 - 8,500
7,000 - 7,500	9	5	7,500 - 8,000
7,500 - 8,000	5	4	2,500 - 3,000
8,000 - 8,500	6	4	9,000 - 9,500
8,500 - 9,000	6	3	9,500 - 10,000
9,000 - 9,500	4	2	1,500 - 2,000
9,500 - 10,000	3	2	10,000 - 10,500
10,000 - 10,500	2	1	2,000 - 2,500
10,500 - 11,000	1	1	10,500 - 11,000
11,000 - 11,500	1	1	11,000 - 11,500
11,500 - 12,000	1	1	11,500 - 12,000
12,000 - 12,500	1	1	12,000 - 12,500
12,500 - 13,000	1	1	12,500 - 13,000

TABLE G

AGE OF PILOTS INVOLVED IN ACCIDENTS

FIRST PILOTS				CO-PILOTS			
Age	Accidents	Accidents	Age	Age	Accidents	Accidents	Age
25	1						
26	1	16	33	19	2	11	29
27	5	13	30	21	3	9	28
28	8	12	34	23	2	7	30
29	5	8	37	24	3	6	27
30	13	8	28	25	3	4	26
31	4	6	32	26	4	3	37
32	6	6	36	27	6	3	35
33	16	6	39	28	9	3	31
34	12	5	29	29	11	3	25
35	4	5	27	30	7	3	24
36	3	5	42	31	3	2	38
37	8	4	31	32	2	2	36
38	6	4	35	33	3	2	34
39	6	4	43	34	2	2	32
40	1	3	36	36	2	2	23
41	2	2	41	37	3	2	21
42	3	1	25	38	2	2	19
43	4	1	26	40	1	1	40
44	1	1	40				
		1	44				

TABLE H

ACCIDENT FREQUENCY VS. CO-PILOT HOURS

Pilot Experience, Groups of 500 hrs.	Number of Accidents	Number of Accidents	Pilot Experience, Groups of 500 hrs.
0 - 500	1	11	500 - 1,000
500 - 1,000	14	14	1,000 - 1,500
1,000 - 1,500	14	13	1,500 - 2,000
1,500 - 2,000	13	5	2,000 - 2,500
2,000 - 2,500	5	5	2,500 - 3,000
2,500 - 3,000	5	4	3,000 - 3,500
3,000 - 3,500	4	3	3,500 - 4,000
3,500 - 4,000	3	3	4,000 - 4,500
4,000 - 4,500	3	2	4,500 - 5,000
4,500 - 5,000	2	2	5,000 - 5,500
5,000 - 5,500	2	1	5,000 - 5,500
5,500 - 6,000	0	1	0 - 500
6,000 - 6,500	0		
6,500 - 7,000	0		
7,000 - 7,500			

TABLE J

ACCIDENT FREQUENCY VS. PILOT HOURS IN LAST 90 DAYS

Pilot Hours, Groups of 20	Number of Accidents	Number of Accidents	Pilot Hours, Groups of 20
40 - 60	1	29	240 - 260
60 - 80	1	21	220 - 240
80 - 100	3	15	300 - 220
100 - 120	1	12	160 - 180
120 - 140	3	9	180 - 200
140 - 160	5	5	140 - 160
160 - 180	12	4	260 - 280
180 - 200	9	3	80 - 100
200 - 220	15	3	120 - 140
220 - 240	21	2	280 - 300
240 - 260	29	1	40 - 60
260 - 280	4	1	60 - 80
280 - 300	2	1	100 - 120
300 - 320	1	1	300 - 320
Unknown	6		

TABLE K

AIRCRAFT TYPE & AGE (In Months)

Accident Number	Type	Age in Months
401	B.247	1
402	Stn SM 6000	Unknown
403	Lkd Vega 5-C	42
404	B. 247	13
405	Condor T-32	3
406	Ptcn PA-7M	50
407	Ptcn PA-8	39
408	Electra 10-A	1
409	Ford	60
410	Stn SM-6000	36
411	Ford 5-ATD	Unknown
412	Stn Relt	3
413	Stn SM 6000-B	39
414	Stn SR-5E	5½
415	Stn SM 6000-B	41
416	Lkd Orion 9-D	15
417	Northrop IPCLM	44
418	Stn SM 6000-B	43
419	Lkd Vega 5-C	48
420	Ptn PA-8	46
421	Lkd Vega 5-C	40
422	B. 247-D	19
423	Lkd Orion	15
424	Doug. DC 2	5
425	Condor	20
426		
501	Lkd Orion 9-D	Unknown
502	Fleetster	24
503	Northrop Alpha 4-A	43
504	Stn SM 6000-B	48
505	Vultee V1-A	6
506	B. 247	24
507	Stn Relt SR-5A	8
508	Doug. DC 2	5
509	Doug. DC 2	8
510	Lkd Vega #75	66
511	Doug. DC 2	3
512	B. Monomail 221-A	48
513	Stn SM 6000-B	45
514	B.247	24
515	Doug. DC 2	7
516	Condor AT-32	27
517	Doug. DC 2	12
518	Stn A	2
519	Lkd Electra 10-A	8
520	B. 247-D	27
521	Doug. DC 2	9
522	B. 247-D	29
523	Lkd Vega 5-C	54
524	Stn - U	30
525	Stmn 4-CM-1	54
526	Lkd Vega 5-C	60
527	Stn "A"	3
528	Lkd Electra 10-A	6
529	Lkd Sirius 8-C	Unknown
601	Lkd Electra 10-A	9
602	Lkd Electra 10-B	3
603	Doug. DC 2	12
604	Detroit Vega D4-1	30
605	DC 3	14
606	Vultee V1-A	15
607	Stn U	40½
608	B. 40 B-4	84
609	Condor	33
610	Condor AT-32	24
611	DC 2	15
612	DC 2	14
613	Ford 5-AT-B	75
614	B. 247-D	36
615	DC 2	16
616	Stn "A"	4
617	Vultee	21
618	DC 2	18
619	DC 2	18
620	DC 2	10
621	Vultee	Unknown
622	Stn "A"	17

TABLE K (Contd)

Accident Number	Type	Age in Months
623	DC 2	3
624	Lkd Electra 10-B	8
625	Stn "A"	5
626	Lkd Electra 10-B	3
627	Lkd Electra 10-A	30
628	B. 247	39
629	Lkd Orion 9-D	36
630	Lkd Electra 10-A	30
631	Condor AT-32	30
632	Stn "A"	15
633	B. 247-D	43
634	B. 247-D	15
635	Lkd Electra	21
636	DC 2	27
637	B. 247-D	40
701	B. 247-D	30
702	DC 2	38
703	Lkd Electra 10-B	4
704	Lkd Electra 10-A	4
705	DC 3-A	2
706	DC 2	27
707	DC 2	32
708	Lkd Electra 10-A	30
709	DC 2	29
710	DC 3	5
711	Lkd Electra 10-A	32
712	Lkd Vega 5-C	96
713	DC 2	31
714	Lkd Vega 5-C	84
715	DC 2	34
716	DC 3-A	7
717	DC 3	3
718	DC 3-A	10
719	DC 3	12
801	Lkd 14-H	4
802	Lkd Electra 10-B	28

TABLE L

ACCIDENT FREQUENCY VS. AGE OF AIRCRAFT

Age Groups Months	Number of Accidents	Number of Accidents	Age Groups Months
1 - 5	16	16	1 - 5
5 - 10	14	14	5 - 10
10 - 15	8	11	15 - 20
15 - 20	11	11	30 - 35
20 - 25	8	9	40 - 45
25 - 30	7	8	10 - 15
30 - 35	11	8	20 - 25
35 - 40	7	7	25 - 30
40 - 45	9	7	35 - 40
45 - 50	5	5	45 - 50
50 - 55	3	3	50 - 55
55 - 60	0	2	60 - 65
60 - 65	2	2	80 - 85
65 - 70	1	1	65 - 70
70 - 75	0	1	75 - 80
75 - 80	1	1	95 - 100
80 - 85	2		
85 - 90	0		
90 - 95	0		
95 - 100	1		
Unknown	6		

TABLE M

WEATHER CONDITIONS (112 accidents)

	Hazardous	Questionable	Good	Total
Fatal (28)	18	3	7	28
Serious (34)	15	6	13	34
Minor (50)	10	15	25	50
TOTAL (112)	43	24	45	112

TABLE N

ACCIDENT FREQUENCY - TERRAIN CONDITIONS

	Airport	Mountains	Near Airport	Rolling	Level	Hills	Swamp	Air	Water	Total
Fatal..... (28)	0	12	5	3	2	4	1	0	1	28
Serious .... (34)	10	3	8	5	6	1	1	0	0	34
Minor..... (50)	27	5	4	5	2	4	1	2	0	50
Total..... (112)	37	20	17	13	10	9	3	2	1	112

TABLE N

TABLE P

GENERAL DATA - 112 ACCIDENTS

Acc. No.	Date	Hour	Place	Type Aircraft	Damage to Aircraft	Fatalities Pass.	Fatalities Crew	Injuries Pass.	Injuries Crew
401	2/23 '34	2:26P	20 miles East of Salt Lake	Boeing 247	Destroyed	5	3	0	0
402	2/26 '34	1:22P	Near Savannah	Stinson SR 6000	Minor	0	0	0	0
403	6/1 '34	12.30A	Near Pittsburgh	Lockheed Vega-5C	Serious	0	0	0	1
404	6/7 '34	5:14P	35 miles East of Seattle	Boeing 247	Serious	0	0	4	3
405	6/9 '34	5:04P	26 miles N.W. of Liberty, N.Y.	Condor T-32	Destroyed	4	3	0	0
406	7/9 '34	12:35A	Near airp.-Atlanta	Pitcairn PA-7M	Serious	-	0	-	1
407	7/9 '34	2:30A	Near airp.-Chattanooga	Pitcairn PA-6	Serious	-	9	-	0
408	8/7 '34	11:56P	Near sirp.-Milwaukee	Lockheed Electra 10-A	Serious	0	0	2	2
409	8/8 '34	4:20P	3 miles South of Lebanon, Mo.	Ford	Minor	0	0	0	0
410	8/31 '34	10:47P	Near Oregon, Mo.	Stinson SR 6000	Destroyed	4	1	0	0
411	9/2/ '34	9:25P	Near Cochrane, Wis.	Ford S-ATD	Major	-	0	-	2
412	9/13 '34	8:00A	Adj.Love Field, Dallas	Stinson Reliant	Destroyed	-	0	-	1
413	9/29 '34	5:00A	Near N. Jackson, Ohio	Stinson SR 6000-B	Serious	-	0	-	1
414	11/2 '34	6:00P	Near Marlin, Texas	Stinson SR-5E	Serious	-	0	-	0
415	11/6 '34	1:30A	Near Centerville, Pa.	Stinson SR 6000-B	Serious	-	0	-	1

TABLE P

TABLE P-2

Acc. No.	Date	Hour	Place	Type Aircraft	Damage to Aircraft	Fatalities Pass.	Fatalities Crew	Injuries Pass.	Injuries Crew
416	11/15 '34	12:15A	Airp. Memphis	Lockheed Orion 10-D	Destroyed	-	0	-	9
417	11/15 '34	8:45P	3 miles S.S.W. of Newhall, Calif.	Northrop	Serious	-	0	-	1
418	11/15 '34	11:42P	Near Amazonia, Mo.	Stinson SM 6000-B	Destroyed	1	1	0	0
419	11/24 '34	5:15A	Near Clemscott, Okla.	Lockheed Vega-5C	Serious	-	0	-	1
420	11/28 '34	5:10A	Near Kyles, Ala.	Pitcairn PA-8	Minor	-	0	-	1
421	12/8 '34	5:20A	4 3/4 miles East of Columbia, Mo.	Lockheed Vega 5-C	Destroyed	-	1	-	0
422	12/20 '34	8:15P	Near Western Springs, Ill.	Boeing 247-D	Major	0	0	0	2
423	12/22 '34	3:45A	Near Seabright, Tenn.	Lockheed Orion	Destroyed	-	1	0	0
424	12/26 '34	3:30A	Near Columbia, Mo.	Douglas DC-2	Serious	0	0	0	0
425	12/28 '34	8:35P	Near Wilmurt, N.Y.	Condor	Serious	0	0	0	0
501	12/10 '35	6:20A	Near Pittsburg Landing, Tenn.	Lockheed Orion 9-D	Destroyed	-	0	-	0
502	1/26 '35	2:20A	Near airpt.-Pittsburgh	Consol. Fleetster	Destroyed	-	1	0	0
503	1/31 '35	6:00P	Near Glendale, Cal.	Northrop Alpha 4-A	Serious	-	0	-	0
504	2/11 '35	6:55P	Near Yorkville, Ill.	Stinson SM 6000-B	Major	0	0	0	0

TABLE P-3

Acc. No.	Date	Hour	Place	Type Aircraft	Damage to Aircraft	Fatalities Pass.	Fatalities Crew	Injuries Pass.	Injuries Crew
505	2/15 '35	2:40P	Near Sullivan, Mo.	Vultee 4-A	Serious	0	0	2	1
506	2/26 '35	7:38P	Near Orange, Va.	Boeing 247	Minor	0	0	0	0
507	3/7 '35	3:10P	20 miles North of Casper, Wyo.	Stinson Reliant SR-5A	Serious	-	0	-	0
508	4/16 '35	4:20A	Near airpt., Detroit	Douglas DC-2	Major	0	0	0	3
509	4/16 '35	12:44P	On airpt., Columbus	Douglas DC-2	Serious	0	0	0	0
510	5/1 '35	10:45A	Rattlesnake Butte, Colo.	Lockheed Vega	Destroyed	-	1	-	0
511	5/6 '35	3:30A	Near Atlanta, Mo.	Douglas DC-2	Destroyed	3	2	7	1
512	5/27 '35	4:15P	Vic. Glendo, Wyo.	Boeing Monomail 221-A	Destroyed	-	1	-	0
513	5/28 '35	10:26P	4 miles Northwest of Milwood, Ill.	Stinson SM-6000-B	Destroyed	1	1	0	0
514	6/12 '35	5:35P	Near Harpers Ferry, Va.	Boeing 247	No	0	0	3	0
515	7/8 '35	10:35P	Airpt. Washington, D.C.	Douglas DC-2	Major	0	0	0	0
516	7/27 '35	2:55A	Near Murphreesboro, Tenn.	Condor AT-32	Major	0	0	3	0
517	8/3 '35	12:55A	30 miles East of Albuquerque	Douglas DC-2	Destroyed	0	0	0	0
518	8/14 '35	11:45P	Near Silmer, Texas	Stinson "A"	Destroyed	2	2	0	0
519	8/17 '35	2:50P	Near airpt. Seattle	Lockheed Electra 10-A	Major	0	0	0	0
520	9/1 '35	11:07P	Near airpt. Burbank	Boeing 247-D	Destroyed	-	3	0	0

TABLE P-4

Acc. No.	Date	Hour	Place	Type Aircraft	Damage to Aircraft	Fatalities Pass.	Fatalities Crew	Injuries Pass.	Injuries Crew
521	9/8 '35	3:50P	On airpt. Buffalo	Douglas DC-2	Minor	0	0	0	0
522	10/7 '35	2:19A	Near Cheyenne	Boeing 247-D	Destroyed	9	3	0	0
523	10/17 '35	2:30A	Near Jackson,Miss.	Lockheed Vega 5-C	Serious	-	0	-	0
524	10/18 '35	10:30A	On airpt. E.St.Louis	Stinson "U"	Serious	-	0	-	0
525	10/24 '35	4:55P	Near Franconia, Va.	Stearman 4-CH-1	Major	-	0	-	0
526	11/11 '35	11:00A	Near Crowley, La.	Lockheed Vega 5-C	Minor	0	0	0	0
527	11/16 '35	11:20A	On airpt. Pittsburgh	Stinson "A"	Major	0	0	0	0
528	12/12 '35	7:20A	Near Childress,Tex.	Lockheed Electra 10-A	Major	0	0	0	0
529	12/24 '35	5:13A	Near airpt.Birmingham	Lockheed Sirius 8-C	Major	-	0	-	1
601	1/3 '36	9:30A	On airpt.St.Paul,Minn.	Lockheed Electra 10-A	Serious	0	0	0	0
602	1/4 '36	1:40A	On airpt. Chattanooga	Lockheed Electra 10-B	Serious	-	0	-	0
603	1/14 '36	7:33P	Goodwin, Arkansas	Douglas DC-2	Destroyed	14	3	0	0
604	1/19 '36	7:50A	On airpt. Wichita Falls, Texas	Detroit Vega DL-1	Minor	-	0	-	0
605	1/29 '36	11:09A	79 miles East of Detroit	Douglas DC-2	Minor	0	0	0	0

TABLE P-5

Acc. No.	Date	Hour	Place	Type Aircraft	Damage to Aircraft	Fatalities Pass.	Fatalities Crew	Injuries Pass.	Injuries Crew
606	1/29 '36	3:06P	Little Elm, Texas	Vultee V1-A	Major	0	1	5	0
607	2/6 '36	11:54A	Airpt. Albany	Stinson "U"	Major	0	0	0	1
608	2/9 '36	12:20A	Airpt. Omaha	Boeing 40-B-4	Serious	-	0	-	0
609	2/12 '36	1:15A	Airpt.Louisville,Ky.	Condor	Serious	0	0	0	0
610	2/12 '36	3:20A	Airpt. El Paso	Condor AT-32	Serious	0	0	0	0
611	2/12 '36	7:25P	Airpt.Louisville,Ky.	Douglas DC-2	Serious	0	0	0	0
612	2/13 '36	12:30P	Airpt. Washington,D.C.	Douglas DC-2	Minor	0	0	0	0
613	3/9 '36	7:02P	Airpt. Lansing	Ford 5-AT-B	Serious	-	0	-	0
614	3/17 '36	3:45A	Adj. airpt. Cheyenne	Boeing 247-D	Serious	-	0	-	0
615	3/24 '36	11:16P	Airpt. Newark	Douglas DC-2	Serious	0	0	0	0
616	4/1 '36	7:14P	2 miles East of Pavilion, N.Y.	Stinson "A"	Destroyed	1	1	0	0
617	4/3 '36	3:04P	Adj.airpt.St.Louis	Vultee	Serious	0	0	0	0
618	4/7 '36	10:20A	Near Fairchance, Pa.	Douglas DC-2	Destroyed	10	2	1	1
619	4/11 '36	8:52P	Airpt. Columbus	Douglas DC-2	Serious	0	0	0	0

TABLE P-6

Acc. No.	Date	Hour	Place	Type Aircraft	Damage to Aircraft	Fatalities Pass.	Fatalities Crew	Injuries Pass.	Injuries Crew
620	4/15 '36	1:54A	Airpt. Chicago	Douglas DC-2	Serious	0	0	0	0
621	5/8 '36	7:10P	1 mile East of Maderia, Ohio	Vultee	Minor	0	0	0	0
622	5/26 '36	3:35P	Airpt. Chicago	Stinson "A"	Destroyed	0	0	2	1
623	5/31 '36	9:04P	Vic. Airpt. Chicago	Douglas DC-2	Major	0	0	12	3
624	6/10 '36	7:20A	On airpt. Mobile	Lockheed Electra 10-B	Serious	0	0	0	0
625	6/14 '36	12:22P	On airpt.Elkins,W.Va.	Stinson "A"	Serious	0	0	0	0
626	8/5 '36	10:00P	Vic.airpt. Robertson, Mo.	Lockheed Electra 10-B	Destroyed	6	2	0	0
627	8/22 '36	9:40A	On airpt. Minneapolis	Lockheed Electra 10-A	Serious	-	0	-	0
628	8/23 '36	10:00P	On airpt. Detroit	Boeing 247	Serious	0	0	0	0
629	10/24 '36	12:10P	Buffalo, Wyo.	Lockheed Orion 9-D	Serious	0	0	0	1
630	10/26 '36	1:50A	On airpt. Kansas City	Lockheed Electra 10-A	Serious	-	0	-	0
631	10/26 '36	2:45P	On airpt. Robertson, Mo.	Condor AT-32	Serious	0	0	0	0
632	11/14 '36	4:45A	On airpt. Washington, D.C.	Stinson "A"	Serious	0	0	0	0
633	11/24 '36	3:00A	Vic. airpt. Newark	Boeing 247-D	Major	0	0	0	1
634	12/15 '36	3:14A	Near Salt Lake City	Boeing 247-D	Destroyed	4	3	0	0

TABLE P-6

TABLE P-7

Acc. No.	Date	Hour	Place	Type Aircraft	Damage to Aircraft	Fatalities Pass.	Fatalities Crew	Injuries Pass.	Injuries Crew
635	12/18 '36	3:23A	12 miles SW of Kellogg, Idaho	Lockheed Electra 10-A	Destroyed	0	2	0	0
636	12/19 '36	8:47P	4 miles NE of Milford, Pa.	Douglas DC-2	Major	0	0	1	2
637	12/27 '36	7:38P	Near Newhall, Calif.	Boeing 247-D	Destroyed	9	3	0	0
701	1/12 '37	11:07A	Near Newhall, Calif.	Boeing 247-D	Destroyed	5	1	6	2
702	1/17 '37	1:00P	On airpt. Charleston	Douglas DC-2	Serious	0	0	0	0
703	1/19 '37	10:50A	On airpt. Jackson, Miss.	Lockheed Electra 10-B	Major	0	0	0	0
704	2/5 '37	9:32A	On airpt. Portland, Mo.	Lockheed Electra 10-A	Serious	0	0	0	0
705	2/9 '37	6:50P	Vic. airpt. San Fran.	Douglas DC-3A	Destroyed	8	3	0	0
706	2/18 '37	1:40A	On airpt. Atlanta	Douglas DC-2	Serious	0	0	0	0
707	3/25 '37	6:40P	New Clifton, Pa.	Douglas DC-2	Destroyed	10	3	0	0
708	4/9 '37	12:17A	2 miles North of Townsend, Mont.-enroute	Lockheed Electra 10-A	Serious	0	0	0	0
709	4/26 '37	12noon	Enroute - near Springfield, Mo.	Douglas DC-2	Minor	0	0	0	0
710	4/27 '37	9:05P	½ NE airpt. Cheyenne	Douglas DC-3	Major	0	0	0	0
711	5/17 '37	1:54P	Near Billings, Mont.	Lockheed Electra 10-A	Minor	0	0	0	0
712	5/18 '37	3:55P	On airpt. El Paso	Lockheed Vega 5-C	Major	0	0	2	0

TABLE P-7

TABLE P-8

Acc. No.	Date	Hour	Place	Type Aircraft	Damage to Aircraft	Fatalities Pass.	Fatalities Crew	Injuries Pass.	Injuries Crew
713	6/5 '37	7:10P	On airpt. Pittsburgh	Douglas DC-2	Major	0	0	0	0
714	8/1 '37	3:45P	6 miles NW of Ellendale,N.Dak.-enroute	Lockheed Vega 5-C	Minor	0	0	0	0
715	8/10 '37	4:40A	Vic. airpt. Daytona Beach	Douglas DC-2	Destroyed	2	2	4	1
716	8/19 '37	3:05P	On airpt. Chicago	Douglas DC-3-A	Major	0	0	0	0
717	10/2 '37	6:04A	On airpt. Chicago	Douglas DC-3	Serious	0	0	0	0
718	10/17 '37	9;00P	Near Humpy Ridge,Utah	Douglas DC-3A	Destroyed	16	3	0	0
719	10/29 '37	2:00P	On airpt. Newark	Douglas DC-3	Serious	0	0	0	0
801	1/10 '38	3:07P	Near Bozeman,Mont.	Lockheed 14-H	Destroyed	5	2	0	0
802	1/30 '38	4:56P	On airpt. Concord,N.H.	Lockheed Electra 10-B	Serious	0	0	0	0

TABLE P-8