AN ANALYSIS OF AIRCRAFT ACCIDENT DATA

U. S. AIR CARRIER OPERATIONS

1967

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NATIONAL TRANSPORTATION SAFETY BOARD
Department of Transportation
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This report provides a compilation and a statistical analysis of aircraft accidents in U. S. Air Carrier Operations that occurred during calendar year 1967. This analysis is in the form of statistical data which is presented in the following pages of narrative and illustrative tables.

Section I of this report presents data on accidents, fatalities, rates, and growth changes as percentage changes of the 1967 data compared with a base figure. The base figure was established by averaging the data for the five year period 1962 - 1966. Such a presentation helps to eliminate annual variations inherent in accident report data and allows more meaningful comparisons than would the customary year-by-year comparisons. This base figure establishes a standard by which data from two or more years can be gauged. This standard should be useful in comparing growth and annual percentage changes in fatalities, accident rates, aircraft miles and hours, passengers carried, passenger-miles, and other important annual variables. Furthermore, if this method of analysis is used for several consecutive years the Board will have a sound basis for analyzing and projecting trends dealing with both growth and accident indices. It is important to note, however, that this section, which is a comparison of one years's data with the base period data, does not provide the basis for trends and/or projections, any more than would a comparison of data from two individual years. This section and similar sections over the next several years will provide such a basis, however.

Section II presents an analysis of turbulence accidents during the period 1964 through 1967. Data from earlier years is included to provide a more realistic picture of the nature of these accidents.

Section III explains, presents, and analyzes a new method employing phase of operation for determining safety rates for U. S. Air Carriers.

Section IV examines the 70 accidents occurring in 1967 by several indices in an effort to determine the nature and effect of certain variables which appear to affect aircraft safety.

Highlights of the analysis are:

1. U. S. Certificated Route and Supplemental Air Carriers in All Operations showed in 1967 an increase over the base figure of 54.74 per cent in aircraft miles flown. The total accident rate per million aircraft miles flown decreased 40.77 per cent to .0321. The fatal accident rate per million aircraft miles flown was .0056, compared with .0072 in the base period.

2. Comparing 1967 to the base period, U. S. Certificated Route Air Carriers in All Operations recorded a 54.55 per cent increase in aircraft miles flown. The total accident rate per million aircraft miles flown decreased from .0503 during the base period to .0317 in 1967, while the fatal accident rate per million aircraft miles flown decreased from .0064 to .0050.

3. U. S. Certificated Route Air Carriers in All Scheduled Service recorded 49.58 per cent more aircraft miles in 1967 than during the average base period year. Aircraft hours and aircraft departures increased 28.40 per cent and 23.82 per cent, respectively. The total accident rate per million aircraft miles flown decreased from .046 to .029, while the fatal accident rate per million aircraft miles flown decreased from .006 to .004. The total accident rate per 100,000 aircraft departures decreased from 1.397 to 1.092, while the fatal accident rate per 100,000 departures decreased to .162 from .170. Very similar rates per 100,000 aircraft hours flown were recorded. The total accident rate declined from 1.455 to 1.097, while the fatal accident rate decreased to .162 from .177.

4. U. S. Certificated Route Air Carriers in Scheduled Domestic and International Passenger Service carried 57.32 per cent more passengers in 1967 than in the average base period year. The passenger fatality rate per 100 million passenger miles increased from .2181 to .2186 in 1967.

5. U. S. Certificated Route Air Carriers in Scheduled Domestic Passenger Service carried 58.19 per cent more passengers in 1967 than in the average base period year. The number of fatal injuries increased 88.82 per cent in 1967, and the passenger fatality rate per 100 million passenger miles flown increased from .209 during the base period to .286 in 1967.

6. U. S. Certificated Route Air Carriers engaged in Scheduled International Passenger Service experienced a 50.07 per cent increase in passengers carried over the base period figure. The total number of accidents increased 8.11 per cent but no fatal accidents or fatalities were recorded in 1967. This excellent record also helps to keep the fatality figures and rates low when the data is combined with that of Domestic Service, as in item #4 above.

7. An increase of 58.87 per cent in aircraft miles flown was recorded by the U. S. Supplemental Air Carriers in All Operations in 1967. The total number of accidents showed a 53.49 per cent decrease, and fatal accidents decreased 37.50 per cent. A total of three fatalities (crew members) was recorded in 1967, and the fatality rate per million aircraft miles flown decreased from .341 to .031.

8. In 1967, U. S. Supplemental Air Carriers engaged in Civil and Military Passenger Operations recorded a 136.04 per cent increase in passengers carried over the base period. No accidents and no fatalities were recorded in 1967 despite the very substantial increase in activity.

9. Turbulence accidents seldom damage the aircraft involved and in over 40 per cent of the accidents studied the only persons injured were cabin attendents. Based on the accidents studied, turbulence accidents are more prevalent at certain times of the year, in certain states, and when the aircraft is in certain phases of operation.

10. During the period 1964-1967, the total accident rate in certain phases of operation was over seven times higher for nonscheduled service than for scheduled service.

11. There appear to be substantial differences between the safety of the operations of other classes of carriers when those operations are examined by phase of operation. Differences are noted in Scheduled Domestic Service vs. Scheduled International Service as well as in Trunk Carriers vs. Local Service Carriers within Scheduled Domestic Service.

12. The most frequent type of accident in 1967 was turbulence, and it occurred most often in the in flight phase of operation, as opposed to the takeoff or landing phase of operation.

13. Turbojet aircraft established the best aircraft-hours-per-accident rate, total and fatal, in 1967, recording 135,974 hours per accident and 611,893 hours per fatal accident.

14. The pilot was cited as a cause (not necessarily the cause) in 50 per cent of the fatal accidents in 1967.

15. Almost 25 per cent of the 70 accidents occurring in 1967 were weather involved, and the most frequent weather involvement was turbulence-associated with clouds, thunderstorms.

SECTION I

ANALYSIS BY CLASS OF CARRIER

U. S. CERTIFICATED ROUTE AND SUPPLEMENTAL AIR CARRIERS ALL OPERATIONS

In 1967, U. S. Certificated Route and Supplemental Air Carriers in all operations flew 2,179,739,000 aircraft miles, an increase of 54.74 per cent over the 1962-1966 base period average of 1,408,681,200 aircraft miles per year. The total number of accidents decreased but fatal accidents and fatal injuries showed increases of 13.21 per cent and 4.76 per cent respectively. This decrease in total accidents coupled with an increase in fatal accidents is probably a reflection of the recent trend toward faster aircraft with increased passenger capacity. The increased safety of operations in this area is shown in the 40.77 per cent decrease of the total accident rate per million aircraft miles flown and in the 22.22 per cent decrease of the fatal accident rate per million aircraft miles flown. The fatality rate per 1,000,000 aircraft miles flown showed a decrease of 27.31 per cent.

ACCIDENTS, FATALITIES, RATES, AND GROWTH CHANGES FROM BASE (1962-1966)

	Base	1967	Percentage Change
Aircraft Miles Flown	1,408,681,200 a/	2,179,739,000 a/	+54.74%
Accidents			
Total Accidents	76.8	70	- 8.85%
Fatal Accidents	10.6	12	+13.21%

a/ Nonrevenue miles of the Supplemental Air Carriers were not reported in 1963, 1964, 1965, 1966, and 1967.

ACCIDENTS, FATALITIES, RATES, AND GROWTH CHANGE FROM BASE (1962-1966)

	Base	1967	Percentage Change
Fatal Injuries	273.0	286	+ 4.76%
Accident Rate Per Million Aircraft Miles Flown			
Total Accidents	.0542	.0321	-40.77%
Fatal Accidents	.0072	.0056	-22.22%
Fatality Rate Per Million Aircraft Miles Flown	.1805	.1312	-27.31%

Note: Sabotage accidents occurring 5/22/62 (45 fatalities) and 5/7/64 (44 fatalities) are included in all computations except rates.

U. S. CERTIFICATED ROUTE AIR CARRIERS
ALL OPERATIONS
1967

During the base period 1962 - 1966, U. S. Certificated Route Air Carriers, All Operations, flew an average of 1,348,208,800 aircraft miles per year. In 1967, the figure was 2,083,668,000, representing an increase of 54.55 per cent. The total number of accidents decreased while fatal accidents increased 22.22 per cent. Fatal injuries increased 12.12 per cent. This pattern of a decrease in total accidents coupled with an increase in both fatal accidents and fatal injuries is similar to the data in these categories in Section I. It, too, is probably due to the continued increase in 1967 in the use of higher capacity, higher cruising speed aircraft. Again, accident rates per million aircraft miles showed significant decreases, with the figures for total accidents and fatal accidents representing 36.98 per cent and 21.88 per cent decreases, respectively.

ACCIDENTS, FATALITIES, RATES, AND GROWTH CHANGES FROM BASE (1962 - 1966)

	Base	1967	Percentage Change
Aircraft Miles Flown	1,348,208,800	2,083,668,000	+54.55%
Accidents			
Total Accidents	68.2	66	- 3.23%
Fatal Accidents	9.0	11	+22.22%
Fatal Injuries	252.4	283	+12.12%
Accident Rates Per Million Aircraft Miles Flown			
Total Accidents	.0503	.0317	-36.98%
Fatal Accidents	.0064	.0050	-21.88%
Fatality Rate Per Million Aircraft Miles Flown	.1740	.1358	-21.95%

Note: Sabotage accidents occurring 5/22/62 (45 fatalities) and 5/7/64 (44 fatalities) are included in all computations except rates.

U. S. CERTIFICATED ROUTE AIR CARRIERS

ALL SCHEDULED SERVICE

This segment of U. S. Air Carrier Operations showed a significant increase in aircraft activity. Aircraft hours flown increased from 3,835,028 for the base period to 4,924,080 for 1967, an increase of 28.40 per cent. The corresponding figures for aircraft miles flown indicate an increase from 1,225,823,307 for the base period to 1,833,562,999 for 1967, an increase of 49.58 per cent. Aircraft departures increased 23.83 per cent, from 3,994,565 for the base period to 4,945,696 for 1967. Since aircraft miles flown have increased much more rapidly than aircraft hours flown, it can be concluded that faster aircraft are replacing slower aircraft in the fleet at a rapid pace. Even with this large increase in activity, the total number of accidents decreased 3.91 per cent. Fatal accidents increased by 11 per cent, but, due to the small number of cases involved, it is difficult to interpret such a percentage rise.

Accident rates for total accidents show that 1967 was a significantly safer year than the average base period year. The rates per million aircraft miles flown decreased 36.96 per cent for the total number of accidents, while fatal accident rates showed a decrease of 33.33 per cent from the base period. The accident rates per 100,000 aircraft departures showed a decrease of 21.73 per cent for total accidents in 1967 and a decrease of 4.71 per cent in fatal accidents. Accident rates per 100,000 hours flown showed, for all accidents, a 24.60 per cent decrease from the 1962 - 1966 average, while the number of fatal accidents decreased 8.47 per cent.

ACCIDENTS, ACCIDENT RATES, GROWTH CHANGES FROM BASE (1962 - 1966)

	Base	1967	Percentage Change
Aircraft Miles Flown	1,225,823,307	1,883,562,999	+49.58%
Aircraft Hours Flown	3,835,028	4,924,080	+28.40%
Aircraft Departures	3,994,565	4,945,696	+23.82%
Accidents			
Total Accidents	56.2	54	- 3.91%
Fatal Accidents	7.2	8	+11.11

ACCIDENTS, ACCIDENT RATES, GROWTH CHANGES FROM BASE (1962-1966)

Accident Rates Per Million Aircraft Miles Flown	Base	1967	Percentage Change
Total Accidents	.046	.029	-36.96%
Fatal Accidents	.006	.004	-33.33%
Accident Rates Per 100,000 Aircraft Departures			
Total Accidents	1.397	1.092	-21.83%
Fatal Accidents	0.170	0.162	- 4.71%
Accident Rates Per 100,000 Aircraft Hours Flown			
Total Accidents	1.455	1.097	-24.60%
Fatal Accidents	0.177	0.162	- 8.47%

Note: Sabotage accidents occurring 5/22/62 and 5/7/64 are included in all computations except rates.

U. S. CERTIFICATED ROUTE AIR CARRIERS

SCHEDULED DOMESTIC AND INTERNATIONAL PASSENGER SERVICE

Scheduled Domestic and International Passenger Service of the U. S. Certificated Route Air Carriers in 1967 showed a significant increase (57.32 per cent) over the base period in the number of passengers carried. Passenger-miles flown also increased from 62,903,552,000 for the base period to 103,381,996,000 for 1967, an increase of 64.35 per cent. The familiar pattern of decrease (2.30 per cent) in the total number of accidents and an increase (33.33 per cent) in the number of fatal accidents again points to an increase in the use of faster, higher passenger-capacity aircraft which are more reliable than the aircraft they replace. However, survivability in a fatal crash situation is of considerable concern during the continuing transition to high performance, higher passenger capacity aircraft. This is demonstrated by the fact that passenger fatalities increased 47.91 per cent, while fatal accidents increased 33.33 per cent.

Even though fatalities increased by 42.21 percent in 1967, the even greater increase in passenger-miles flown nearly countered the effects of such a large fatality increase, the passenger fatality rate per 100 million passenger miles flown increasing only 0.23 per cent from the base period figure.

ACCIDENTS, ACCIDENT RATES, GROWTH CHANGES FROM BASE (1962 - 1966)

	Base	1967	Percentage Change
Passengers Carried	83,960,274	132,088,083	+57.32%
Passenger Miles Flown	62,903,552,000	103,381,996,000	+64.35%
Accidents			
Total Accidents	52.2	51	- 2.30%
Fatal Accidents	6.0	8	+33.33%
Fatal Injuries			
Passengers	152.8	226	+47.91%
Crew	23.0	24	+ 4.35%
Total	175.8	250	+42.21%
Passenger Fatality Rate Per 100 Million Passenger Miles Flown	0.2181	0.2186	+ 0.23%

Note: Passenger deaths occurring in sabotage accidents 5/22/62 (37 fatalities) and 5/7/64 (41 fatalities) are included in all computations except rates.

U. S. CERTIFICATED ROUTE AIR CARRIERS
SCHEDULED DOMESTIC PASSENGER SERVICE
1967

U. S. Certificated Route Air Carriers engaged in Scheduled Domestic Passenger Service during 1967 carried 118,663,542 passengers, representing a significant increase (58.19 per cent) over the base period figure of 75,014,942. Passenger-miles flown, however, showed a larger rate of increase, indicating that the average passenger in 1967 was carried more miles (665) than the average passenger in the base period (636.7). The total number of accidents decreased slightly, while fatal accidents showed a marked increase of 60 per cent. Fatal injuries to passengers increased from an average of 115.2 for the 1962 - 1966 period to 226 in 1967, indicating a 96.18 per cent increase. Crew fatalities climbed 39.53 per cent, while injuries to others numbered 4 (since the base figure for this category is 0, no percentage of increase can be given). The total number of fatalities in 1967 increased 88.82 per cent over the base period figure. These increases are reflected in the passenger fatality rate per 100 million passenger-miles flown, which increased 37.32 per cent.

ACCIDENTS, ACCIDENT RATES, GROWTH CHANGES FROM BASE (1962 - 1966)

	Base	1967	Percentage Change
Passengers Carried	75,014,942	118,663,542	+58.19%
Passenger-Miles Flown	47,762,970,400	78,911,773,000	+65.21%
Accidents			
Total Accidents	44.8	43	- 4.02%
Fatal Accidents	5.0	8	+60.0%
Fatal Injuries			
Passengers	115.2	226	+96.18%
Crew	17.2	24	+39.53%
Total	132.4	250	88.82%
Passenger Fatality Rate Per 100 Million Passenger-Miles Flown	0.209	0.286	+37.32%

Note: Passenger deaths occurring in sabotage accidents 5/22/62 (37 fatalities) and 5/7/64 (41 fatalities) are included in all computations except rates.

U. S. CERTIFICATED ROUTE AIR CARRIERS
SCHEDULED INTERNATIONAL PASSENGER SERVICE
1967

In 1967, U. S. Certificated Route Air Carriers engaged in Scheduled International Passenger Service showed large increases in activity indicators while registering no fatalities. The number of accidents increased slightly, but did not match the degree that both the number of passengers carried and the number of passenger-miles flown increased in 1967. U. S. Certificated Route Air Carriers engaged in Scheduled International Passenger Service have completed two consecutive years of operation without recording any fatalities to passengers or crew.

ACCIDENTS, FATALITIES, RATES, AND GROWTH CHANGES FROM BASE (1962-1966)

	Base	1967	Percentage
Passengers Carried	8,945,331	13,424,496	+50.07%
Passenger-Miles Flown	15,142,067,800	24,470,223,000	+61.60%
Accidents			
Total Accidents	7.4	8	+ 8.11%
Fatal Accidents	1.0	0	-100%
Fatal Injuries			
Passengers	37.6	0	-100%
Crew	5.8	0	-100%
Others	0.2	0	-100%
Total	43.6	0	-100%
Passenger Fatality Rate Per 100 Million Passenger-Miles Flown	0.248	0	-100%

U. S. SUPPLEMENTAL AIR CARRIERS
ALL OPERATIONS
1967

All operations in 1967 were safer for U. S. Supplemental Air Carriers than in the average base period year, despite a 57.87 per cent increase in aircraft miles flown. The total number of accidents decreased 53.49 per cent, while fatal accidents decreased 37.50 per cent. Large percentage decreases can be noted in the fatality categories. There were no passenger fatalities, and crew fatalities showed an 85.44 per cent decrease. Accident rates per million aircraft miles flown showed substantial decreases of 70.42 per cent and 62.96 per cent for the total number of accidents per million aircraft miles and the fatal accidents per million aircraft miles flown, respectively. The fatality rate per million aircraft miles flown decreased 90.91 per cent to 0.031.

ACCIDENTS, FATALITIES, RATES AND GROWTH CHANGES FROM BASE (1962 - 1966)

	Base	1967	Percentage Change
Aircraft Miles Flown	60,472,400 a/	96,071,000 a/	+58.87%
Aecidents			
Total Accidents	8.6	.4	-53.49%
Fatal Accidents	1.6	1	-37.50%
Fatal Injuries	20.6	3	-85.44%
Accident Rates Per Million Aircraft Miles Flown			
Total Accidents	0.142	0.042	-70.42%
Fatal Accidents	0.027	0.010	-62.96%
Fatality Rate Per Million Aircraft Miles Flown	0.341	0.031	-90.91%

a/ Nonrevenue miles not reported for 1963, 1964, 1965,1966, and 1967.

U. S. SUPPLEMENTAL AIR CARRIERS
PASSENGER OPERATIONS-CIVIL AND MILITARY
1967

In 1967, U. S. Supplemental Air Carriers engaged in Civil and Military Passenger Operations flew approximately six billion passenger-miles, representing a significant 162.07 per cent increase over the approximately 2.3 billion passenger-miles averaged during the base period of 1962 - 1966. An increase of 136.04 per cent in passengers carried is further evidence of the large increase in activity for 1967. Since there were no accidents and no fatalities in 1967, all the categories of accident, fatality, and rate information either show a 100 per cent decrease or indicate no change from the base figure. The extremely safe year recorded by Passenger Operations of the Supplemental Air Carriers helped to keep the accident, fatality, and rate figures presented under "All Operations" down as well.

ACCIDENTS, FATALITIES, RATES, AND GROWTH CHANGES FROM BASE (1962 - 1966)

	Base	1967	Percentage Change
Passenger-Miles Flown	2,287,920,000	5,995,901,000	+162.07%
Passengers Carried	981,121,6(est.)	2,315,820	+136.04%
Accidents			
Total Accidents	.8	0	-100%
Fatal Accidents	.2	0	-100%
Fatal Injuries			
Passengers	15.6	0	-100%
Crew	1.0	0	-100%
Others	0	0	No Change
Total	16.6	0	-100%
Passenger Fatality Rate Per 100 Million Passenger-Miles Flown	.682	0	-100%

A COMPARISON OF SCHEDULED INTERNATIONAL PASSENGER SERVICE VS. SCHEDULED DOMESTIC PASSENGER SERVICE 1967

Growth rates of Domestic Passenger Service and International Passenger Service of the U. S. Certificated Route Air Carriers for 1967 were similar, with Domestic Service showing a 58.19 per cent increase over the base period in passengers carried and International Service showing a 50.07 per cent increase. Domestic Service accounted for a larger increase in passenger-miles flown in 1967, with a growth rate of 65.21 per cent as compared with 61.60 per cent for International Service. Both areas showed little deviation from the 1962 - 1966 average in total number of accidents, but Domestic Service suffered a 60 per cent increase in the number of fatal accidents, while International Service showed a 100 per cent decrease. The other fatality indices show similar differences with International Service showing sharp decreases and Domestic Service showing substantial increases.

U. S. CERTIFICATED ROUTE AIR CARRIERS

Accident Data	Domestic Service	International Service
Accidents		
Base	44.8	7.4
1967	43	8
Percentage Change	-4.02%	+8.11%
Fatal Accidents		
Base	5.0	1.0
1967	8	0
Percentage Change	+60%	-100%
Fatalities		
Passenger		
Base	115.2	37.6
1967	226	0
Percentage Change	+96.18%	-100%
Crew		
Base	17.2	5.8
1967	24	0
Percentage Change	+39.53%	-100%

U. S. CERTIFICATED ROUTE AIR CARRIERS

Accident Data	Domestic Service	International Service
Total		
Base	132.4	43.6
1967	250.0	0
Percentage Change	+88.82%	-100%
Passengers Carried		
Base	75,014,942	8,945,331
1967	118,663,542	13,424,496
Percentage Change	+58.19%	+50.07%
Passenger-Miles Flown		
Base	47,762,970,400	15,142,067,800
1967	78,911,773,000	24,470,223,000
Percentage Change	+65.21%	+61.60%
Passenger Fatality Rates Per 100 Million Passenger Miles Flown		
Base	0.209	0.248
1967	0.286	0
Percentage Change	+37.32%	-100.%

Note: Passenger deaths occurring in sabotage accidents are included in the passenger fatality column but excluded in the computation of passenger fatality rates. 1962 - 37; 1964 - 41.

SECTION II

AN ANALYSIS OF TURBULENCE ACCIDENTS 1964-1967

The purpose of this section is to provide statistical data on U. S. Air Carrier accidents involving inflight turbulence. Unless otherwise indicated, the data in this section were drawn from the records of the 49 turbulence accidents occurring from 1964 through 1967. These 49 turbulence accidents represent 16 per cent of the 307 air carrier accidents occurring in the four year period.

Aircraft Damage

Of those aircraft involved in turbulence accidents, 82 per cent incurred no damage. Substantial damage occurred in 12.2 per cent of the accidents, while 4.1 per cent of the aircraft were destroyed.

Type of Aircraft Power

Almost 86 per cent of all clear air turbulence accidents involved turbojet powered aircraft, while 7.1 per cent involved piston powered aircraft and 7.1 per cent involved turboprop powered aircraft. Over 63 per cent of all turbulence/associated with clouds, thunderstorms accidents involved turbojet powered aircraft, while 16.7 per cent involved piston powered aircraft, and 20.0 per cent involved turboprop powered aircraft.

Weather Forecast

When the weather forecast information provided to the pilot was available and reported to the accident investigator, it was found to be substantially correct in 80.0 per cent of the accidents. In 11.4 per cent of the accidents, the weather was slightly worse than forecast; while in 8.6 per cent, the weather was considerably worse than forecast.

Phase of Operation

Nearly all of the accidents (98 per cent) occurred in the in flight phase of operation as opposed to the takeoff or landing phase of operation. Over 63 per cent of the 49 turbulence accidents occurred in the in flight, normal cruise phase, while the in flight, descending and in flight, climb to cruise phases accounted for 18.3 per cent and 16.3 per cent, respectively.

Injuries

In over 40 per cent of the 49 accidents, the only persons injured were crew members. In 51 per cent, the only persons injured were passengers, while in 6.1 per cent, both passengers and crew substained injuries. In two per cent of the accidents there was no injury.

Probable Cause

In 45 accidents in which a probable cause was assigned, turbulence-associated with clouds or thunderstorms was listed as a cause (not necessarily the cause) 29 times. Turbulence-in flight, clear air, was cited 12 times. Miscellaneous personnel-passengers, were listed as a cause in 12 instances, while the category of Miscellaneous Acts, Conditions-seat belt not fastened, was cited 10 times. Other flight personnel were listed five times, as was the pilot in command. No other causal category was listed more than twice.

The following data are based on reports of the 83 turbulence accidents occurring during the period 1960-1967.

Month of Occurrence

There appears to be a substantial relationship between the number of turbulence accidents and the time of year. In the five month period from October through February, turbulence accidents occurred at a rate (an average of 4.4 turbulence accidents per month) slightly less than one half the rate (8.7 per month) of the remaining seven months of the year.

Location of Accident

Twenty nine states and several foreign countries were listed as places of occurrence for the 83 turbulence accidents recorded during the period 1960-1967. Seven states, Flordia (11 accidents), California (5), Illinois (5), Pennsylvania (5), Colorado (4), Nebraska (4), and North Carolina (4) accounted for 45.8 per cent of the accidents.

SECTION III

ACCIDENTS, RATES, BY PHASE OF OPERATION
1964-1967

Table I was compiled from aircraft accident and growth data from the four-year period 1964-1967. The table provides two separate rates (a total accident rate and a fatal accident rate) for two broad phases of operation. The "inflight" phase of operation begins after the first power reduction following takeoff and ends when landing manuevers (such as traffic pattern-circling, initial and final approach, etc.) begin. The "other than in flight" broad phase encompasses the static, taxi, takeoff, and landing phases of operation.

The table is presented to provide a basis of comparison for the similar table (1967 data only) presented on page 7 of the review.

Scheduled Service vs. Nonscheduled Service

The total and fatal accident rates, in flight phase are slightly higher for scheduled service than for nonscheduled service. The total accident rate, other than in flight phase is, however, over seven times higher for nonscheduled service than for scheduled service (5.394 vs. .796). The fatal accident rate, other than in flight phase is over 16 times higher for nonscheduled service than for scheduled service.

Scheduled Domestic vs. Scheduled International

The total accident rate, in flight phase is higher for Scheduled Domestic Service than for International Service (.017 vs. .012 respectively). The total accident rate, other than in flight is nearly twice as high for International Service as for Domestic Service (1.362 vs. .758 respectively). The fatal accident rate, other than in flight phase is almost three times higher for International Service than for Domestic Service (.182 vs. .061).

Trunk vs. Local Service Carriers-Scheduled Domestic Service

Local service carriers have established a total accident rate, in flight phase which is two times higher than the rate for trunk carriers (.030 vs. .014). The fatal accident rate, in flight phase is five times higher for local service than for trunk carriers (.010 vs. .002). The total and fatal accident rates, other than in flight phase are similar for the two classes of carriers, with the rates for trunk being slightly higher.

Comparisons such as these are subject to change as new data become available, but the conclusions drawn in these comparisons appear to be valid. Comparisons using Table I are likely to be questionable if those comparisons include classes of carriers with relatively small exposure figures.

TABLE I

ACCIDENTS, RATES
BY PHASE OF OPERATION
CERTIFICATED ROUTE AIR CARRIERS
ALL REVENUE OPERATIONS
1964 - 1967

CLASS OF CARRIER	FIRST PHASE OF OPERATION: Inflight Total	Inflight Fatal	Other Than Inflight Total	Other Than Inflight Fatal	Aircraft Miles Flown	Number of Departures	ACCIDENT RATES: Inflight Phase Per Million Aircraft Miles Total	Inflight Phase Per Million Aircraft Miles Fatal	Other Than Inflight Phase Per 100,000 Departures Total	Other Than Inflight Phase Per 100,000 Departures Fatal
SCHEDULED SERVICE 1/										
1. Domestic Carriers										
Trunk	54	7	61	5	3,988,782,701	9,398,584	.014	.002	.649	.053
Local Service	19	6	32	3	628,818,307	5,721,460	.030	.010	.559	.052
Helicopter	1	0	7	0	8,861,935	543,338	.113	.000	1.288	.000
All Cargo	1	1	6	2	43,652,371	65,601	.023	.023	9.146	3.049
Other	0	0	0	0	67,122	588	.000	.000	.000	.000
Subtotal	75	14	106	10	4,670,182,436	15,729,571	.016	.003	.674	.064
Intra-Alaska	5	3	17	0	32,161,176	402,243	.155	.093	4.226	.000
Intra-Hawaii	1	0	1	0	27,477,100	237,595	.036	.000	.421	.000
TOTAL DOMESTIC	81	17	124	10	4,729,820,712	16,369,409	.017	.004	.758	.061
2. International Carriers										
Passenger/Cargo	13	2	15	2	1,098,571,489	1,075,317	.012	.002	1.395	.186
All Cargo	0	0	0	0	30,078,673	26,044	.000	.000	.000	.000
TOTAL INTERNATIONAL	13	2	15	2	1,128,650,162	1,101,361	.012	.002	1.362	.182
TOTAL SCHEDULED SERVICE	94	19	139	12	5,858,470,874	17,470,770	.016	.003	.796	.069
NONSCHEDULED REVENUE SERVICE										
1. Domestic Carriers										
Trunk	1	0	2	0	74,226,040	44,452	.013	.000	4.499	.000
Local Service	0	0	1	1	7,424,813	24,579	.000	.000	4.069	4.069
Helicopter	1	0	0	0	992,381	10,488	1.008	.000	.000	.000
All Cargo	0	0	1	0	79,627,408	71,223	.000	.000	1.404	.000
Other	0	0	0	0	481	2	.000	.000	.000	.000
Subtotal	2	0	4	1	162,271,123	150,744	.012	.000	2.654	.663
Intra-Alaska	1	0	8	1	8,691,602	82,412	.115	.000	9.707	1.213
Intra-Hawaii	0	0	0	0	352,078	2,572	.000	.000	.000	.000
TOTAL DOMESTIC	3	0	12	2	171,314,803	235,728	.018	.000	5.091	.848
2. International Carriers										
Passenger/Cargo	1	0	3	0	166,512,992	83,392	.006	.000	3.597	.000
All Cargo	0	0	4	2	72,816,555	33,107	.000	.000	12.082	6.041
TOTAL INTERNATIONAL	1	0	7	2	239,329,547	116,499	.004	.000	6.009	1.717
TOTAL NONSCHEDULED SERVICE	4	0	19	4	410,644,350	352,227	.010	.000	5.394	1.136
GRAND TOTAL	98	19	158	16	6,269,115,224	17,822,997	.016	.003	.886	.090

1/ Collisions between U. S. Air Carrier aircraft in different classes of Carriers counted as one phase of operation in total.

Note: Phase of operation category "other than inflight" includes all static, taxi, takeoff and landing phases of operation.

SECTION IV

ANALYSIS OF 1967 AIR CARRIER ACCIDENTS

Type of Accident vs. Phase of Operation

The most frequent combination of type of accident and phase of operation was turbulence - in flight, normal cruise, which accounted for 10 (14.3 per cent) of the 70 accidents. Six (8.6 per cent) accidents were wheels-up landings occurring during the level off/touchdown phase of operation. Four accidents (5.7 per cent) were ground-waterloop, swerves occurring during landing roll, while four more (5.7 per cent) were instances of gear collapsing during the landing roll. No other combination of accident type vs. phase of operation accounted for as much as 5 per cent of the total of 70 accidents.

Analysis by Type of Aircraft

There appears to be a relationship between the safety of operations and the type of aircraft involved in those operations. In 1967, for instance, piston engined aircraft flew 42,964 hours per accident, while turboprop aircraft flew 52,572 hours per accident. Turbojet aircraft had the best record, flying 135,974 hours per accident. Piston engined aircraft flew 286,428 hours per fatal accident; turboprop aircraft flew 482,152 hours per fatal accident; turbojet aircraft flew 611,893 hours per fatal accident.

Accidents by Broad Cause/Factor

Fatal Accidents:

The Pilot was cited a a cause (not necessarily the cause) in five of the 10 fatal accidents, while Personnel (other than the pilot) were cited in three. The Powerplant was listed twice as a cause, while Systems were cited once. One fatal accident cause fell in the Miscellaneous category, while one was Undetermined.

The Pilot was cited as a factor in one fatal accident, as were Systems, Weather, Airports/Airways/Facilities, and Miscellaneous. Personnel were cited twice as factors.

Nonfatal Accidents:

The Pilot was cited as a cause in 16 of the 62 nonfatal accidents. Personnel were cited 22 times. Weather was cited as a cause 12 times, while Landing Gear was cited nine times. The Powerplant and Systems were cited as causes three times each, while the Miscellaneous category was listed twice. Assigned once as a cause in nonfatal accidents were the Airframe, Instruments/Equipment and Accessories, and Airport/Airways/Facilities. One cause was Undetermined.

In contrast to the causal assignments listed above, the Pilot was cited as a factor in nonfatal accidents only three times, whereas Personnel were cited seven times. Weather, listed as a factor six times was second highest. Airports/Airways/Facilities were cited twice, while the Miscellaneous category was cited once.

Weather Involvement

Weather involvement (weather listed as a probable cause and/or a related factor) occurred in 17 (24.3 per cent) of the 70 air carrier accidents occurring in 1967 and in one of the twelve fatal air carrier in 1967. The most frequent weather involvement was turbulence-associated with clouds, thunderstorms (8 accidents). In order of frequency, the remainder were: low ceiling (4 accidents); turbulence in flight, clear air (4 accidents); thunderstorm activity (3 accidents); snow (2 accidents); icing conditions (2 accidents); line squalls (1 accident); and fog (1 accident).

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