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Crashes of Instructional Flights: Analysis of Cases and Remedial Approaches

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16. Abstract

Instructional flights experience more than 300 crashes annually and are involved in more than one-third of all midair collisions. Research was undertaken to identify the circumstances of instructional crashes and describe factors related to pilots, aircraft, and the environment. METHODS: NTSB data tapes were analyzed for crashes during 1989-1992 that involved a student pilot or a flight for instructional purposes. RESULTS: During 1989-1992, 1226 instructional airplanes were involved in crashes, resulting in 250 deaths and 128 serious injuries. Midair collisions during these four years involved 38 instructional airplanes (2.5%) and accounted for 20% of all deaths. Sixteen pilots in midair collisions were on solo flights; on average, they were younger but more experienced than trainees in other crashes on solo. Detailed review of crashes during 1989 and 1991 revealed that loss of control on landing characterized 227 of the 638 crashes, or 36%. Crosswinds contributed to 28% of all crashes. The 94 stalls were 15% of the series and 46% of all fatal crashes. Student solos were 51% of the series; 193 of the 360 students on solo foundered due to loss of control on landing or takeoff. Touch-and-go landings accounted for 22% of all crashes on solo. Among the 84 crashes on cross-country solos, 26 (31%) were due to running out of fuel. Thirty-four (40%) of the trainees who crashed on cross-country solos had not filed flight plans. Twenty-three pilots flying with student licenses were illegally carrying one or more passengers. In 13 of the 25 crashes due to carburetor icing, the problem began during cruise phase. Instructors were present in 50% of crashes from stalls and 32% of crashes from fuel starvation. Simulated emergencies ended in 49 crashes. The NTSB identified factors related to the instructor as contributory in one-third of the cases. Many incidents reported to ASRS occurred under circumstances similar to the crashes. For example, in both data bases, aircraft in midair collisions or near-collisions included several piloted by a student under a hood and two collisions with helicopters. CONCLUSIONS: Greater emphasis during flight training needs to be placed on avoiding stalls and midair collisions, managing crosswinds, and understanding the elements of takeoff and landing flight dynamics prior to solo touch-and-go practice. Instructors contribute to crashes both directly during dual instruction and, less directly, through failure to successfully monitor their students and convey the elements of safe and proficient flight. Problems identified in this study should be communicated to flight instructors in their initial training as instructors, during preparation for their biennial re-licensure, and through dissemination of materials to all instructors.

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ABBREVIATIONS

ac — aircraft
AC — FAA advisory circular
apt — airport
ASRS — Aviation Safety Reporting System
ATC — air traffic control
ATP — airline transport pilot
BFR — biennial flight review
CFI — flight instructor
CTAF — common traffic advisory frequency
eng — engine
FAA — Federal Aviation Administration
FBO — fixed base operator
fpm — feet per minute
hood — vision-restricting device for instrument training
IAP — initial approach point
IFR — instrument flight rules
ILS — instrument landing system
IMC — instrument meteorological conditions
IP — instructor pilot
kts — knots
LAX — Los Angeles airport
LOC — loss of control
LTT — light transport (14,501-30,000 lb)
M/M — make and model
MAC — midair collision
mil — military
msl — altitude above mean sea level
ndb — non directional beacon
NMAC — near-midair collision
NTSB - National Transportation Safety Board
PIC — pilot-in-command
PTS — Performance Test Standards
rwy — runway
sim — simulated
SMA — small aircraft (<5001 lb)
SMT — small transport (5001-14,500 lb)
T&G — touch-and-go
tfc — traffic
TO — takeoff
TT — total flight time
turb — turbulence
twr — tower
VFR — visual flight rules
xing — crossing

EXECUTIVE SUMMARY

METHODS

The National Transportation Safety Board (NTSB) reports all aviation crashes ("accidents" in NTSB terminology) that result in death within 30 days, serious injury, or substantial damage to the aircraft. We use the term "crash" because it is a more scientific term—without the connotations of bad luck, randomness, and unpreventability.

NTSB computer tapes for instructional crashes of fixed-wing civilian airplanes during 1989-1992 were analyzed. Crashes of helicopters, ultralights, and homebuilt aircraft were excluded. For all midair collisions during the four years 1989-1992 and for all crashes during 1989 and 1991, two-page briefs from NTSB describing the crashes were read and categorized as to the circumstances of the crashes and contributing factors. The years 1989 and 1991 were representative of the four-year period.

In addition to NTSB data, a key-word search of NASA's Aviation Safety Reporting System (ASRS) was made for reports related to instructional flights of general aviation airplanes during 1992 and 1993. These years were selected because they were the most recent for which data were available; 164 reports that met study definitions were abstracted and categorized in a manner similar to the crash reports.

RESULTS

I. NTSB Data: 1989-1992

During the four years 1989-1992, 1226 instructional airplanes were involved in 1218 crashes included in the NTSB files. The casualties included 250 deaths, 128 serious injuries, and 270 minor injuries.

Midair collisions

Thirty midair collisions involving 38 instructional airplanes occurred during the four years. They comprised 2.5% of all crashes of instructional flights and accounted for 20% of all deaths (50/250). All occurred in VMC weather and during daytime hours, between 0800 and 1959 h. Sixteen of the trainees were pilots-in-command on solo training flights; compared with trainees on solo flights involved in crashes other than midairs, these pilots were younger (with a median age of 24 vs 34) but more experienced — i.e., they had more flight time and were more likely to be private pilots undergoing advanced training. Aircraft involved in the midair collisions included two helicopters and two bi-wing acrobatic airplanes. Visibility may have been affected by the angle or glare of the sun in four cases, and in six instances the student was receiving instrument training, in which the trainee is usually under a hood (a vision-restricting device).

II. NTSB Data: Details of Crashes in 1989 and 1991

During 1989 and 1991, 635 crashes occurred, involving 638 instructional airplanes. The findings in this section relate to the detailed review of the crashes of these 638 flights.

Fifty-one percent of the flights were solos of pilots with student certificates; an additional 5% were solos of pilots with private licenses who were undergoing instruction for more advanced ratings. Thirty-nine percent of crashes occurred in connection with dual instruction and 5% on checkout flights or biennial flight reviews.

Phase of flight

The most common phases of flight when the problem arose, determined by reading the two-page NTSB briefs, were landing (26%) and touch-and-go's (19%). The 118 crashes on touch-and-go landings included 79 solos and 39 with an instructor. The touch-and-go's on solo constituted 22% of all crashes on solo flights and 19% of all crashes. Three out of four inadvertent gear retractions occurred when a dual flight (i.e., with an instructor aboard) was about to make a touch-and-go landing.

Crashes on go-arounds numbered 56, of which 27 (48%) involved stalls. Five airplanes struck wires on go-arounds. Fifteen go-around crashes followed simulated emergencies.

Circumstances

Loss of control on landing was the most common type of crash, resulting in 227 crashes (36%). Eighteen of the crashes occurred while executing a go-around following an unsuccessful attempt to land. Twenty-one occurred in connection with a simulated emergency. Crosswinds were involved in 109 cases of loss of control on landing (48%) and tailwinds in 21 (9%).

Stall was the primary event in 94 cases (15%). An instructor was on board when half of the stalls occurred. Most stalls were takeoff/departure (39 cases) or approach to landing (28) stalls. Of the 39 stalls on takeoff/departure, 23 occurred on go-arounds, 17 involved crosswinds and 8, tailwinds. Thirteen simulated emergencies resulted in stalls. The 31 fatal stalls accounted for 46% of all fatal crashes.

Fuel starvation resulted in 74 crashes (12%), 29 of which were on cross-country solos. An instructor was present in 24 cases, including 10 of the 14 flights on which the fuel selector was set on an empty tank. Nineteen crashes occurred when fuel was adequate, but the pilots misunderstood the fuel system or set the fuel selector for the empty tank. In 51 cases, the fuel was exhausted because the pilot(s) misjudged the available fuel; Cessna aircraft, in which the high wings make visualization of the fuel more difficult, accounted for 86% of these cases, versus 60% of all other crashes in the study.

Mechanical failure was the primary cause of 80 crashes (13%). The major problems were unexplained loss of power (31 cases) and failure of the landing gear (13). Nine instructors mishandled the resulting emergency, or even compounded it with an improper response.

Midair collisions numbered 15 (3%) and involved 18 instructional airplanes, of which 10 were dual instruction or checkout flights. (Part I describes the 30 midair collisions during the entire four-year period.)

Carburetor icing downed 25 flights (4%), 10 with instructors on board, 3 in connection with simulated forced landings, and 6 on student cross-country flights. Thirteen of the crashes were caused by carburetor icing during cruise, a phase of flight when carburetor icing is not usually anticipated.

Wire strikes occurred in 11 instances (2%), 5 of which involved a simulated emergency during dual instruction or a checkride.

Simulated emergencies led to 49 crashes (8%), predominantly loss of control on landing and stalls. Instructors sometimes killed the engine with the mixture at idle-cutoff or by shutting off the fuel supply, then were unable to restart the engine.

Winds at the airport were an apparent factor in 232 crashes (36%). Crosswinds were involved in 28% of all crashes and tailwinds in 6%.

Pilots

The median total flight time was 43 hours for trainees and 1552 hours for instructors. Eleven instructors had less than 10 hours time in type.

Eleven pilots with student licenses had more than 200 hours total time, suggesting that many of these "students" were not still flying under an instructor's supervision.

The primary circumstances of the 84 crashes on cross-country solos were fuel starvation (33%) and loss of control on landing (31%). Eight of the students crashed after becoming lost.

Twenty-three pilots flying with student licenses were illegally carrying one or more passengers.

Pilot performance

Poor crosswind correction was apparent in 79 crashes, a bounced landing in 48, rudder misuse in 42, and poor handling of surface wind or turbulence in 40.

Thirty-four of the 84 trainees who crashed on solo cross-country trips (40%) had not filed flight plans; 6 of the 34 were lost at the time of the crash.

Thirteen students were geographically lost when they crashed; 8 had run out of fuel.

Instructor performance

Contributory instructor-related factors cited by the NTSB included inadequate supervision (77 cases), delayed remedial action (34), mishandled simulated emergency (20), and inadvertent stall/spin (15).

Twenty-seven percent of the solos reflected inadequate training, primarily in evaluation of crosswinds and weather (69 cases), touch-and-go landings (48),

and recovery from bounced landings (35). Fifty-four instructors let the student get so far into an operational problem that the instructor could not recover the aircraft. Nineteen crashes occurred because the CFI did not anticipate a student's hasty action. Ten crashes occurred after the CFIs simulated forced landings in areas that did not afford safe landing places when the simulated emergencies turned into real ones.

Airplane characteristics

Twin-engine planes comprised only 6% of the series, but 18% of the crashes following simulated emergencies and 13% of mechanical failures.

Tailwheel aircraft (61) were involved in only 9% of all crashes, but in 17% of noseovers and 79% of ground loops.

Aircraft with retractable landing gear (86) constituted only 14% of all aircraft, but 26% of the crashes due to mechanical failure.

Crash outcome

At least one fatality occurred in 11% of crashes. The crashes that were most likely to be fatal were VFR into IMC (71% fatal), midair collisions (44%), and stalls (33%).

The pilot was more likely to be killed if the weather was IMC, postcrash fire occurred, the aircraft was a twin-engine, or the pilot was not restrained with a shoulder harness.

Nine percent of trainees and 16% of instructors known to have a shoulder restraint available were not wearing it.

III. ASRS DATA

The ASRS data describe incidents that did not result in crashes, but they offer insight into the circumstances, as provided in the pilots' own words. In general, they were consistent with the findings from the study of crashes. Of particular interest were the 34 near-midair collisions (NMACs), which comprised 11% of the reports. Similar to the 30 midair collisions, they included 3 cases in which a student was under a hood, and two cases involving helicopters. A description of the NMACs is provided in Section D.

Although ASRS is a voluntary reporting system and, therefore, not representative of all incidents, it is noteworthy that many of the circumstances described in the ASRS reports are similar to those in the crashes. This suggests that it would be of potential advantage to make greater use of this data base for identifying problem areas and their causes.

RECOMMENDATIONS

Special attention should be given to collision avoidance during training flights in the traffic pattern, where midair collisions involving instructional flights typically occur (DeLacerda 1988). Avoidance of midair collisions in VFR flight primarily depends upon pilots to "see and avoid" other aircraft, a requirement with recognized limitations (NTSB 1985, 1988). Pilot broadcasts of position and intention do not relieve the pilot of the obligation to thoroughly scan the area for other aircraft. Pilots working with ATC must be alert to the positions of other aircraft being controlled by ATC. Helicopters, which do not fly a standard pattern, and bi-wing acrobatic airplanes, in which the pilot's visual field is limited, were each involved in 2 of the 30 midair collisions, despite the fact that they represent only a very small percentage of aircraft at airports where students undergo training. Pilots of these aircraft and students who share their traffic environment should take cognizance of the increased risk.

The ability to cope with crosswinds deserves emphasis, since this appeared to be a factor in more than one-fourth of all crashes. Students may require more dual instruction under challenging crosswind conditions. Although the usual practice is to select a runway with ideal wind direction, it is often possible to choose a runway where the winds have a substantial crosswind component. Greater learning may occur if an instructor picks runways with less favorable winds for landing practice, until the student is proficient in crosswind landings and competent at assessing safe crosswind landing criteria.

Touch-and-go's require greater scrutiny. This practice, common to almost one-fourth of the crashes, has the advantage of maximizing the number of landings

that can be made in a time-limited lesson. It has the disadvantages, however, of 1) requiring a complicated series of operations in a few moments, often at high speed and 2) not affording the student the time needed to reflect over each flight and identify any deficiencies before initiating the next. The specific dynamics of flight control usage (rudder, aileron, elevator, elevator trim, and flaps) and power usage (throttle and carburetor heat) must be understood by the student in relation to landing rollout, transition to takeoff phase, and takeoff. Allowing touch-and-go's on the first few solos is inappropriate unless mastery of these elements has been achieved. The FAA should amend the Flight Instructor Practical Test Standards to include instructions for teaching touch-and-go landings and criteria for determining when students are ready to practice touch-and-go's during solo flight.

Adherence to guidelines for simulated emergencies is crucial. Standards for practical tests of flight instructors state that in the case of single-engine airplanes the examiner shall tell the instructor applicant that such practices as "placing the fuel selector in the 'off' position or placing the mixture control in the 'idle-cutoff' position" to simulate a power failure "are violations of FAA policy," and that in the case of multi-engine aircraft this shall not be done below 3,000 feet (FAA, 1991) Seven crashes, including 3 in twin-engine airplanes, resulted from shutting off an engine by such means, rather than reducing power with the throttle. Furthermore, although continuing a simulated emergency approach below 500 feet is similarly forbidden, it was clear that many crashes occurred because recovery was initiated too low. That 14 simulated emergencies terminated in damaging hard landings or stalls close to the ground suggests that student pilots need additional training in power-off landings.

Instructors need to set a good example, a fact that should be emphasized in instructor training. When an instructor descends to within 150 feet of the ground while demonstrating a simulated forced landing, or initiates a stall at a low altitude, it sets a poor example for students. Evidence of some instructors' failure to set a good example was the fact that one-sixth of those with available shoulder restraints were not wearing them. Moreover, pilots not wearing shoulder restraints have been shown to have more than three times as great a risk of being killed when a crash occurs as those wearing shoulder restraints (Li and Baker, 1993; Baker and Lamb, 1989). For their own safety, as well as that of their students, instructors should stress the use of restraints by all aircraft occupants.

Instructor re-licensure can be used to convey these recommendations, as well as the results of this research. Flight instruction is the only category of flying that requires re-licensure by the FAA; every two years, a flight instructor must obtain a new certificate from the FAA based upon training given, or after taking a recertification course and a flight check ride. This contact provides a unique opportunity for information transfer between the two parties. In addition to recertification courses, results of the study can be incorporated into other modalities, including: pamphlets and newsletters distributed to all CFIs; the FAA's Accident Prevention series, which should be sent to all instructors and new students; modules used for initial training of instructors; and the FAA's Flight Instructor Practical Test Standards.

CRASHES OF INSTRUCTIONAL FLIGHTS ANALYSIS OF CASES AND REMEDIAL APPROACHES

A. DESCRIPTION OF CRASHES OF INSTRUCTIONAL FLIGHTS

INTRODUCTION

Crashes of instructional flights, averaging more than 300 each year, comprise 14% of all general aviation crashes. Their occupants account for 7% of all fatal and serious injuries that occur in general aviation. During 1987-1992, instructional flights were involved in 36% of all midair collisions (NTSB 1987-1993).

Despite the size of the problem, there has been no published research on the circumstances of crashes of instructional flights and the characteristics of the pilots involved. The content of flight training "often is based upon tradition and upon instructors' judgments and unique experiences rather than upon detailed, systematic analyses of piloting tasks" (Caro, 1988).

Research was therefore undertaken to provide information that can be used in the development of relevant educational materials. The objectives were to determine the circumstances under which crashes of instructional flights occur, identify factors involved in such crashes, and analyze the relationships between the circumstances of the crashes and the characteristics of the instructors and their trainees.

METHODS

The National Transportation Safety Board (NTSB) reports all crashes of non-government aircraft that result in death, serious injury, or substantial damage to the aircraft. NTSB computer tapes for instructional crashes of fixed-wing airplanes in 1989 through 1992 (the most recent years available) were analyzed. A four-year period was selected to obtain a large number of midair collisions for analysis and to make the results generalizable. Selection of cases was based upon whether 1) the purpose of the flight was coded by the NTSB as instructional (this included checkrides and biennial flight reviews (BFRs) and/or 2) the pilot-in-command was a student, since pilots flying on student licenses are required to be under the supervision of an instructor. Crashes of helicopters and ultralight or homebuilt aircraft were excluded.

Cases included not only student pilots undergoing their initial training but also pilots holding private, commercial, or even ATP licenses who were undergoing advanced training, checkouts, or air carrier qualification/proficiency training. Inclusion of these cases was based, in part, upon the high crash rates of pilots of air taxis and small commuter aircraft (Baker and Lamb, 1992; Baker et al., 1993).

To obtain more details than were in the coded data, the NTSB's two-page briefs describing all midair collisions in 1989-1992, and all crashes in 1989 and 1991 were read. These crashes were categorized as to their circumstances and contributing factors, including pilot performance, errors contributing to loss of control, emergency handling, training deficiencies, and poor decisions.[1] These interpretations were coded and combined with information on the data tapes for the purpose of conducting multiple-variable analyses. The results of the cases from this portion of the analysis, described under RESULTS: Part II, constitute the major part of the study findings.

Reading and coding the circumstances described in the briefs of all of the crashes was an extremely time-consuming process; because of time and budget constraints, the briefs were studied and analyzed only for two years. Based on analyses of the NTSB-coded data for the years 1989-1992, the years 1989 and 1991 were representative of the four-year period with regard to circumstances of the crashes (e.g., wind speed), characteristics of pilots, and outcome. The NTSB investigations of 1992 crashes had not been completed at the initiation of this project; therefore, the 1992 cases were not chosen for review of the briefs.

[1] The coding scheme is available from the investigators upon request.

Denominator data on the number of instructional flights was not available, making calculation of rates impossible. Internal comparisons, however, permitted identification of associations between circumstances of the crashes and characteristics of the pilots and aircraft.

RESULTS

Part I. NTSB Data: 1989-1992

During the four years 1989-1992, 1226 instructional airplanes were involved in 1218 crashes. The crashes involved collisions with terrain, trees, fences, etc., or with another aircraft, plus one fatal propeller injury to on-ground personnel.

The casualties included 250 deaths, 128 serious injuries, and 270 minor injuries (Table 1). Twenty-one of the fatalities were occupants of other aircraft involved in midair collisions with instructional airplanes. Of the 1226 pilots-in-command of the instructional airplanes, 126 (10%) were killed.

The states with the largest numbers of crashes were California (150), Florida (108), Texas (97), Michigan (55), Arizona (54), and Colorado (54) (Table 2). While the large numbers of crashes in California and Texas probably correspond to the large populations of those states, as well as the popularity of general aviation, the many cases in Florida and Arizona may reflect the presence in those states of large flight training schools. Alaska, where 7% of all general aviation crashes occur (NTSB 1993), had only 47 crashes of instructional flights, 4% of the total.

Midair collisions

Thirty midair collisions involving 38 civilian instructional airplanes occurred during the four years. They accounted for 2.5% of all the crashes of instructional flights and for 20% of all deaths (50/250). Eight of the midairs were collisions between two civilian instructional airplanes. In a ninth case, a military airplane (not one of the aircraft in the study series) struck a civilian trainer; in both aircraft, the trainees were undergoing dual instruction.

Twenty-two of the 38 trainees involved in midair collisions were with an instructor, and 16 were on solo flights. The 16 trainees on solo flights were generally more experienced than trainees not in midair collisions: 75% had over 50 hours total flight time, compared with 40% of pilots in other crashes on solo. Of the 16 solo pilots in midairs, 7 (44%) had private licenses, compared with 9% of solo trainees in other types of crashes. Although more experienced, they were younger: The median age of these 16 pilots was 24 years, versus 34 for other trainees.

Except for four cases, the midair collisions occurred in or near an airport traffic pattern. One of the four exceptions involved two private pilots in training at the same flight school who were flying cross-

Table 1. Injury Severity
Crashes of Instructional Flights, 1989-1992

INJURY	OCCUPANTS OF INSTRUCTIONAL AIRPLANES		TOTAL NUMBER OF PERSONS*	
	#	%	#	%
Fatal	220	12.1	250	12.6
Serious	123	6.5	128	6.5
Minor	261	13.7	270	13.7
None	1295	67.7	1330	67.2
TOTAL	1899	100.0	1978	100.0

*Includes occupants of helicopters and non-instructional airplanes involved in midair collisions.

Table 2. State of Occurrence
Crashes of Instructional Flights, 1989-1992

STATE	#	STATE	#	STATE	#
Alabama	17	Louisiana	11	Ohio	35
Alaska	47	Maine	6	Oklahoma	17
Arizona	54	Maryland	18	Oregon	21
Arkansas	9	Massachusetts	12	Pennsylvania	32
California	150	Michigan	55	Rhode Island	3
Colorado	54	Minnesota	30	South Carolina	5
Connecticut	7	Mississippi	13	South Dakota	1
Delaware	2	Missouri	26	Tennessee	22
Florida	108	Montana	11	Texas	97
Georgia	15	Nebraska	6	Utah	19
Hawaii	2	Nevada	12	Vermont	5
Idaho	4	New Hampshire	3	Virginia	25
Illinois	46	New Jersey	17	Washington	43
Indiana	29	New Mexico	16	West Virginia	6
Iowa	8	New York	26	Wisconsin	20
Kansas	16	North Carolina	17	Wyoming	0
Kentucky	4	North Dakota	12	TOTAL*	1219

*Excludes 7 cases in Atlantic Ocean, foreign country, Puerto Rico, or unknown.

country in formation. In addition to this case, there were three other cases in which pilots at the same flight school collided with one another.

In three cases, one airplane descended on top of another — on final approach in one case, and in two instances, onto an airplane that had just landed.

Two of the collisions involved a Pitts (an acrobatic bi-wing airplane), one of which descended onto a Bellanca on final; the other Pitts collided over the takeoff runway with a helicopter. In another midair, a climbing helicopter collided with a Cessna practicing touch-and go's.

All midairs occurred in VMC weather and during daytime hours, between 0800 and 1959 h. Figure 1 shows that the midairs are more likely than other crashes to occur between 0800 and 1000 h, or in the afternoon between 1600 and 2000 h — periods when the pilot's ability to see another aircraft may be diminished by the sun's angle.

The briefs indicated that one midair occurred at sunset, sun in the pilot's eyes was a factor in a second, and in a third, the investigator noted that sunglare reduced visibility. In a fourth midair, the sun was to the left of and in front of both aircraft, which collided while flying parallel westerly courses.

Six of the midairs occurred during instrument training, which typically is conducted with the trainee under a hood (two briefs specifically mentioned that the trainee was under a hood). In 4 of these 6 instrument training cases, the other aircraft was coming from the right (instructor's) side of the airplane. One student was under a hood practicing "air work maneuvers" with an

instructor, when his Cessna 172 was hit in the right side by a military T38 going 330 knots during dual instruction.

In at least one midair collision, recommended radio procedures were not followed. In at least 6, the pilots of both aircraft made radio calls, but did not see and avoid one another's aircraft. In 5 other midairs, ATC (air traffic control) did not provide separation to 2 aircraft that collided, although both were in contact with ATC; in 1 case, ATC was controlling 1 IFR aircraft, but was apparently unaware of a VFR aircraft in the area before the two collided.

Each of the midair collisions is summarized in Section B.

Part II. NTSB Data: Details of Crashes in 1989 and 1991

During 1989 and 1991, 635 crashes occurred, involving 638 instructional airplanes. The findings in this section relate to the detailed review of the crashes of these 638 flights. Descriptive summaries of many of the cases are to be found in Section B.

Fifty-one percent of the flights were solos of pilots with student certificates; an additional 5% were solos of private pilots who were working toward a commercial license (Table 3). Thirty-nine percent of crashes occurred in connection with dual instruction, and 5% on checkout flights or biennial flight reviews.

Figure 1
Percent Distributions of Time of Crash
All Crashes vs Midair Collisions, 1989 - 1992

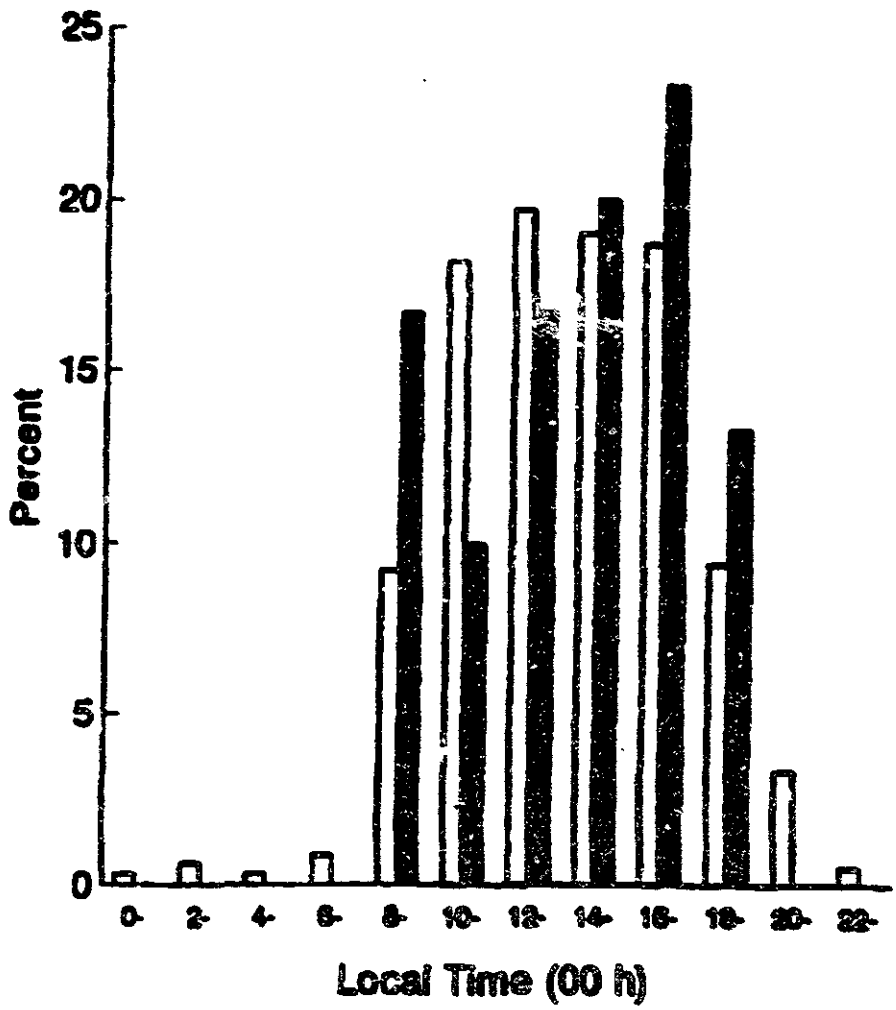

Table 3. Phase of Flight by Type of Flight
Crashes of Instructional Flights, 1989 and 1991

PHASE	STUDENT SOLO	PRIVATE PILOT SOLO	DUAL	BFR OR CHECK-RIDE	TOTAL #	TOTAL %
Takeoff	21	1	21	1	44	6.9
Climbout	12	0	35	1	48	7.5
Cruise	52	5	26	3	86	13.5
Descent	7	4	9	0	20	3.1
Downwind or base leg	7	1	4	1	13	2.0
Final approach	8	2	17	5	32	5.0
Landing	89	7	50	9	165	25.9
Go-around	26	2	25	3	56	8.8
Taxi	4	1	3	0	8	1.2
Not in motion	0	1	6	0	7	1.1
Touch-and-go	78	6	30	4	118	18.5
Practicing stalls	1	0	3	0	4	0.6
Turns	4	0	6	0	10	1.6
Other	8	3	14	2	27	4.3
TOTAL #	327	33	249	29	638	100.0
TOTAL %	51.3	5.2	39.0	4.5	100.0	

* Excludes 7 cases in Atlantic Ocean, foreign country, Puerto Rico, or unknown.

Phase of flight

Phase of flight was determined by reading the two-page briefs; it did not always coincide with the NTSB-coded "phase" because it was based upon the period when the problem arose.

The most common phases were landing (26%) and touch-and-go's (19%) (Table 3 and Figure 2). Although the length of exposure to each phase of instructional flight is not known, it is obvious that certain phases are over-represented among the crashes in relation to exposure. For example, although there are as many takeoffs as landings, crashes were almost 4 times as common on landing as on takeoff.

In touch-and-go landings, the airplane does not come to a complete stop before taking off again; these 118 crashes included 84 solos and 34 with an instructor (Table 4). The touch-and-go's on solo constituted 23% of all crashes on solo flights. Three of the four inadvertent gear retractions occurred when a dual flight (i.e., with an instructor aboard) was about to make a touch-and-go landing.

Crashes on go-arounds numbered 56, of which 27 (48%) involved stalls. Five airplanes struck wires on go-arounds. Fifteen crashes on go-around occurred during simulated emergencies.

Circumstances

On the basis of information included in the NTSB two-page description of the crash, each case was assigned to 1 of 14 categories (Table 5).

Loss of control on landing was the most common type of crash, resulting in 227 crashes, or 36% of the entire series. Although common, they rarely resulted

Figure 2
Proportion of Crashes in Each Phase of Flight
(Based on Phase in Which Problem Arose)

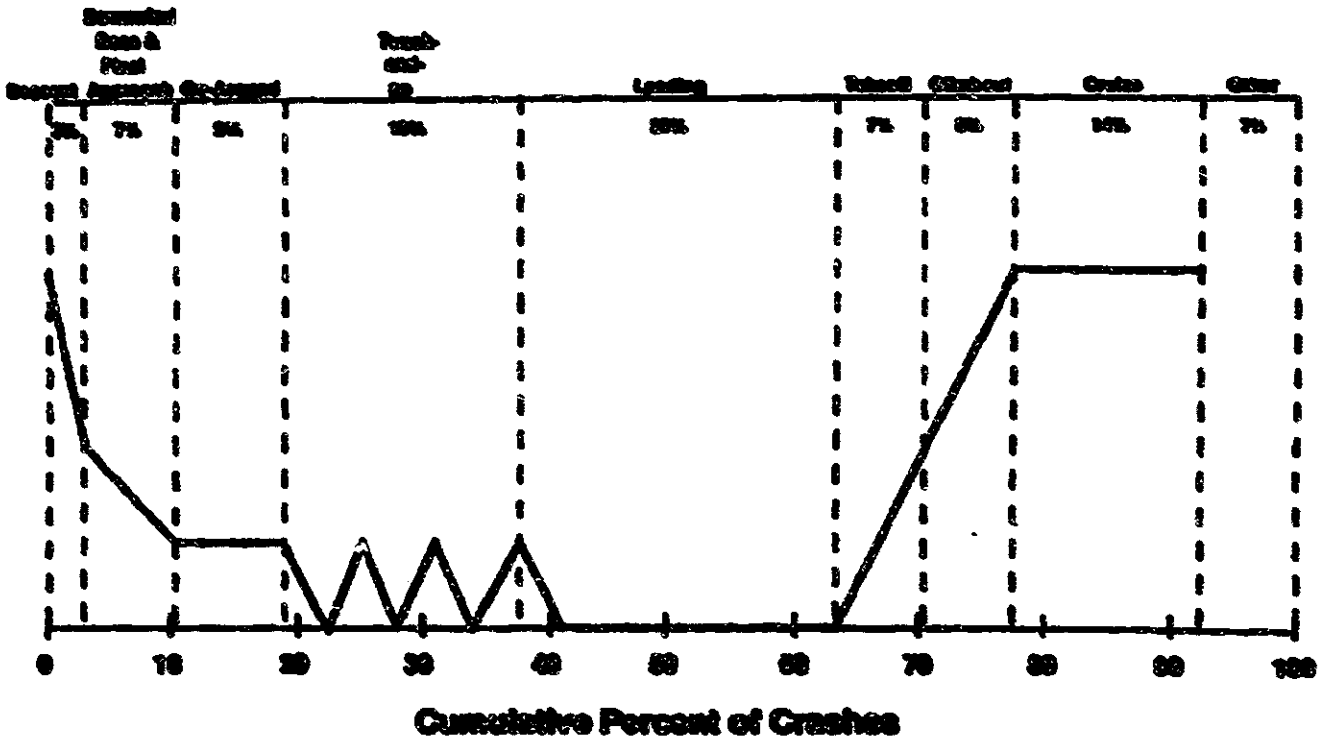

Table 4. Crashes of Aircraft Practicing Touch-and-Go Landings
Instructional Flights, 1989 and 1991

CIRCUMSTANCES	SOLO*	DUAL**	TOTAL
Stall	9	5	14
Takeoff, ran off side	13	4	17
Other loss of control on takeoff	5	1	6
Landing, ran off side	18	3	21
Landing, ran off end	3	2	5
Landing, nosedover	9	3	12
Landing, hard	7	1	8
Other loss of control on landing	7	1	8
Fuel starvation	5	2	7
Midair collision	1	1	2
Mechanical failure	5	5	10
Inadvertent gear retraction	0	3	3
Other	2	3	5
TOTAL	84	34	118

*Includes 6 pilots with private licenses.
**Includes 3 checkout flights and 1 biennial flight review.

Table 5. Circumstances of Crashes by Type of Flight
Instructional Flights, 1989 and 1991

CIRCUMSTANCES	STUDENT SOLO	PRIVATE SOLO	PILOT DUAL	IFR OR CHECK-RIDE	TOTAL #	TOTAL %
Stall	42	5	44	3	94	14.7
Loss of control - Takeoff	35	2	15	3	55	8.6
Loss of control - Landing	146	10	59	12	227	35.6
Fuel starvation	43	7	20	4	74	11.6
VFR into IMC	5	0	2	0	7	1.1
Midair collision	6	2	9	1	18	2.8
Taxiing/standing	3	2	6	0	11	1.7
Mechanical failure	21	0	55	4	80	12.6
Mountain terrain	2	0	2	0	4	0.6
Gear up landing	0	0	6	1	7	1.1
Carburetor icing	12	3	10	0	25	3.9
Wire strike	6	0	4	1	11	1.7
Other	4	2	15	0	21	3.4
Undetermined	2	0	2	0	4	0.6
TOTAL	327	33	249	29	638	100.0

in serious injury and only 1 proved fatal. Within this category, the largest subgroups were: ran off side of runway (69 cases), noseover (52), hard landing (37), and ran off end of runway (19).

Eighteen of the crashes occurred while executing a go-around following an unsuccessful attempt to land. Twenty-one occurred in connection with a simulated emergency. Crosswinds were involved in 109 cases of loss of control on landing (48%) and tailwinds in 21 (9%).

Loss of control on takeoff resulted in 55 crashes, 9% of the series. Most commonly, pilots ran off the side of the runway (43) or off the end (8). As in the case of loss of control on landing, crosswinds were a major factor.

Stall was the primary event in 94 cases (15%). An instructor was on board when half of the stalls occurred (Table 6). Most stalls were takeoff/departure (39 cases) or approach to landing (28) stalls. Of the 39 stalls on takeoff/departure, 23 occurred on go-arounds, 17 involved crosswinds, and 8, tailwinds. Thirteen stalls ensued from simulated emergencies.

The 31 fatal stalls accounted for 46% of all fatal crashes and occurred under a variety of circumstances (Table 6). An instructor was present on 19 flights that terminated in fatal stalls. Details of the 31 fatal stall cases are presented in Section B.

Fuel starvation[2] resulted in 74 crashes (12%), 29 of which were on cross-country solos. An instructor was present on 24 of the 74 flights, including 3 instrument training flights and 10 of the 14 flights on which the fuel selector was set on an empty tank. Nineteen crashes occurred when fuel was adequate, but the pilots misunderstood the fuel system or set the fuel selector for the empty tank. Four crashes subsequent to fuel exhaustion terminated in fatal stalls. These were classified in this category, rather than as "stall," because the lack of fuel was the precipitating problem.

In 51 cases, the fuel was exhausted because the pilot(s) misjudged the available fuel; Cessna aircraft, in which the high wings make visualization of the fuel difficult, accounted for 86% of these cases, versus 60% of all other crashes in the study. Eighteen percent of the fuel exhaustion cases occurred in Texas, which had only 7% of all the crashes.

[2] Fuel starvation includes both fuel exhaustion, in which the aircraft is out of fuel, and other situations causing insufficient fuel to reach the engine.

Table 6. Circumstances and Outcome of Crashes Involving Stalls
Instructional Flights, 1989 and 1991

CIRCUMSTANCES	NON-FATAL SOLO	NON-FATAL DUAL*	FATAL SOLO	FATAL DUAL**	TOTAL SOLO	TOTAL DUAL
Practicing stalls or spins	0	0	1	2	1	2
Takeoff/departure stall	20	15	2	2	22	17
Approach to landing stall	12	12	3	1	15	13
Other stall	3	1	6	14	9	15
TOTAL	35	28	12	19	47	47

*Includes 1 biennial flight review.
**Includes 2 checkrides.

Table 7. Mechanical Failures
Crashes of Instructional Flights, 1989 and 1991

TYPE OF FAILURE	#
Unexplained power loss	31
Gear failure	13
Stuck or failed valve	6
Carburetor	
Throttle/mixture control separation	5
Blocked by rubber seal/alair door	2
Debris from autogas; large bug	2
Failure	2
Heat control loose	1
Fuel	
Water/ice	3
Contamination	3
Autogas	1
Oil line failure	3
Oil starvation	2
Oil contamination	1
Crankshaft/bearing/piston seized	3
Magnetos weak	3
Sparkplugs fouled/worn	2
Nosewheel shimmy	2
Propeller came off	2
Smoke in cockpit	2
Miscellaneous	13
TOTAL*	102

*80 crashes were attributed primarily to mechanical failure and in 22 other cases another cause was primary.

Mechanical failure was the primary cause of 80 crashes (13%), most of which ended in a forced landing with extensive damage to the airplane. In another 22 cases, there was a mechanical problem, but another factor was considered the primary cause. The major problems were unexplained loss of power (31 cases), and failure of the landing gear (13) (Table 7). Twelve pilots (9 of whom were instructors) mishandled the resulting emergency or even compounded it with an improper response, such as failing to feather the propeller on engine failure or reject a takeoff when the elevator control was binding (Table 8).

Midair collisions during these 2 years numbered 15 and involved 18 instructional flights, of which 9 were dual instruction and 1 was a checkout for a Convair pilot. These midairs are included in the four-year series of midair collisions described above in Part I and Section B.

Carburetor icing downed 25 flights, 10 with instructors on board and 3 in connection with simulated forced landings. Thirteen of the crashes (52%) were caused by carburetor icing during cruise, a phase of flight when carburetor icing is not usually anticipated. Three cases occurred on climbout, 3 on descent, and 2 during touch-and-go's. Carburetor icing occurred on 6 student cross-country solos. In 12 of the 13 cases of carburetor icing during cruise, the NTSB determined that the atmospheric conditions were conducive to carburetor icing (in the remaining

Table 8. Mishandled Emergencies
Crashes of Instructional Flights, 1989 and 1991

CIRCUMSTANCES	STUDENT SOLO	PRIVATE	DUAL	BFR OR CHECK-RIDE	TOTAL
Improper use of emergency procedures	14	3	13	1	31
Improper response compounded emergency	5	0	9	2	16
TOTAL	19	3	22	3	47

Table 9. Crashes Resulting From Simulated Emergencies
Instructional Flights, 1989 and 1991

CIRCUMSTANCES	#
Stall	
Takeoff/departure	4
Approach to landing	6
Other	3
	(13)
Loss of control - landing	
Nosedover	4
Hard landing	8
Undershoot	3
Other	6
	(21)
Mechanical failure	3
Carburetor icing	3
Wire strike	5
Other	4
TOTAL	49

case, this information was missing from the brief). Six of the reports included the temperature/dewpoint relationship.

Wire strikes occurred in 11 instances, 5 of which involved a simulated emergency or simulated forced landing during dual instruction or a checkride. Of the six solo students who collided with wires, 3 were illegally carrying passengers.

Taxiing collisions were reported 11 times and resulted in no injuries. The instructional airplane was moving in 6 cases, and in 5, was struck by another aircraft while standing.

Other crash circumstances

Simulated emergencies, in which a flight instructor simulated a power loss, electrical failure, or gear system failure, led to 49 crashes — predominantly loss of control on landing and stalls (Table 9). (Because a simulated emergency is usually considered a routine part of flight training, it was not a separate category of crash circumstances.) Instructors sometimes killed the engine with the mixture at idle-cutoff, or by shutting off the fuel supply, followed by difficulty in restarting the failed engine. In 3 instances, all Cessna 152s, the crew did not use carburetor heat, and the aircraft crashed. Three simulations were followed by actual mechanical problems, and the crew could not avoid a crash.

Winds played a role in 232 (36%) of the instructional crashes (Table 10). Crosswinds, in particular, were a problem, contributing to 177 crashes, or 28% of the series. They appeared to have contributed to 36% of the crashes of student solos and 19% of other crashes.

In the cases where crosswinds were judged to have been a factor, wind direction usually ranged from 10 degrees to 90 degrees off runway heading, and wind speed from 5 to 24 knots (Table 11). Rather than using a crosswind component chart to calculate the crosswind component for each case, the wind speed and angle were evaluated relative to the experience of the student pilot, so that in a few cases, wind speeds less than 5 knots or angles greater than 90 degrees were considered to have been a factor in the crash. In most cases, the student appeared to have lacked the experience to make a successful landing, as most crosswinds were within the skill range of a typical pilot.

Weather was typically fair, with IMC conditions in only 2% of cases, but adverse elements other than winds contributed to 46 crashes. The predominant factors were clouds or fog in 17 cases, density altitude in 9, and smoke or haze in 6.

Nighttime crashes were rare except, in the case of air carrier pilots undergoing advanced training or checkouts. Of the 5 crashes of aircraft capable of carrying more than 18 passengers, 4 occurred between 2100 h and 0345 h. In one such crash at 0200 h, the instructor had conducted ground training all day and the trainee had been without rest for at least 30 hours.

Pilot characteristics

The NTSB reports routinely provide pilot age, ratings, flight time, and other information specific to the pilot-in-command, who typically is the instructor, except when a trainee is soloing. In some cases of dual instruction, it appeared that a trainee was regarded by the NTSB as pilot-in-command if he had a

Table 10. Winds in Relation to Circumstances
Crashes of Instructional Flights, 1989 and 1991

CIRCUMSTANCES	CROSSWIND	TAILWIND	OTHER WIND*	TOTAL
Stall	22	10	6	38
Loss of control-takeoff	30	3	1	34
Loss of control-landing	109	21	10	140
Other	16	3	1	20
TOTAL	177	37	18	232

*Other wind conditions include 6 gusts, 6 windshears, 4 downdrafts, 1 microburst, and 1 dust devil.

private license, owned the aircraft in which he was receiving instruction, or was undergoing a checkout or biennial flight review.

The median age was 33 for instructors and 35 for pilots with student licenses. Eight percent of students were younger than 20; 5% of the students and 9% of the instructors were age 60 or older (Table 12). Fifty-seven percent of the student pilots and 58% of the instructors were between 20 and 34 years old.

Females constituted 15% of the trainees and 5% of the instructors. There was no apparent relationship between pilot age or sex and the circumstances of the crash.

Table 11. Number of Crashes by Wind Speed and Wind Angle with Runway Heading Instructional Flights, 1989 and 1991

WIND ANGLE WITH RUNWAY HEADING	WIND SPEEDS (knots)					
	<5	5-9	10-14	15-19	20-25	TOTAL
10°-	0	6	4	2	0	12
20°-	2	11	4	1	2	20
30°-	0	10	11	1	1	23
40°-	0	10	6	1	1	18
50°-	0	6	6	3	2	17
60°-	0	6	8	4	1	19
70°-	1	9	5	2	0	17
80°-	2	7	5	0	0	14
90°-	3	4	6	2	0	15
100°-	0	6	2	1	0	11
110°-	0	2	0	1	1	4
120°+	0	2	2	0	0	4
TOTAL	8	81	59	18	8	174

Table 12. Age of Students and Instructors Crashes of Instructional Flights, 1989 and 1991

AGE	STUDENTS**		INSTRUCTORS		OTHER	TOTAL
	#	%	#	%	#	#
<20	26	8.1	0	--	4	30
20-	53	16.7	52	21.3	15	120
25-	36	11.3	52	21.3	10	98
30-	42	13.0	37	15.1	5	84
35-	51	15.8	23	9.4	4	78
40-	39	12.2	17	7.0	10	66
45-	30	9.4	18	7.4	3	51
50-	15	4.7	18	7.4	1	34
55-	12	3.8	5	2.1	6	23
60+	16	5.0	22	9.0	3	41
TOTAL	320	100.0	244	100.0	61	625

*Excludes 13 pilots whose age was unknown.
**Excludes trainees with private licenses, included in "other."

The principal profession of 88% of the instructors was "pilot" (Table 13). The profession coded for most trainees was either "business" (40%) or "student" (33%).

Of the 386 trainees for whom pilot information was provided, 34% already had private pilot licenses; 2% also had multi-engine ratings, as had 84% of the instructors (Table 14).

The median total flight time of the instructors was 1552 hours (mean=3124 h) (Table 15). Six instructors had fewer than 10 hours flight time in the 90 days prior to the crash. Eleven instructors had less than 10 hours experience in the type of aircraft flown at the time of the crash ("time in type"); 4 of these 11 aircraft stalled.

The median number of flight hours as an instructor was 781 hours (mean=1384 h). Five instructors had less than 5 hours of previous instructional time. Loss of control on landing occurred disproportionately among instructors with fewer than 300 hours' experience as an instructor.

The median total flight time of the trainees was 43 hours (mean=108 h), and 19% had less than 25 hours' total flight time when they crashed (Table 15). Eleven pilots with student licenses had more than 200 hours' total time, suggesting that many of these "students" were not still flying under an instructor's supervision.

Of the 327 crashes of trainees with student licenses, 39 (12%) were known to have occurred on the first, second, or third solo flight (Table 16), typically due to loss of control on landing.

Almost one-fourth of the student solo crashes occurred on cross-country flights. The most common circumstances of the 84 crashes on cross-country solos were fuel starvation (33%) and loss of control on landing (31%).

Pilots flying with student licenses may not legally carry passengers, yet 23 crashes in the series occurred when student pilots were carrying 1 or more passengers. Ten of these 23 crashes (43%) were fatal (4 times the overall fatality rate for the series) and 12 (52%) involved stalls. Three of the 11 wire strikes in the series involved students who were flying with passengers.

Table 13. Principal Profession of Pilots in Crashes Instructional Flights, 1989 and 1991

PROFESSION	TRAINEES		INSTRUCTORS	
	#	%	#	%
Pilot	7	6.5	98	87.5
Business	43	39.8	7	6.3
Student	36	33.3	1	1.0
Doctor/Dentist	6	5.5	0	--
Police	4	3.7	0	--
Teacher	1	1.0	3	2.6
Engineer	3	2.8	0	--
Other	8	7.4	3	2.6
TOTAL	108	100.0	112	100.0

Table excludes 418 pilots for whom profession or instructor status was unknown.

Table 14. Airplane Ratings
Crashes of Instructional Flights, 1989 and 1991

RATING	TRAINEES		INSTRUCTORS	
	#	%	#	%
None	255	66.1	0	–
Single engine land	123	31.9	40	16.3
Single and multi-engine land	8	2.0	206	83.7
TOTAL	386	100.0	246	100.0

Excludes 6 cases where ratings or instructor status was unknown.

Table 15. Total Flight Time
Crashes of Instructional Flights, 1989 and 1991

HOURS	TRAINEES		INSTRUCTORS	
	#	%	#	%
<25	73	19.3	-	-
25-	139	36.7	-	-
50-	96	25.3	-	-
100-	32	8.4	-	-
200-	13	3.4	2	0.8
300-	14	3.7	24	9.9
500-	8	2.1	57	23.6
1000-	2	0.5	62	25.6
2000-	1	0.3	54	22.3
5000-	1	0.3	26	10.8
10000+	0	0.0	17	7.0
TOTAL	379	100.0	242	100.0

Excludes 17 cases where total time or instructor status unknown.
"-" not applicable.

Table 16. Type of Solo Flight by License
Crashes of Instructional Flights, 1989 and 1991

TYPE OF SOLO FLIGHT	LICENSE				TOTAL	
	STUDENT		PRIVATE			
	#	%	#	%	#	%
First solo	24	7.3	0	–	24	6.7
Second or third solo	15	4.6	0	–	15	4.2
Solo cross-country	77	23.6	7	21.2	84	23.3
Other or unspecified solo	211	64.5	26	78.8	237	65.8
TOTAL	327	100.0	33	100.0	360	100.0

Pilot performance

Specific pilot-related performance factors were inferred for 86% of crashes (Table 17). The most common pilot factor, "lost control," noted in half of the crashes, is detailed in Table 18. Poor crosswind correction was apparent in 79 crashes, a bounced landing in 48, rudder misuse in 42, and poor handling of surface wind or turbulence in 40.

Thirteen students crashed when they were lost; 8 who were lost had run out of fuel. Six of the lost students had not filed flight plans.

Although it is standard and recommended practice to file a flight plan prior to a trip, 34 of the 84 trainees who crashed on solo cross-country trips (40%) had not done so.

Instructor performance

In one-third of the cases, the NTSB investigator cited instructor-related factors as contributory to the crash. The most commonly cited factors were inadequate supervision (77 cases), delayed remedial action (34), mishandled simulated emergency (20), and inadvertent stall/spin (15) (Table 19).

On the basis of review of the two-page NTSB briefs, it appeared that many of the solos reflected inadequate training, primarily in evaluation of crosswinds and weather (69 cases), touch-and-go landings (48), and recovery from bounced landings (35). In 54 cases, the instructor let the student get so far into an operational problem that the instructor could not recover, or even compounded the problem. Nineteen

Table 17. Pilot Performance Factors by Type of Flight
Crashes of Instructional Flights, 1989 and 1991

PILOT PERFORMANCE	STUDENT SOLO	PRIVATE PILOT SOLO	DUAL	BFR OR CHECK-RIDE	TOTAL #	TOTAL %
Poor preflight plan	2	1	3	0	6	0.9
Improper preflight	7	0	12	3	22	3.5
Misjudged taxiing	2	0	1	0	3	0.5
Used gear handle for flaps	0	0	2	0	2	0.3
Did not feather prop	0	0	3	0	3	0.5
Mishandled flaps	4	0	3	0	7	1.1
Misused mixture	0	1	5	1	7	1.1
Misjudged fuel available	28	4	6	0	38	6.0
Misjudged fuel system	0	0	1	0	1	0.2
Fuel selector set wrong	3	1	7	2	13	2.0
Misjudged weather	11	2	9	0	22	3.5
Poor handling of density altitude	1	0	1	0	2	0.3
Got lost	11	1	0	0	12	1.9
Student froze on controls	0	0	2	0	2	0.3
Alcohol	2	0	0	0	2	0.3
Failure to see and avoid	6	3	12	2	23	3.6
Insufficient altitude	3	0	5	0	8	1.3
Misused brakes	5	0	1	0	6	1.0
Did not use carb heat	11	2	8	0	21	3.3
Lost control*	200	15	92	14	321	50.2
Other	9	2	15	1	27	4.2
Not a factor	22	1	61	6	90	14.0
TOTAL	327	33	249	29	638	100.0

*See Table 18 for details.

Table 18. Pilot Errors Leading to Loss of Control on Takeoff or Landing
Crashes of Instructional Flights, 1989 and 1991

ERROR	STUDENT SOLO	PRIVATE PILOT SOLO	DUAL	IFR OR CHECK-RIDE	TOTAL
Landed long	4	0	2	0	6
Porpoised	11	0	0	0	11
Bounced	40	1	7	1	49
Ballooned	5	0	1	0	6
Approach speed too fast	8	0	2	0	10
Approach speed too slow	5	0	1	0	6
Flared too high	12	0	7	0	19
Misjudged landing surface	6	2	5	0	13
Rudder too little or misused	31	1	10	1	43
Poor crosswind correction	64	4	10	4	82
Misjudged approach profile	17	2	16	5	40
Mishandled surface wind/turbulence	19	6	18	2	45
Mishandled wing tip vortices	3	1	1	0	5
Misjudged short/narrow runway	4	0	3	0	7
Mishandled hazardous runway conditions	7	2	5	0	14
Misused brakes	2	0	3	0	5
Unfamiliar with aircraft	0	0	5	2	7
Other	10	0	3	3	16
TOTAL*	248	19	99	18	384

*Of 321 pilots with at least one error, a second error was recorded for 63.

Table 19. Flight Instructor Factors Cited by NTSB
Crashes of Instructional Flights, 1989 and 1991

FACTOR	#	%
Inadequate supervision	77	35.8
Delayed remedial action	34	15.8
Mishandled simulated emergency	20	9.3
Inadvertent stall/spin	15	7.0
Directional control not maintained	9	4.2
Poor preflight planning	8	3.7
Improper initial training	6	2.8
Inadequate preflight	5	2.3
Did not use carb heat	5	2.3
Airspeed not maintained	4	1.9
Used gear handle for flaps	2	0.9
Other	30	14.0
TOTAL	215	100.0

Table excludes 423 cases (two-thirds of all cases) in which no instructor factors were cited.

crashes occurred because the CFI did not anticipate a student's hasty action. Ten crashes occurred when the CFIs simulated forced landings in areas that did not afford safe landing places, when the simulated emergencies turned into real ones.

Airplane characteristics

Most of the aircraft (94%) were single-engine training planes such as, Cessna 150s, 152s, and 172s and Piper Cherokees; twin-engine planes constituted 6% of the series. Twins were over-involved in crashes, due to mechanical failure (13% of mechanical failures were in twins, compared with 5% of crashes from other causes). This is probably because loss of control on takeoff or landing, which accounted for 44% of all crashes, and an even greater proportion of crashes involving inexperienced students, was much less common in twins, occurring in only 10 of 39 cases (26%).

Nine of the 39 crashes of twins (23%) resulted from simulated emergencies, in contrast to 7% of the crashes of single-engine aircraft.

Tailwheel aircraft (61) were involved in 9% of all crashes, 17% of nosovers, and 79% of ground loops. The 86 aircraft with retractable landing gear constituted only 14% of all aircraft but 26% of the crashes due to mechanical failure.

Crash outcome

The likelihood of a crash having fatal results varied dramatically with the circumstances (Table 20). The kinds of crashes most likely to be fatal were VFR into IMC (crashes in instrument meteorological conditions when flying under visual flight rules) (71% fatal), midair collisions (44%) and stalls (33%). In contrast, less than 1% of the crashes resulting from loss of control on landing were fatal.

The total number of cases in which 1 or more persons were killed was 67, or 11% of all crashes. The likelihood of being fatal is related to the number of occupants of the aircraft; in order to avoid this bias, the following fatality rate comparisons are for the

Table 20. Injury Severity by Circumstances of Crash
Instructional Flights, 1989 and 1991

CIRCUMSTANCES	INJURY				TOTAL	
	NONE	MINOR	SERIOUS	FATAL	# FATAL	% FATAL
Stall	36	19	8	31	94	33.0
Loss of control - Takeoff	48	6	0	1	55	1.8
Loss of control - Landing	200	21	5	1	227	0.4
Fuel starvation	45	19	6	4	74	5.4
VFR into IMC	0	2	0	5	7	71.4
Midair collision	7	1	2	8	18	44.4
Taxiing/standing	11	0	0	0	11	-
Mechanical failure	44	19	13	4	80	5.0
Mountain terrain	2	1	0	1	4	25.0
Gear up landing	7	0	0	0	7	-
Carburetor icing	20	4	1	0	25	-
Wire strike	4	4	1	2	11	18.2
Other	8	3	4	6	21	28.6
Undetermined	0	0	0	4	4	100.0
TOTAL	432	99	40	67	638	10.5

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Table 21. Factors Related to Pilot Survival
Crashes of Instructional Flights, 1989 and 1991

FACTOR	PILOTS INVOLVED*	PILOTS KILLED	CASE FATALITY RATE (%)	P-VALUE
Weather				
IMC	10	4	40.0	<0.01
VMC	626	54	8.6	
Postcrash Fire				
Yes	33	11	33.3	<0.01
No	605	49	8.1	
Number of Engines				
Two	39	6	15.4	<0.20
One	599	54	9.0	
Shoulder Harness Used				
No	160	24	15.0	<0.01
Yes	402	24	6.0	

*Total may vary within groups due to missing data.

pilot-in-command. Sixty pilots-in-command (9.4%) were killed. Table 21 shows that the pilot was more likely to be killed if:

- the weather was IMC (40% fatality vs 9% in VFR crashes, $p<0.01$)
- postcrash fire occurred (33% vs. 8% if no fire, $p<0.01$)
- the aircraft was a twin (15% vs. 9% in single-engine planes, $p<0.20$)
- the pilot was not restrained with a shoulder harness (15% vs 6% of those restrained $p<0.01$).

Information on availability and/or use of shoulder restraints was missing for two-thirds of cases. Nine percent of trainees and 16% of instructors known to have a shoulder restraint available were not wearing it at the time of the crash.

One crash was precipitated when the instructor opened the door to retrieve his flapping seatbelt, contributing to the student's loss of control on takeoff.

Reflecting the fact that aircraft damage is 1 of the criteria for NTSB investigation of a crash, 83% of the aircraft sustained serious damage, and an additional 15% were destroyed. There were 32 post-crash fires, almost half of which followed either stalls (8) or mechanical failures (7).

DISCUSSION

Until now, there has been little knowledge about the circumstances under which crashes of instructional flights occur, except for individual case descriptions. This research provides information on factors related to crashes of instructional flights and should be useful for improving flying and decision-making skills, not only of students and instructors, but also of future pilots at all levels.

Student solos in this series of crashes illustrated several types of problems that generally are not recognized, including carrying passengers (in violation of federal aviation regulations), misunderstanding the dynamics of touch-and-go landings, inadequate planning and preflight fuel checks, and failure to file flight plans.

Even on a dual flight, most of the piloting errors may have been made by the trainee, who typically would have been at the controls; the instructor, however, is expected to closely monitor the student and to be able to avert a crash.

The involvement of flight instructors in certain types of training-flight crashes was surprising. Direct actions by flight instructors included retracting the landing gear prior to a touch-and-go landing, and initiating simulated emergencies at low altitude. Often, there was evidence that the instructor had allowed the student to develop a problem past the point where recovery was possible, which occurred in many cases of loss of control on landing. Lack of instructor awareness of an impending problem was exemplified by the fuel starvation crashes due to failure to monitor the fuel supply while in flight, or failure to realize that the fuel selector was set to an empty tank.

In the majority of flights that terminated in midair collisions or fatal stalls, an instructor was in the airplane. These 2 categories of crashes comprised the majority of all fatal crashes. The involvement of instructors in crashes with such serious consequences (to themselves, their students, and people in other aircraft) underscores the need to ensure that instructors are trained as to the importance of their unique responsibilities. Flight instructors are called upon to split their attention between the teaching function — in the difficult milieu of a noisy cockpit — and the safety function. The latter demands high awareness, in terms of other air traffic, ATC communications, and airport surface winds, along with an awareness that the trainee may respond in a surprising and hazardous way. Therefore, a greater focus on training instructors and improving the quality and results of their instruction may be an appropriate outcome of this research. Specific recommendations for disseminating the results of the research, especially to instructors, are set forth in Section C.

CONCLUSION

For student pilots, their early aviation knowledge and judgment skills are a product of both the flight training program and their instructors' skills and teaching ability. The skills and knowledge that students take away from this training are what they build on as they continue to accrue flying experience. Thus, a pilot's basic flight training influences the safety of his or her entire flying career. Improvements in flight instruction, therefore, should not only reduce crashes of training flights, but also enhance the safety of licensed pilots.

B. DETAILS OF INDIVIDUAL CRASHES

The following summaries are based upon the narrative and other information in the 2-page NTSB briefs.

Topics were selected because of their apparent importance. Cases were chosen to be illustrative of the major problems encountered in instructional crashes.

The descriptions provide examples, rather than attempting to describe every case, with 2 exceptions: Because of their importance, all fatal stalls and all midair collisions are described.

Midair collisions from all 4 years, 1989-1992, are included, rather than being limited to the years 1989 and 1991, as in the case of the other categories. This was done to obtain an adequate number of collisions of this important type.

FATAL STALLS

(31 cases from 1989 and 1991 instructional crashes)

Solos

1-21-89	#387	33-hour student pilot carrying 2 passengers in C-172 lifted off 1320-foot cow-pasture strip below stall speed; 2 killed and 1 seriously injured.
3-22-89	#131	36-hour student pilot practicing stalls alone in C-150; made fatal descent into snow-covered terrain.
3-24-89	#902	50-hour student pilot carrying passenger in PA-38-112 flying low over river, pulled up sharply. Both occupants killed when right wing stalled and aircraft dived into river.

Fatal Stalls (continued)

3-28-89 #2082 46-hour student pilot solo in C-150 in pattern made flight path erratic in altitude and airspeed; aircraft nosed over and collided with terrain. Pilot killed.

4-15-89 #757 33-hour student in C-152 killed in approach-to-landing stall while attempting S-turns for spacing behind another aircraft.

5-4-89 #1098 Both 120-hour student and passenger in Aeronca 11AC killed in takeoff/departure stall after low passes over grass strip.

9-6-89 #2237 *95-hour student, 95 hours M/M, killed in AA-5B stall out of base-to-final turn on third attempt to land in 18-knot crosswind.*

9-19-89 #1770 34-hour student pilot with 16 M/M doing touch-and-go's in C-150 with passenger; stalled and crashed on takeoff phase, both killed.

10-14-89 #2040 30-hour student on first supervised solo in C-152 left pattern after second landing, stalled into field after circling house and flying low over golf course.

5-5-91 #1856 97-hour student pilot with 71 hours M/M ((PA-38-112) killed in stall. NTSB characterized stall as intentional.

5-26-91 #194 30-hour student with 23 hours PA-28-140, buzzed his home, rolled inverted from steep bank; fatal crash.

7-5-91 #1330 228-hour student pilot, with 129 hours in his Champion 7AC, carrying passenger, made inadvertent stall into terrain.

Dual:

4-6-89 #1303 *1500-hour CFI giving dual in C-150 to a CFI applicant. Witnesses saw aircraft pitch up and then nose down. Both pilots killed.*

4-12-89 #2103 1592-hour CFI, hours M/M unknown, giving seaplane training in Lake LA 4-200 to another pilot. Both crew killed in flat spin.

5-9-89 #1304 4800-hour CFI, 600 M/M, giving crew coordination training in PA-44-180 to two other pilots; radar data indicated stall/spin into sea.

5-22-89 #402 Part 135 training by 4000-hour ATP with 30 M/M, in DC-3. Two pilots and one passenger killed in stall/spin.

6-25-89 #2369 Private pilot practicing in C-152 stalled in turbulence and windshear in the traffic pattern; pilot and passenger killed.

7-2-89 #2101 Experienced CFI doing touch-and-go's with student in C-150. One killed and 1 seriously injured in stall/spin in first gust.

8-15-89 #2173 1024-hour CFI gave simulated engine failure in C-152; student suddenly pulled nose up into stall. During recovery aircraft hit mountainous terrain. Student killed; CFI seriously injured.

1-2-91 #141 *2517-hour CFI with 420 hours M/M stalled attempting go-around in C-172 from snowy, 1500-foot runway. Three on-board; student killed.*

2-2-91 #1957 130-hour private pilot with 13 hours M/M started takeoff phase of touch-and-go with 400 feet runway remaining; 3 killed in takeoff/departure stall, C-172.

2-25-91 #432 534-hour CFI and student flying C-152 killed in approach-to-landing stall, on final approach.

3-27-91 #981 After purchase of Beech 58P, owner-pilot hired CFI with 1000 hours M/M to fly with him until owner proficient. Both killed in spin into terrain.

5-18-91 #1785 2401-hour CFI with 1 hour M/M giving training to wife of owner of PA-24-150. Both killed in accelerated stall.

Fatal Stalls (continued)

7-28-91 #2054 1505-hour CFI, with 2 private pilots, giving mountain flying training in PA-28-181, observed in climbing turn, sudden descent, in mountain canyon. All 3 killed.

8-7-91 #2085 4502-hour CFI giving dual in PA-28-140, started spin too low; 2 killed crashing into terrain. Scattered clouds 2150 feet above crash site may have been a factor.

8-20-91 #1505 1575-hour CFI in C-150 trying to cure 9-hour student of fear of stalls; both killed in spin into ground.

9-24-91 #2130 2508-hour CFI giving dual in C-150 could not recover from inadvertent stall/spin; both hand grips broken off left yoke and left grip broken off right yoke. Two deaths.

11-16-91 #2010 250-hour private pilot with 167 M/M receiving dual in C-310 for multi-engine check ride. Aircraft was observed below 3500 feet AGL gliding with gear and flaps extended; power added, then reduced; aircraft snapped into spin, recovery impossible. Two fatal.

12-21-91 #2079 540-hour CFI with 168 hours M/M giving introductory lesson; seen climbing steeply at low altitude; then diving into ground. Both occupants killed. CFI certified 7 months earlier.

12-28-91 #2121 Night commuter training, Beech 1900, instructor pilot disabled attitude indicator, then in addition, on procedure turn, simulated engine failure. Captain trainee felt disoriented, asked IP to take over control; IP refused; loss of control into ocean. Three fatal.

SIMULATED EMERGENCIES

(Examples from 49 instructional crashes in 1989 and 1991, listed by crash category)

Single engine aircraft

Stalls:

1-16-91 #53 312-hour CFI with 11 hours M/M reduced power to idle on downwind; when attempting go-around PA-28-140 stalled into trees. Five-knot tailwind may have contributed; aircraft was over gross weight.

2-25-91 #259 21-year old instructor, 387 TT and 346 M/M, simulated engine failure on climbout resulting in stall-spin in PA-28-161. Six-knot tailwind may have compounded situation.

7-6-91 #538 6340-hour CFI with 30 M/M, "pulled the engine" in BE-77 to simulate emergency; aircraft could not climb in high density altitude and settled into terrain.

8-16-91 #1156 685-hour CFI with 96 hours M/M stalled demonstrating turn back to runway in simulated emergency, Champ 7GCAA.

9-20-91 #870 Very experienced CFI let 2-hour student in C-172 start simulated forced landing recovery 150-200 feet AGL; student pulled up nose and stalled.

12-28-91 #1770 500-hour CFI retracted flaps on go-around from power-off approach; C-172RG stalled into ground and cartwheeled.

Carburetor ice:

1-17-91 #59 On simulated forced landing practice in C-152, crew did not use carb heat; carb ice prevented climbout and aircraft overturned landing on uneven terrain.

Wire strike:

5-18-89 #369 C-152 hit wires on go-around following simulated forced landing.

Simulated Emergencies (continued)

4-13-91 #1465 Practicing ground reference maneuvers in C-177RG, 530-hour CFI with 55 hours M/M gave simulated forced landing. When CFI initiated go-around, aircraft hit power lines and crashed into field.

Loss of control on takeoff:

9-11-91 #789 426-hour CFI in C-152 simulated engine failure; total power loss occurred and aircraft made successful forced landing. After engine started, CFI attempted takeoff from unsuitable terrain and crashed.

Loss of control on landing:

4-9-89 #73 292-hour CFI in C-152 shut off fuel to simulate engine failure; could not restart. Aircraft landed short of road, hit fence.

3-22-91 #988 CFI giving BFR in C-182 pulled mixture to idle cutoff on approach. Owner/pilot tried to add throttle to make runway; aircraft hit near runways and nosed over.

Multi engine aircraft

Stalls:

11-16-91 #2010 250-hour private pilot with 167 M/M receiving dual in C-310 for multi-engine check ride. Aircraft was observed below 3500 feet AGL gliding with gear and flaps extended; power added, then reduced; aircraft snapped into spin, recovery impossible. Two fatal.

12-28-91 #2121 Night commuter training, Beech 1900, instructor pilot disabled attitude indicator, then in addition, on procedure turn, simulated engine failure. Captain trainee felt disoriented, asked IP to take over control; IP refused; loss of control into ocean. Three fatal.

Loss of control on landing:

2-4-89 #360 After short field takeoff in PA-44-180, CFI idled left engine. Student retarded right throttle, lowered flaps; CFI took control, flared too high, collapsed landing gear on hard landing.

Fuel starvation:

10-8-91 #2167 9500 hour CFI with 16 hours M/M left fuel selector in C-337 on wrong tank; following simulated engine-out landing, ran out of gas on takeoff, made forced landing in cornfield near airport.

Mechanical failure:

1-23-89 #158 785 hour CFI with 46 hours M/M simulated power loss right engine; on approach pulled gear circuit breaker. Crew could not restore gear system; aircraft would not perform single engine go-around because right prop not feathered.

Other:

3-24-89 #531 CFI with 130 hours M/M shut down left engine in PA-34-200, told student to make single engine landing on 2600-foot dirt runway. Student high and fast on final; on attempted go-around, aircraft would not climb on 1 engine.

LOSS OF CONTROL IN AIRPORT SURFACE WINDS

(Examples from 232 instructional crashes from 1989 and 1991)

Crosswinds

03-24-89 #231 1200-hour CFI giving dual in a C-172, tried to take control of aircraft after student drifted off centerline in crosswind. Student would not relinquish control; aircraft collided with a hangar.

04-19-89 #725 43-hour student pilot flying C-150, trying to land on runway 22, winds 270 at 10 knots, attempted go-around in crosswind, settled onto runway and hit a hangar.

05-26-89 #592 20-hour student in C-152, on third solo, veered off left side of runway 32 and hit a sign. Winds 260 at 9 knots.

07-29-89 #1806 30-hour student with 17 hours M/M on short final for runway 27 in C-172 when he noticed a crosswind (190 at 13 knots). Trying to cope with crosswind, student let high sink rate develop; aircraft hit nosewheel first and porpoised.

02-26-91 #26 27-hour student doing touch-and-go's on first solo, using runway 27. Winds 230 at 6 knots. On third takeoff ground roll, aircraft yawed left, veered off runway, crossed a clearway and stopped in a plowed field.

11-26-91 #1751 22-hour student attempting takeoff in C-152 on runway 7, winds 030 at 8 knots. Student lost control, retarded throttle, misused rudder and brakes, ran off runway into ditch and nosed over.

Tailwinds

07-07-89 #497 37-hour student doing touch-and-go's on runway 34 in C-150; wind 180 at 5 knots and density altitude 6500 feet msl. Student sensed aircraft not climbing properly nor providing full power; stalled in turn avoiding obstacle.

08-27-89 #1361 39-hour student with 2 hours in C-172 doing touch-and-go's on runway 17, winds 340 at 4 knots. Aircraft bounced down runway, porpoised and veered off.

12-03-89 #1616 28-hour student landing on runway 22, winds 360 at 15 knots. Aircraft bounced, drifted off runway, flew over ditch, stalled and nosed over.

03-15-91 #91 56-hour student with 27 hours M/M, landed C-152 on runway 2, winds 210 at 6 knots. Pilot landed normally, but pulled back on yoke and aircraft ballooned, porpoised, and collapsed nose gear.

08-21-91 #2143 34-hour student in C-152 sensed too fast on final to runway 8, winds 300 at 5 knots. Student tried to extend flare to dissipate airspeed; aircraft bounced and landed hard.

TOUCH-AND GO'S

(Examples from 118 instruction crashes in 1989 and 1991)

Solos

1-22-89 #234 16-hour student in PA-28-180 lost control on takeoff phase, trying to retract the flaps.

1-29-89 #537 C-150 and C-172 both doing touch-and-go's at uncontrolled airport. C-150 landed on top of C-172.

2-10-89 #136 During landing phase, left brake locked for 41-hour student flying PA-38-112. Aircraft veered off runway and nose and right gear collapsed.

4-1-89 #530 40-hour student in Beech C24R made very hard landing, collapsed all three landing gear.

Touch-and-Go's (continued)

4-22-89 #292 18-hour student in C-150 landed short, bounced onto runway, nosed over.
7-3-89 #1599 12-hour student practicing in C-150 bounced, ground looped.
8-27-89 #1361 39-hour student with 2 hours in C-172 bounced down the runway attempting landing in slight tailwind. After 3rd touchdown, prop hit runway and aircraft veered off.
2-26-91 #26 27-hour student on first solo veered left off runway 27 on ground roll of third takeoff. Winds 230 at 06.
3-31-91 #1349 19-hour student on second solo in C-172 stalled attempting go-around.
8-24-91 #1581 15-hour student flying C-150 lost control on landing, tried go-around with full flaps and carb heat on.
10-28-91 #1790 17-hour student on first solo in C-152, attempting landing, ballooned, stalled into hard landing.

Dual:
1-7-89 #226 CFI giving dual in C-172; slight tailwind and snowy runway. Aircraft drifted left off runway and nosed over in snow.
1-29-89 #98 Private pilot receiving dual in Commander 112TC banked steeply to land on runway centerline; hit a wingtip and bent wing.
2-8-89 #11 2215-hour CFI with 165 hours M/M giving rental checkout to private pilot in PA-15-150. On takeoff phase, CFI could not correct swerve to left.
7-27-89 #2167 Following preflight inspection, student told CFI that aircraft needed fuel; CFI thought not, and aircraft ran out of gas doing touch-and-go's.
8-8-91 #774 2000-hour CFI with 1 hour M/M giving dual in PA-31-350, retracted gear instead of flaps.
12-23-91 #2119 Student receiving dual in C-152 landed long on touch-and-go, ran off runway end trying to stop.

FUEL STARVATION

(Examples from 74 instructional crashes from 1989 and 1991)

Fatal:
1-14-89 #309 268-hour student carrying passenger in PA-24-180 took off with fuel selector on empty tank. Aircraft collided with ground on attempt to turn back to airport. Pilot killed.
7-23-89 #2109 103-hour student in Beech 77 doing solo cross country radioed that engine losing power. Pilot sounded panic-stricken. Aircraft crashed into pond; pilot killed. Left wing fuel cap was unfastened and lying on wing in flight; fuel siphoned out.
7-24-89 #1043 30-hour student practicing touch-and-go's in C-152 entered steep spiraling descent after takeoff and crashed. No usable fuel left in tanks; pilot killed.
9-12-91 #2199 30-hour student practicing touch-and-go's in PA-38-112 dove into ground attempting to turn back to runway after engine quit, out of fuel. Pilot killed.

Non-fatal:
5-12-89 #596 502-hour CFI with 20 M/M giving private pilot checkout in C-T210; after an hour of airwork, engine quit, fuel selector on empty tank. Aircraft crashed in forced landing. CFI did not notice that pilot did not switch tanks.
7-8-89 #604 52-hour student carrying passenger in C-150 ran out of fuel, landed in barley field.

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Fuel Starvation (continued)

7-27-89 #2167 Following preflight inspection, student told CFI that aircraft needed fuel; CFI thought not and aircraft ran out of gas doing touch-and-go's.

8-25-89 #2001 20-hour student in PA-38-112 ran out of gas on final approach doing touch-and-go's, landed short. Engine had run 4.6 hours without refueling.

9-2-89 #1856 47-hour student with 29 hours M/M, flying C-150, got lost after returning to airport with radio problems and not refueling before setting out again. After 4.1 hours, engine quit due to fuel exhaustion.

11-14-89 #1327 30-hour student on solo cross country in C-150 got lost; eventually was guided by FSS back to departure airport, but ran out of gas and landed in an oil field pipe yard.

1-6-91 #289 4900-hour CFI with 4300 hours C-150, attempted introductory flight in C-150 with empty tanks. Aircraft crashed 1/4 mile from end of takeoff runway.

6-18-91 #1024 44-hour student with 30 hours M/M ran out of gas doing touch-and-go's in C-150; on climbout ran out of fuel and entered accelerated stall on turnback to runway.

FLIGHT INSTRUCTOR PERFORMANCE

(Examples from 278 dual instructional crashes from 1989 and 1991)

Let problem develop too far:

7-9-89 #593 9100-hour CFI with 10 M/M gave student simulated engine failure in PA-38-112. Student performed emergency procedures but was too high on final to land on runway. CFI then took control and stalled the aircraft attempting another 360-degree turn.

8-22-89 #1988 645-hour CFI with 100 M/M did not correct flat approach in Bellanca 8KCAB. Trainee saw power lines on short final and raised nose; high sink rate developed and aircraft hit a parked truck short of the runway. CFI said he did not apply power because of "aircraft pitch-up tendency."

9-29-89 #1319 Two CFIs giving instruction to each other in short field landings, in C-182. One CFI noticed that high descent rate had developed on short final, told other CFI to apply power. Flying pilot did not respond and aircraft landed hard. PIC CFI said he could have prevented crash if he had not delayed taking action.

8-12-91 #929 1039-hour CFI with 374 hours M/M doing touch-and-go's in PA-38-112 with student in 10-knot left crosswind. On takeoff, aircraft drifted left; CFI told student to apply right rudder, but left drift continued. CFI applied right rudder but aircraft pivoted onto grass.

9-1-91 #2242 2062-hour CFI with 1450 M/M giving dual in C-152. Student landed hard and aircraft bounced about 20 feet into air. CFI could not recover from the bounce before the aircraft stalled.

9-20-91 #870 5175-hour CFI with 2000 M/M gave 2-hour student simulated forced landing in C-172. CFI had student start recovery 150-200 feet AGL and student stalled the aircraft; CFI could not recover.

12-7-91 #913 1940-hour CFI with 6 M/M gave student in PA-15 emergency landing on sod strip; 30-degree crosswind at 14 knots. Before CFI could recover, aircraft veered off runway and nosed over.

12-28-91 #2121 Night commuter training, Beech 1900, instructor pilot disabled attitude indicator, then in addition, on procedure turn, simulated engine failure. Captain trainee felt disoriented, asked IP to take over control; IP refused; loss of control into ocean. Three fatal.

Did not anticipate improper hasty action by student:

3-12-89 #263 518-hour private pilot with 57 hours M/M receiving instruction in PA-34-220T, inadvertently retracted gear while landing.

Flight Instructor Performance (continued)

4-2-89 #120 591-hour CFI with 53 M/M teaching in PA-38-112. 4-hour student started takeoff roll with left aileron into 13-knot left crosswind, but relaxed aileron pressure. When CFI told student to increase left aileron, student applied left rudder and brake; aircraft swerved left and CFI could not recover.

4-10-89 #436 559-hour CFI with 94 M/M making low approach with student in C-152. CFI instructed student to add power to go around. Instead, the student raised the aircraft nose and the right wing dropped, resulting in a stall.

3-19-91 #429 315-hour CFI with 26 M/M gave student in C-150 a simulated engine failure by pulling throttle to idle. Student responded by pulling mixture to idle cutoff, which CFI did not notice until student applied throttle to go around. Forced landing.

STUDENT PILOT CARRYING PASSENGER

(Examples from 23 instructional crashes from 1989 and 1991)

1-14-89 #309 268-hour student in PA-24-180 took off with fuel selector on empty tank. Passenger seriously injured; pilot killed.

2-12-89 #358 26-hour student flying C-150 with passenger (who claimed to be asleep) made forced landing after wire strike. Pilot first said he hit a bird; later said he hit a parachutist. Finally he said aircraft hit "something."

3-5-89 #400 23-hour student flying PA-28 with passenger crashed into trees after departing airport in fog, drizzle at 0400 hrs. Passenger killed; pilot had blood alcohol of .085%.

5-6-89 #204 61-hour student with 29 M/M, flying with another student in C-150, stalled out on final.

9-19-89 #1770 34-hour student pilot with 16 M/M doing touch-and-go's in C-150 with passenger; stalled and crashed on takeoff phase, both killed.

9-29-91 #1610 137-hour student pilot in Aeronca 7EC stall-mush while helping passenger spot alligators.

7-31-91 #2253 Student with passenger in C-150 landed for meal at private airstrip. Restaurant closed; student lost control on takeoff in light crosswind and crashed.

MIDAIR COLLISIONS

(30 cases; 38 instructional aircraft; 1989-1992

Fatal:

8-29-89 #1846 Private pilot in C-152 receiving instrument dual in uncontrolled airspace at sunset climbed out at 700-800 fpm on path converging with BE-J35 cruising level at 1600 feet msl on heading directly into sun. Fatal to four.

9-3-89 #2230 30-hour student in pattern doing touch-and-go's in C-152 hit on base leg by helicopter climbing out for positioning at nearby hospital. Airport tower had closed 46 minutes earlier; neither aircraft was heard giving traffic advisories. Three killed.

9-24-89 #1661 27267-hour CFI giving slow flight dual in C-172, at 800 feet msl. Radar plots revealed another aircraft target crossing C-172 flight path. Rear wing spar of C-172 failed in flight. Tire mark from other aircraft found on C-172 wing top. Two crew killed in C-172 crash. Other aircraft, a C-152 operated by a 24-hour student, returned to airport. Student said he could not recall hitting anything.

Midair Collisions (continued)

11-5-89 #1997 1600-hour CFI with 200 M/M doing touch-and-go's with student in C-172 at uncontrolled airport, runway 18. Winds: 190/05 kts. A Beech C90 flown by 2 ATPs was departing runway 6 on an IFR flight plan. Both crews made radio calls but aircraft collided over runways with 4 people killed.

2-3-90 #895 147-hour private pilot with 49 hours M/M concluding cross country in PA-28-161, made left base. While PA-28 on final, AA-1A cut inside on closer left base, overshot final slightly, and prop and nosewheel hit tail of PA-28. Both aircraft broadcasting position: PA-28 pilot killed, and AA-1A pilot could not recall details of occurrence.

2-6-90 #1629 4300-hour CFI giving dual in Beech 95-55, doing touch-and-go's with right traffic for runway 31R. Beech twin made 30-degree constant turn with no rollout climbing out from crosswind and turning downwind. C-182, which had reported NW initially and been cleared to enter left downwind, reported other side of airport and was also cleared for right downwind; the 2 aircraft collided 2 miles north of airport; 3 killed. C-182 did not enter downwind abeam runway midpoint and C-182 pilot tested positive for marijuana.

3-90-90 ATC working traffic on north and south runways on 2 different radio frequencies. 1135-hour CFI giving dual in C-152, planned touch-and-go's on south runway, where 2 other Cessnas were already in pattern. A banner towing aircraft radioed on north frequency and was cleared to descend through pattern for banner drop. ATC informed banner aircraft of Cessnas on downwind, and the latter, of the banner aircraft. When the C-152 turned downwind, it and the banner towing aircraft collided; 3 fatal.

7-1-90 #982 Two newly licensed private pilots with 118 hours M/M were flying PA-38-112's on the same cross country route. After an intermediate stopover, the 2 flew formation; the trailing aircraft hit the leading aircraft while maneuvering. Both pilots killed.

7-23-90 #1826 CFI giving instrument dual in PA-28 was climbing out on course of 282 degrees, at 80 knots. A PA-60 was cruising at 2100 feet and at 165 knots, course 258 degrees. The PA-60 converged on the PA-28 from the right rear; the PA-28 converged on the PA-60 from its lower left forward area. The aircraft collided at 2100 feet and all 3 pilots were killed. Neither aircraft had obtained ATC/radar assistance.

8-19-90 #2190 271-hour CFI with 114 hours M/M giving dual in C-172, which was flying a course parallel to a PA-28RT-201, which was configured for slow flight with gear and flaps down. Cessna flying faster and hit Piper with left wing, severing outboard portion of Piper right wing. Both aircraft flying toward sun. Collision killed 4. (No ATC information)

9-8-90 #1902 Taylorcraft flown by 100-hour student pilot collided head-on with another aircraft. Both pilots in McKinley National Park area at 500 feet AGL checking on friends at hunting camps. Both pilots killed.

2-3-91 #294 Cessna 182 climbing out with 4 skydivers converged laterally with approaching instructional PA-28-140 about 1.5 miles from airport. Aircraft tangled and crashed; 7 people killed.

2-13-91 #905 17,300-hour CFI giving dual in Pitts S-2A collided with helicopter which had lifted off a pad near runway and turned to depart over same runway. Pitts crew killed.

12-7-91 #2111 847-hour CFI with 561 M/M giving instrument dual in C-172; weather VMC in controlled airspace. ATC gave C-172 missed approach clearance to altitude of 2000 feet. When 5 miles east of airport, C-172 involved in midair at 2,200 feet with VFR aircraft cruising on VFR flight plan and not in contact with ATC. Two in C-172 killed.

Midair Collisions (continued)

6-1-92 #548 1430-hour CFI giving dual in C-172 returning to uncontrolled airport at 2500 feet msl; a C-182 was also inbound to airport at 1500 feet. CFI in C-172 told C-182 he would circle and follow C-182; C-182 pilot saw C-172; later looked out right window and saw C-172 converging in descending right turn. Left wing of C-172 hit right side of C-182. Two killed in C-172.

7-7-92 #2170 560-hour CFI with 300 M/M doing touch-and-go's with student in C-172. Another C-172 reported inbound from wrong direction; ATC did not identify on radar and controller, in briefing replacement, did not point out inbound C-172, which never reported on downwind as instructed, but did report turning base. Second C-172 was tracking inside flight path of dual C-172, and aircraft converged and crashed. Four people killed.

8-27-92 #679 2300-hour CFI with 1500 M/M doing touch-and-go's with student in C-150, broadcasting intentions on 122.9, the current CTAF. C-182 made right traffic for same runway and turned a high final. C-150 clipped C-150 as C-172 turned left base to final. C-182 pilot killed.

Non-fatal:

1-10-89 #1640 20,700-hour CFI giving dual in Bellanca 7GCBC broadcast position on final; Pitts pilot announced position on downwind. Pitts overtook and landed on Bellanca on short final.

1-29-89 #537 27-hour student flying C-150 landed on top of landing C-172 at uncontrolled airport. Both pilots said they broadcast intentions; neither aware of other's position. Both aircraft were doing touch-and-go's.

2-8-89 #337 ATC handling 3 small high wing Cessnas at busy airport misidentified the C-152 flown by a 53-hour student pilot and gave it a clearance to land, intending the clearance for another Cessna. The C-152 and a C-150 collided about 20-30 feet AGL on final.

9-21-89 #2328 C-172 in which 440-hour CFI giving instrument training collided "in flight" while "maneuvering" with a training C-152. C-152 returned to home airport; C-172 made forced landing.

7-22-90 #2012 C-150 being flown by 27-hour student was on final at dusk when it was hit on upper cockpit and right wing root area by low wing aircraft that had turned to final. Neither pilot saw other. (No information on radio procedures)

8-7-90 #2236 3232-hour CFI doing airwork in C-172 with student under hood; right side of engine hit by military T-38 vertical stabilizer. T-38 was being vectored for Kelly AFB ILS, going about 330 knots. C-172 did not have Mode C.

10-20-90 #2038 Two C-152s flown by a 213-hour "commercial" pilot and a 67-hour private pilot collided in a flight school traffic pattern at an uncontrolled airport on a clear day. There were 7 aircraft in the pattern and radio frequency was saturated. One aircraft is described as in the pattern, the other on a go-around. Pilots lost visual contact with each other.

4-16-91 #323 Two flight school PA-28-161s, operated by private pilots with 88 and 75 hours respectively, collided while approaching airport under positive control. Propeller of 1 hit bottom of other's stabilizer. Both aircraft did touch-and-go's following incident.

4-23-91 #255 50-hour student pilot in PA-28-151 had just touched down when a 69-hour student pilot in a C-150 with 1 hour M/M landed on top. (Apparently the airport was uncontrolled)

11-20-91 #481 7200-hour CFI with 5100 hours M/M giving practice instrument approaches to commercial pilot, under a hood, in left seat of Convair 600. A developmental controller was controlling traffic under supervision and cleared a Beech 19 to cross the area at or below 2400 feet. Aircraft converged and collided, after B19 pilot tried to avoid Convair. ATC had not notified either aircraft of other's position.

Midair Collisions (continued)

11-22-91 #1893 1657-hour CFI giving dual in C-150, made close-in baseleg; C-150 left wing hit the vertical stabilizer of a C-172 that had entered the pattern on downwind and was making a long final.

3-31-92 #1920 61-hour student pilot flying C-172 planning landing at tower-controlled airport; cleared to land from a right downwind. 1600-hour CFI with 700 M/M giving dual touch-and-go's in another C-172 to student; on left downwind. CFI and his student misidentified aircraft ATC said to follow, and on final approach, descended onto student's aircraft. Student landed safely on runway; CFI made forced landing in rough terrain.

11-11-92 #9762 3,500-hour CFI with 1500 M/M giving dual in C-182; made improper traffic pattern entry and collided with C-150 flown by 390-hour CFI with 43 hours M/M/, giving flight check. C-150 was rolling out of turn from climb to downwind; left seat pilot saw the C-182 approaching from behind and to the left, pulled nose up sharply. C-182 rear seat passenger alerted 182 crew, which made sharp left turn. (No information in report on communications; airport apparently uncontrolled)

Note: None of the midair collisions occurred at night.

C. DISSEMINATION OF STUDY RESULTS

Results of the investigation of crashes of instructional flights are described in detail in other sections of this report to the Federal Aviation Administration. This section presents more details on some of the specific problems identified and focuses on how the results can be disseminated by the FAA to the aviation community, especially flight instructors.

HIGHLIGHTS OF THE CRASH REPORTS

Our analysis of 638 crashes in 1989 and 1991 involving instructional flights has brought to light a number of facts that probably are not well known, even to instructors. Among the surprising findings were the large numbers of crashes that occurred in 2 years under the following circumstances:

- crosswinds at the airport (120 crashes on solo, 57 dual),
- touch-and-go landings (84 on solo, 34 dual),
- fuel starvation, due to either inadequate planning/preflight or misunderstanding the fuel system (50 on solo, 24 dual),
- go-arounds (28 on solo, 28 dual), and
- simulated emergencies (sometimes at a low altitude or after instructor shut down engine) (1 on solo, 48 dual).

The above problems occurred in the course of dual instruction, as well as on solo flights.

Additional problems or deficiencies noted in connection with crashes of student solos included:

- students carrying passengers (23 crashes),
- getting lost (13), and
- failure to file flight plans on cross-country solos (34) — although not the cause of the crash, these cases suggest poor oversight by the instructor.

Less common problems, of special interest because they are not widely recognized, included:

- carburetor icing while in cruise phase (13) and
- midair collisions with helicopters or acrobatic airplanes — 2 types of aircraft in which the flight patterns may be unusual — or the pilots' visual field may be limited (4 cases among the 30 midair collisions in the 4-year series).

That the most common event immediately preceding the crash was loss of control on landing (227 cases) may surprise no one. The 94 stalls, however (half of them with an instructor on board), are noteworthy, not only because of their numbers, but also because of their severity: ***Stalls accounted for almost half of all fatal crashes.***

INSTRUCTOR DEFICIENCIES

Solo student flights

A student on solo is the pilot in command (PIC) and must be held responsible for anything that happens on the flight. The identification of some crashes as being suggestive of inadequate training is often subjective, as is the choice of categories. fuel starvation, for example, was not selected as one of the above categories because training in this area is relatively straightforward and it is reasonable to assume that the essentials have been taught by the time a student solos. The skills required for the above 4 categories require much more interaction between student and instructor before mastery is achieved. Even with the best training, some student pilots may be likely to be involved in a crash because of their personal approach to decision-making and risk-taking.

Nevertheless, loss of control of the aircraft by the solo student, as well as many other problems, may reflect directly on the certified flight instructor (CFI) because of either inadequate training or CFI misjudgment of the student's capabilities.

On the basis of review of the 2-page NTSB briefs, it appeared that many of the 360 crashes on solo were suggestive of inadequate training, primarily in:

- evaluation of crosswinds and weather (69 crashes),
- touch-and-go landings (48),
- recovery from bounced landings (35), and
- navigation (13).

In addition, 8 crashes occurred when instructors allowed students to solo in hazardous conditions (poor visibility, snowy runway, etc.).

Dual flights

Based on review of the 2-page briefs describing the 278 crashes of flights with an instructor on board, the most common instructor deficiencies were:

- letting the student get too far into an operational problem, so that the instructor was unable to recover control of the aircraft — or even compounded the problem (54 crashes);
- not anticipating a student's hasty action (19) (Table 22);
- simulating a forced landing in an area that did not afford a safe landing place when the simulated emergency turned into a real one (10); and
- inadequate training in touch-and-go landings (8).

NTSB appraisals

In one-third of all crashes in the series, the NTSB investigator cited instructor-related factors as contributory to the crash. The factors most commonly cited were:

- inadequate supervision (77 crashes),
- delaying remedial action (34),
- mishandling of a simulated emergency (20), and
- inadvertent stall/spin (15).

Unanticipated student actions

Flight instructor training often does not include preparing the CFI for the student's surprising, inappropriate reactions. As can be seen from the examples in Table 22, students do unpredictable things. Flight instructors must anticipate and guard against these reactions.

CFI INSIGHTS INTO STUDENT BEHAVIOR

Looking at situations in which students experience problems, it is fairly simple to say that student crashes are due to student lack of experience, lack of practice, or insufficient understanding of aerodynamics and the function of flight controls, or poor preflight inspection or planning. But no matter what the direct cause, instructional techniques hover in the background.

In addition to improved teaching, the instructor must constantly be perceptive about the student's behavior, and must also have insight into student reactions during each lesson.

The CFI must be particularly alert to any student tendency to respond automatically in a hazardous way, such as pulling the nose up if too low on final, rather than adjusting pitch attitude with power. Each time the instructor solos a student, the CFI must balance objective factors, such as airport surface winds, traffic, etc., with the student's apparent capabilities on that particular day.

An instructor must have insight into factors that might hurry a student (such as the fueler having 6 prior aircraft on the fueling list, so the student departs with partially-filled tanks). It is the CFI's job to perceive things that may be stresses on the student pilot. Flight instruction cannot be hasty; the student needs time, even during lessons, to absorb examples and techniques. Especially during takeoffs and landings, the student pilot needs time between each landing and takeoff to review the events of the previous circuit around the pattern.

CASES AND COMMENTS

The following situations typify many of the crashes involving instructional flights. Section B includes scores of cases that could be used to illustrate these problems, in addition to the ones presented below. (Although the individual case reports in Section B contain less detail than the following, the case number and date make it possible to obtain the relevant two-page brief from the NTSB.) Each of the cases that follow could be used in educational material for student pilots and instructors.

Table 22. Examples of Hasty Actions by Student Pilots Flying with Instructors Resulting in Crashes of Instructional Flights, 1989 and 1991

CIRCUMSTANCES
Student pulled up nose for go-around instead of adding power.
On high altitude takeoff, when stall warning blared, CFI called for gear retraction; private pilot trainee thought that was wrong and retracted flaps.
When amphibious airplane bounced into air on power boat's wake, student reduced power.
On power reduction to idle (simulated emergency), student raised nose beyond stall.
After a bounce on landing, private pilot trainee retracted gear before aircraft settled back on runway.
Following rollout on tailwheel checkout, private pilot trainee added power and swerved left off runway, not using rudder.
When CFI told student to increase left aileron, student applied left rudder and brake.
During multi-engine instruction, student overcorrected; yawed left, then right.
When CFI told student to delay rotating on takeoff, student rejected takeoff, applied brakes.
Student landed long on touch-and-go; CFI thought student would stop but student attempted takeoff.
Student was drifting left on landing; added full power, aggravating drift.
CFI pulled Cessna 150 throttle to idle to simulate engine failure; student then pulled mixture to idle- cutoff, which CFI did not notice.

Loss of control on takeoff — Crosswind

Case 592, 5-26-89. A 19-year old student with 20 hours flight time was trying to take off in a Cessna 152 on runway 32, on his third solo. The winds were 260 at 9 knots. After rotation and during initial climb, the aircraft veered over the left side of the runway and struck a runway locator sign. Upon impact, the nosegear collapsed, right wheel broke off, and right wing hit the ground.

Comments: In this case, student inexperience seems to be a major factor. The case raises the question of how to improve the responsible flight instructor's teaching. This sequence of events appears to be a typical case of not properly using the flight controls (initial left aileron, right rudder) in response to the crosswind and in response to the developing left-turning tendency following rotation and liftoff. The student needed to apply even more right rudder with rotation and liftoff.

The crux of the problem with crosswind landings and takeoffs may be instructional emphasis on flight control coordination. Obviously, it is important to cruise and turn in a coordinated fashion, but there may be so much emphasis upon coordinated flight that the need for independent use of controls in handling crosswinds is ignored, or perhaps disciplined away. For some students, warnings against the dreaded cross-control stall on the base/final turn may have precluded using rudder and aileron independently in situations where that is an obvious requirement.

In the crashes resulting from loss of control, over and over again, it is evident that pilots are not using enough rudder. Flight instructors must emphasize use of the rudder throughout the entire course of training. Students must be taught that rudder and aileron can be used in harmony, as when initiating a turn, but that it is perfectly natural to use these controls in opposition: That upon takeoff, one can hold the upwind wing down by holding aileron up into the wind on that side, and still keep the aircraft moving straight ahead by using right rudder.

Basic to all of the student solo crosswind loss-of-control crashes is the CFI's initial decision to permit solo flight under those crosswind conditions. In this and other cases, an instructor allowed an inexperienced student to solo with a substantial crosswind. While the crosswind loss-of-control crashes in this series generally did not cause serious injury or death, the large number of crosswind crashes indicates that remedial measures are needed. The FAA might consider recommending that flight instructors often select crosswind runways for dual training.

Loss of control on landing — Touch-and-go

Case 234, 1-22-89. A 16-hour student pilot flying a Cherokee 180 at Show Low, AZ (elevation 6412 ft., msl), had completed her second touch-and-go landing and was beginning her third takeoff on runway 24; winds 180 at 8 knots. The student remembered that the flaps were still full down, added power to continue the takeoff, and lost directional control when reaching down to retract the flaps. The aircraft veered left and collided with a dirt bank. The student said she may have stepped on left rudder as she tried to retract the flaps.

Comments: This is an example of a situation requiring careful teaching of the dynamics of touch-and-go's. There was a 60-degree left crosswind at 8 knots; the student was using a 75-foot wide runway. In addition to the changing control pressures required on landing and rollout, and then on adding power to take off, the student must be warned of the potential trouble resulting from reaching for the flap handle (especially in this aircraft, which has a mechanically-linked flap handle on the floor between the seats). The instructor might diagram the flight control and power kinematics for stages: final approach, flare, touchdown, rollout, flap resetting, takeoff, climbout, etc. (Control and power usage vs. conditions, e.g. crosswind left or right, tailwind left or right, and density altitude).

Interestingly, available FAA training materials do not contain information on how to perform or teach touch-and-go's. AC 60-14, Aviation Instructor's Handbook (1977), mentions doing touch-and-go's in dual lesson plans 7 and 8; recommends 3 takeoffs and 3 full-stop landings on first solo; and in lesson 10, suggests for the second supervised solo, 3 takeoffs, 2 touch-and-go's, and 1 full-stop landing. The Flight Instructor Practical Test Standards (PTS) apparently contain no description of, or instructions for, teaching touch-and-go's. Because of the high incidence of crashes on touch-and-go's, the FAA should amend the PTS to include touch-and-go criteria.

Fuel starvation

Case 1327, 11-14-89. At 6:00 p.m., with darkness approaching, a 30-hour student pilot became lost on a solo cross country in a Cessna 150. After trying for some time to locate himself, he called FSS for help; FSS was guiding the student against headwinds back to the departure area when the aircraft ran out of gas; the pilot landed 1 mile north of the airport in an oil field pipe yard. The student listed 1 hour of instrument time.

Case 581, 6-11-89. A 47-hour student, sent on a solo cross country in a Cessna 152, was told that the aircraft had been flown 1.5 hours since being topped off with fuel. The student became lost/disoriented; said he could not find his destination airport due to area flooding and a faulty radio, and was trying to return to departure airport when the aircraft exhausted fuel after 1 hr 50 min. Student was able to land on a road. Aircraft actually had been flown 2.5 hours prior to student departure. Student listed 1 hour instrument time.

Comments: Of the 51 fuel exhaustion cases, 26 were student solo cross country flights, and 8 of these students were lost. Flight instructors should give more thorough instruction on how to handle getting lost. In addition to basic radio orientation procedures, the student should be aware that panic is a common effect of getting lost. Flight Training Handbook, AC 61-21A Rev. 1980, under the topic losing track of position, says, "The greatest hazard to a pilot failing to arrive at a given checkpoint at a particular time, is panic" (p. 172). In addition, being lost is extremely distracting; student pilots should be taught not only to "fly the airplane" but also to maintain awareness of the fuel supply and plan a landing prior to fuel exhaustion.

A number of cases in the crash series indicated insufficient preflight fuel checks: Pilots either did not look in the fuel tanks, relied upon someone else's estimate of fuel on board, or, for other reasons, misjudged the fuel available. The FAA should require, as part of every preflight aircraft inspection, that the pilot actually measure the fuel in the tanks. At least 1 well-known pilot shop advertises fuel sticks calibrated for high wing Cessna tanks. A currently manufactured European trainer, the Czech Zlin 240, has a calibrated fuel dipstick in each gas cap.

Simulated emergency resulting in stall

Case 2173, 8-15-89. A 22-year old, 1024-hour CFI was introducing a 5-hour primary student to simulated engine failure. The CFI selected an area of mountainous terrain and reduced power to idle in the Cessna 152. The student rapidly raised the nose beyond stall attitude. The instructor pushed the nose over, but the Cessna collided with terrain during recovery as it was achieving a climb attitude. The student was killed. The weather was noted as being 3.0 miles visibility, with ceiling partially obscured in fog.

Comments: This simulation should have been started at a much higher altitude. Instructors, moreover, should initiate simulated emergencies in an area where there is a place available to land. This case exemplifies the fact that students can be counted upon to do something surprising. In this case, the surprise pull-up resulted in an unanticipated stall at an altitude too low for recovery by the CFI. The NTSB record indicates CFI flight time of 267 hours in the last 90 days, and 92 hours in the last 30 days. This young flight instructor may have been pushing hard to build hours — so hard that he was doing maneuvers with a primary student in near-IMC. In addition, the sky conditions may have influenced the choice of practice area and the student's reaction.

Simulated emergency — Wire strike

Case 1492, 4-8-91. A 23-year old, 311-hour CFI was giving a checkout to a private pilot in a PA-28-140, near Carefree, AZ. After doing maneuvers, the CFI retarded the throttle and told the pilot to do a simulated forced landing. On final to the landing area, the private pilot noticed power lines and began to add power to go around. The CFI told the private pilot to fly below the wires, took the controls and nosed the aircraft down. The Cherokee struck the power lines and crashed.

Comments: The Flight Instructor PTS for emergency approach and landing says not to continue a simulated emergency approach below 500 feet AGL, unless over an area where a safe landing can be accomplished, in compliance with FAR 91.79. The above report does not list the height AGL of the wires. In 5 cases in the series, aircraft hit wires on simulated forced landings. One preventive measure is to comply

with PTS criteria. Another recommendation is that the CFI find a good location for simulated emergency practice and work there solo, in order to make certain that the area is a safe place for dual practice.

Student pilot carrying passengers

Case 1803, 7-24-89. A 361-hour student pilot (holding a valid medical certificate) was carrying 2 passengers in a PA-28-140, departing a 1940-foot gravel strip at Vashon, WA, destination, Port Townsend, WA. The pilot said later that during takeoff, he rotated about midpoint down the runway; after the Cherokee climbed about 30 feet, the stall warning horn sounded. The PIC, realizing the aircraft would not clear trees at the end of the strip, tried to set the aircraft down in an open field to the left; the landing gear collapsed in soft terrain.

Comments: Unfavorable conditions — 3 people in a 150-hp aircraft in July; a short, gravel strip, and unspecified "unfavorable winds" — make a successful takeoff unlikely. Without carrying the 2 passengers prohibited by FARs, takeoff might have been possible.

Many of the 23 students who were illegally carrying passengers exhibited extremely poor judgment in other respects. Two crashes in the series were known to involve alcohol, and both were student flights with passengers.

Crashes of students carrying passengers were 4 times as likely to be fatal as other crashes in the series. They also were more likely to involve pilots with more than 100 hours total time flying on student licenses.

Eleven student pilots had more than 200 hours flight time. The FAA may wish to ascertain the circumstances under which high-time student pilots are flying on student licenses — for example, whether they are pilots who have been unable to pass flight examinations, whether they are flying under the supervision of an instructor, and whether instructor endorsements for unlimited solo cross-country trips between specified airports are appropriate.

Go-around

Case 2000, 8-13-91. A 1700-hour CFI with 300 hours in make and model was giving dual in a PA-23-250. To simulate engine failure during the initial climbout, the CFI turned off the fuel supply to the right engine. The student performed the emergency checklist, which included feathering the right propeller (aircraft was not equipped with propeller unfeathering system). The CFI told the student to re-enter right traffic pattern; he did so and overshot final. The left main gear down light was not on. The CFI took the controls in an attempt to do a single-engine go-around. The aircraft would not climb; it landed in the street and hit a sign and a pickup truck.

In 3 of the 9 cases of simulated engine failure in twin-engine aircraft, the CFI initiated the simulated emergency by actually shutting down an engine, and ensuing single-engine go-arounds were unsuccessful. Twin-engine simulated emergencies also involved unrelated mechanical failures, fuel starvation of the working engine, wire strikes, and controlled descents into terrain or structures.

While the FAA Flight Training Handbook (AC 61-21A, 1980), approves shutting down an engine at a safe altitude (minimum 3000 ft. above terrain), the text also specifies that such a shutdown be within landing distance of a suitable airport. At lower altitudes, the simulation is accomplished by power reduction.

CONVEYING THE INFORMATION TO FLIGHT INSTRUCTORS

A major part of the FAA's mission is to promote aviation safety; training flight instructors is one of the most important ways in which the FAA accomplishes its statutory objectives. This research provides a basis for developing Advisory Circulars (ACs) and other materials likely to be used by students. In addition, it is important for the FAA to ensure that flight instructors benefit from the results of this investigation.

The FAA series on Accident Prevention (FAA-P-8740-1 to 53, Rev. 1987) contains a great deal of useful information for beginning and advanced pilots. Ideally, the series should be actively distributed to each student when the FAA is first informed of issuance of a student license, since some instructors may not make use of the material in them. The present study suggests, however, that more attention should be given to instructors, themselves, so that they will

know what the problem areas are, and will gain some insight into what they can do to prevent crashes, such as the ones described in this report.

Flight instructor initial certification

Information gleaned from this research should be incorporated in materials that the instructor is required to master in order to be a CFI. This could be accomplished through several avenues, including a) curricular materials used at schools that train instructors, b) questions on written tests for CFIs, and c) discussion during CFI flight tests by FAA flight examiners.

Flight instructor recertification

Flight instructors must renew their certificates every 2 years. This provides a potentially valuable opportunity for interaction between the FAA and CFIs.

Over the past 20 years, the FAA has moved from directly conducting the flight instructor refresher courses, to complete privatization of CFI renewal courses, the curricula of which are reviewed by the FAA and approved. The course content is developed by the contractor, for example the Aircraft Owner's and Pilots Association or Jeppesen Sanderson. Course content does not necessarily reflect FAA knowledge of instructioaal crashes, but could be modified to do so, for example through development of a module based on the findings of this study.

The second method of recertification is based upon a flight instructor's record, i.e., having successfully trained a certain number of students.

Neither of the above methods requires an in-depth encounter with knowledgeable and experienced FAA personnel. Although it is possible for a CFI to renew by taking a check ride with an FAA inspector, this method may be underutilized. During the time when the FAA conducted the CFI renewal course at the Training Academy in Oklahoma City, flight instructors often expressed a perception that the personal contact and communication with FAA personnel were beneficial. We feel that some results of the present study suggest that it may be advantageous for the FAA, once again, to have more direct personal contact with CFIs during recertification.

Direct communication with flight instructors — flight instructor pamphlets

Currently, the FAA sends flight instructors copies of its flight examiner newsletter. A separate, detailed publication specifically targeted to instructors would provide a means of emphasizing potential problems and solutions faced by students and their instructors. The FAA could mail to each instructor holding a current medical certificate a quarterly Flight Instructor Pamphlet, perhaps designed to be 4 pages long, describing a significant instructional problems, suggesting ways in which the instructor could anticipate and prevent this problem.

For example, our study identified 13 cases of carburetor icing in cruise — serious enough that the aircraft crashed. The FAA could develop a pamphlet describing these cases and outlining symptoms of carburetor icing, such as a drop in engine RPMs (fixed pitch prop), decrease in manifold pressure (constant speed prop), engine roughness, or unexplained high fuel consumption.

Pilots are interested in crash reports. If, in each pamphlet, the FAA discussed several instructional crashes that illustrate a significant instructional problem, and outlined preventive measures, this information should be well received.

It would be helpful for the FAA to list the particular unanticipated hasty actions identified in this study, and to develop a flight instructor pamphlet describing the circumstances, and how to handle them.

For example, a common failure is retracting the gear instead of flaps. The CFI should always track the motions of the student's hand, from throttle to flap handle. Training students always to say "flaps identified; flaps up" and not retract flaps until clear of the runway, may be effective. If doing touch-and-go's in a retractable gear aircraft, the CFI must monitor pilot hand motions, or even guard the gear handle.

The FAA has not revised its instructional training book since publication of AC 61-21A, Flight Training Handbook, in 1980. The latest and most specific training information is contained in the Flight Instructor Practical Test Standards, which could be incorporated as reference material in the suggested FAA flight instructor pamphlets.

RECOMMENDATIONS

Communication of study results

We recommend that the findings from this study be communicated in some way to every CFI and to each entity producing CFI renewal courses. This may be accomplished through a variety of approaches, including but not limited to:

1. Development of a series of flight instructor pamphlets could be made available during CFI renewal; this would provide a way for the FAA to communicate the information directly to instructors. Instructional training materials from the Practical Test Standards could also be incorporated in the FAA Flight Instructor Pamphlets.
2. Furnishing a copy of the entire Final Report to sponsors of flight instructor refresher courses, and anyone else known to be developing instructional materials. Copies could be provided to FIRC sponsors upon their renewal.
3. Development of modules for use in flight instructor courses based on the findings of this study, illustrating what can be learned from crashes involving students and instructors.
4. Development of Trigger Tapes that emphasize the problems identified by this research.
5. Publication of this study's results in FAA Aviation News and the development of "popularized" versions of these findings in articles for instructors in magazines such as *Flight Training, Aviation's Proficiency & Careers Magazine* (Publisher: Melissa Murphy, Editor: Scott Spangler).

For the initial certification of instructors, findings from this research could be incorporated in materials that the instructor is required to master, including:

1. Curricular materials used at schools that train instructors.
2. Questions on written tests for CFIs.
3. Discussion during CFI flight tests by FAA flight examiners.

Recommendations specific to touch-and-go's

The FAA should amend the Flight Instructor Practical Test Standards to include instructions for teaching touch-and-go landings and criteria for determining when students are ready to practice touch-and-go's during solo flight.

When AC 60-14 is revised, consideration should be given to deleting the suggestion that the second supervised solo include touch-and-go's. Guidance should be provided to instructors as to how to teach touch-and-go landings and evaluate student readiness for solo touch-and-go's.

D. INFORMATION FROM ASRS REPORTS

Information on instructional flights was obtained from the Aviation Safety Reporting System (ASRS). ASRS is a confidential, voluntary reporting system for safety-related incidents involving aircraft or associated facilities. The ASRS system contains over 176,000 reports. These reports are submitted by pilots, air traffic controllers, and others concerned about aviation safety.

For this study, a request was made for a sample of 200 reports involving general aviation instructional flights occurring in 1992 and 1993. These reports were selected from the ASRS database, using key word searches on the report narrative, since flight instruction is not one of the formatted fields in the database. The reports used for this analysis were limited to general aviation airplane instructional flights. Helicopter and air taxi instructional flights were excluded. One hundred sixty-four of the 200 reports were determined to be valid flight instruction reports.

Each report was reviewed and coded by an experienced aviation safety analyst. Descriptive information was collected including the month and year of the incident, weather conditions, state of occurrence, aircraft type, and reporter function (student, instructor, etc.). Information was also coded on phase of flight when incident occurred, the type of instruction being performed, type of event (NMAC, etc.), pilot

factors associated with the event, flight instructor factors associated with the event, specific characteristics of the event and a short narrative synopsis.

Tables describing these ASRS reports are followed by summaries of the near-midair collisions.

On average, there were 1.9 anomalies mentioned in each ASRS report. Reflecting the kinds of events that are most likely to be self-reported by pilots, the most common anomalies were such conflicts as near-midair collisions, mechanical problems, and violations of the Federal Air Regulations (FARs) (Table 23).

The most common phases of flight when the problem occurred were landing and final approach (Table 24).

As in the case of the crashes of instructional flights, the most common flight instructor performance factors were inadequate supervision and delayed remedial action (Table 25).

Table 23. Anomalies in 164 ASRS Reports

ANOMALY	#
Conflict	
Conflict/NMAC	25
Conflict/airborne less severe	9
Conflict/ground less severe	14
Conflict/ground critical	0
Less than legal separation	2
Weather	
VFR in IMC	4
In-flight encounter/weather	12
In-flight encounter/other	1
Mechanical	
Aircraft equipment problem/critical	45
Aircraft equipment problem/less severe	4
Deviations	
Altitude-heading rule deviation	0
Speed deviation	1
Unctrl airport traffic pattern deviation	7
Erroneous penetration or exit of airspace	9
Track or heading deviation	9
Control	
Loss of control	23
Controlled flight toward terrain	12
Transgressions	
Runway or taxiway excursion	13
Runway transgress/unauthorized landing	7
Runway transgression/other	10
Altitude Deviations	
Alt dev/overshoot on climb or descent	5
Alt dev/excursion from assigned	9
FAR Violations	
Non adherence legal requirement/clearance	30
Non adherence legal requirement/pub procedure	21
Non adherence legal requirement/FAR	35
Non adherence legal requirement/other	3
TOTAL	310

Table 24. Phase of Flight in 164 ASRS Reports

PHASE	#
Takeoff	10
Climbout	11
Cruise	25
Descent	4
Crosswind leg	0
Downwind leg	8
Base leg	2
Final approach	21
Landing (touchdown)	33
Go around	5
Taxi	5
Not in motion	2
Touch-and-go	4
Instrument enroute (includes climb and descent	3
Instrument approach	14
Flight maneuvers	12
Other	5
TOTAL	164

Table 25. Flight Instructor Factors in 164 ASRS Reports

FACTOR	#
Inadequate supervision	52
Delayed remedial action/takeover	43
Poor preflight planning	16
Mishandled simulated emergency	10
Inadequate training in ATC communication	8
Inadequate training in ATC navigation	6
Inadequate training in ATC outside scan	18
Poor judgement	29
Other	23
TOTAL	205

Table 28. Pilot Performance Factors in 164 ASRS Reports

FACTOR	#
Preflight	
Poor preflight planning	19
Improper preflight	7
Misjudged fuel required or available	10
Fuel system misunderstanding	1
Misjudged weather	7
Density altitude error	0
Forecast or known icing	1
Other preflight factors	2
Altimeter set incorrectly	0
Other preflight	0
Aircraft Control	
Misjudged taxi	4
Used gear control instead of flap control	0
Used flap control instead of gear control	0
Did not feather prop	0
Mishandled flaps	1
Misused mixture	1
Fuel selector set wrong	1
Instrument misread or interpreted	1
Wrong engine feathered or shut down	0
Landing gear not extended	7
Lost control	11
Other aircraft control	8
Landed hard	10
Physiological/Emotional/Human Factors	
Student froze on controls	4
Illness	2
Poor communication (instructor/student)	16
Stress	26
Distraction	27
Other human factor, etc.	9
Air Traffic Control/Navigation	
Misunderstood air traffic control	13
Improper ATC procedures	10
Violated TCA	1
Violated airport traffic area	2
Violated other airspace	2
See and avoid failure	12
Improper IFR procedures	8
Radios set incorrectly	7
Got lost	4
Other traffic	8
Other ATC/Navigation	7
TOTAL	249

The pilot performance factors presented in Table 26 provide insight into some of the actions that led to the problems. The most commonly cited were distraction, stress, poor preflight planning, and poor communication between instructor and student.

Additional details on the 34 near-midair collisions, and other conflicts, are presented in summary form at the end of this section. It is interesting that, as in the case of the 30 midair collisions described in Part I of the study results, 3 of the student pilots were under a hood at the time of the conflict. Also, as in the midair collisions, 2 conflicts involved helicopters. One flight instructor reported a near-midair collision with a noncommunicating helicopter, at an airport where helicopter traffic and aircraft from a large training facility nearby offer substantial potential for midairs.

Another near-midair collision in the ASRS data base for 1992, although not included in the sampled cases, provides insight into the problem of conflicts with acrobatic planes. In addition to the possible restriction to vision because of its bi-wing configuration, the case involved an acrobatic plane (with no radio) flying a shorter pattern than aircraft from a nearby flight school, which commonly flew a longer, wider pattern.

In conclusion, the events described in the ASRS reports, although they rarely involve crashes, provide insight into the circumstances surrounding "near-misses" and, therefore, may be valuable in the prevention of actual crashes.

Conflicts and Near-Midair Collisions Reported to ASRS Instructional Flights During 1992-1993

ANOMALIES LIMITED TO *CONFLICT/NMAC*

ID:	237955
ASRSSYNO:	INSTRUCTOR WITH STDNT HAD NMAC WITH SMA.
COMMENT1:	STUDENT UNDER HOOD, 500 FT CLIMB, MISSED OPPOSITE SMA TRAFFIC.
COMMENT2:	NO EVASIVE ACTION TAKEN.
ID:	238636
ASRSSYNO:	NMAC WHEN TWR ISSUED RIGHT TURN OUT OF PATTERN INSTRUCTION TO AC
COMMENT1:	THE FLIGHT WAS IN THE PATTERN, CONFLICT OCCURRED, ATC ISSUED RIGHT
COMMENT2:	TURN OUT INSTRUCTION, NMAC ALMOST OCCURRED.
ID:	204024
ASRSSYNO:	NMAC
COMMENT1:	CFII WITH STDNT UNDER HOOD ON APPRCH, HAD NMAC, NEVER SAW OTHER AC,
COMMENT2:	WAS INFORMED BY PLT OF OTHER AC
ID:	206189
ASRSSYNO:	MULTIPLE RWY OP, INTRSCTNG RWYS, NMAC, SYS ERROR (CONTROLLER)
COMMENT1:	CFI ALMOST HITS SMALL TRANSPORT LANDING ON XING RWY. CONTROLLER ERROR.
ID:	206577
ASRSSYNO:	NMAC
COMMENT1:	CFI ON DOWNWIND NOTICE HELI ENTERING DW IN ERRATIC MANNER. HELI TURN
COMMENT2:	TOWARD CFI WHO TOOK EVASIVE ACTION. SOLO STUDENT IN HELI.

ID: 206773
ASRSSYNO: PLT EXECUTES 180 ON FINAL AND ENCOUNTERS ANOTHER AC ON APPROACH, NMAC
COMMENT1: NEW PILOT (2 DAYS) ON 1.5 MILE FINAL. THOUGHT HE WAS APPROACHING
COMMENT2: WRONG AIRPORT. DID 180 TO GO TO OTHER APT, ALMOST HIT FOLLOWING TRAFFIC

ID: 207176
ASRSSYNO: NMAC WITH SMT DEPARTING FROM SAME AIRPORT
COMMENT1: CFI AND STDNT ALMOST COLLIDE WITH SMT DEPARTING SAME AIRPORT
COMMENT2: DURING CLIMBOUT.

ID: 208170
ASRSSYNO: NEW CFI GIVING BFR TO OTHER CFI HAD NMAC IN APT TFC AREA. BOTH AC EVAS
COMMENT1: PATTERN WORK ON 25L. ASKED FOR FULL STOP ON 25R. ATC CLRED AC FULL
COMMENT2: STOP ON 25L. PLT FLYING SET UP FOR 25R, CROSS IN FRONT OF AC FINAL ON 25

ID: 208377
ASRSSYNO: NMAC AFTER ATC CALLED MULTIPLE TARGETS, AC UNDER RADAR ADVISORIES
COMMENT1: TFC CALLED BY APPRCH, STDNT RESPONDED WITH TRAFFIC IN SIGHT, WRONG TRFF
COMMENT2: CFI HAD TO TAKE CONTROL TO AVOID AIR CARRIER.

ID: 209199
ASRSSYNO: IN PATTERN, CFI HAD NMAC. ATC WAS NO HELP, DID NOT CALL TRAFFIC
COMMENT1: CFI SAW OTHER AC ABOUT 100 FEET AWAY MANEUVERING TO LAND FOR OTHER RWY
COMMENT2: CFI TOOK EVASIVE ACTION. ATC DID NOT CALL OUT OTHER TRAFFIC.

ID: 209491
ASRSSYNO: NMAC AVOIDED AS CFI HAS TFC SIGHTED AND DIVES AS AC JET CLIMBS
COMMENT1: CFI HEARS HIS AC CALLED AS TRAFFIC TO AC JET. STARTS LOOKING AND SEES
COMMENT2: DIVES TO AVOID NMAC, SEE AND AVOID WORKED BUT ATC SHOULD DO BETTER JOB

ID: 210731
ASRSSYNO: 2 VFR AC HAD NMAC WHILE GIVING INSTRUCTION IN EXCELLENT VISIBILITY
COMMENT1: ON APPRCH TO NDB, SMA ALMOST HITS ANOTHER SMA ON APPRCH TO SAME NDB,
COMMENT2: LEFT AREA AND RETURNED AND ALMOST HIT SAME AC AGAIN.

ID: 212233
ASRSSYNO: CFI EXPECTED OPTION ON APPRCH, CLEARED TO LAND, ALMOST HIT AC ON CLIMB
COMMENT1: CFI WAS GOING TO DO BALKED LANDING WITH STDNT, TWR CLEARED HIM TO LAND,
COMMENT2: EXPECTED OPTION, CONDUCTED OPTION, ALMOST HIT MIL FIGHTERS ON CLIMB.

ID: 214578
ASRSSYNO: NMAC WITH ANOTHER AC WHILE PRACTICING SLOW FLIGHT WITH PRIMARY STDNT.
COMMENT1: NMAC WITH ANOTHER AC WHILE CONDUCTING SLOW FLITE WITH STDNT. TRIED
COMMENT2: TO GET OTHER FLT SCHOOLS TO PARTICIPATE IN REDUCING RISK. NO GO.

ID: 215216
ASRSSYNO: CFI AHS NMAC WITH HELI IN TFC PATTERN AT UNCONTROLLED AIRPORT.
COMMENT1: VERY BUSY UNCONTROLLED AIRPORT WITH MUCH FLIGHT TRAINING. CFI COMPLAIN
COMMENT2: THAT HELI TFC OFTEN CUT THROUGH PATTERN ETC, CRASH WAITING TO HAPPEN,

ID: 218498
ASRSSYNO: CFI AND STDNT HAVE NMAC ON FINAL AT UNCONTROLLED AIRPORT.
COMMENT1: CFI KNOWS OF OTHER TRAFFIC IN PATTERN. IT CUTS INSIDE THEM ON BASE,
COMMENT2: DOES NOT SEE IT UNTIL ON SHORT FINAL. HAD TO GO AROUND.

ID: 218912
ASRSSYNO: 2 SMAS HAD NMAC IN LAX SPECIAL FLT RULES AREA.
COMMENT1: CFI AND STDNT HAVE NMAC WITH OTHER SMA AT SAME ALTITUDE IN LAX
COMMENT2: SPECIAL FLIGHT RULES AREA.

ID: 219303
ASRSSYNO: LOST RADIO IN PATTERN DOING T + G. HAD NMAC WITH LTT.
COMMENT1: LOST RADIO IN PATTERN WHILE DOING T+G. CONTINUED TO FLY PATTERN
COMMENT2: ON FINAL, DID GO AROUND WHEN OTHER TFC WAS SEEN.

ID: 220704
ASRSSYNO: CFI IN MULTI HAS NMAC IN PATTERN WITH SMT.
COMMENT1: CFI AND STUDENTS IN MULTI, NMAC WITH SMT IN PATTERN UNDER ATC CONTROL
COMMENT2: OTHER PLT SPOKE VERY POOR ENGLISH.

ID: 222164
ASRSSYNO: 3 AC IN A NIGHT TOUCH AND GO PATTERN. 2 HAD NMAC.
COMMENT1: STDNT DID NOT SPACE WELL IN PATTERN, OVERTOOK AC IN FRONT. CFI
COMMENT2: HAD TO TAKE CONTROL.

ID: 222463
ASRSSYNO: 2 AC HAD NMAC IN MARGINAL CONDITIONS DOING IFR TRAINING.
COMMENT1: TWO TRAINING AC ALMOST COLLIDE IN MARGINAL VFR CONDITIONS CONDUCTING
COMMENT2: IFR TRAIN BEFORE OBTAINING ATC CONTROL.

ID: 223611
ASRSSYNO: ON FINAL APPROACH TAKES EVASIVE ACTION TO AVOID SECOND AC ON FINAL.
COMMENT1: TWIN ALMOST RUNS SINGLE OVER ON TURN TO FINAL AT CONTROLLED AP.
COMMENT2:

ID: 224045
ASRSSYNO: 2 SMAS HAD NMAC IN PATTERN
COMMENT1: NMAC DUE TO CFI LETTING STDNT HANDLE AIRCRAFT TOO LONG. NEVER ANY
COMMENT2: RISK OF COLLISION.

ID: 224747
ASRSSYNO: CFI WITH STUDENT HAS NMAC WITH TWIN WHICH THEN MAKES A SECOND PASS.
COMMENT1: AGGRESSIVE TWIN PLT GETS MAD AFTER NMAC AND MAKES SECOND PASS AFTER
COMMENT2: SLOW ACROBATIC HIGH WING.

ID: 225674
ASRSSYNO: INSTRMT FLIGHT HAD NMAC WITH ANOTHER AC TKOFF IN OPPOSITE DIRECTION.
COMMENT1: ON PRACTICE INSTRUMENT APPROACH TO LAND, AC HAD NMAC WITH ANOTHER AC
COMMENT2: CLEARED BY ATC TO TAKEOFF OPPOSITE DIRECTION.

ANOMALIES LIMITED TO *CONFLICTLESS SEVERE*

ID: 204124
ASRSSYNO: INSTMT TRAINING FLT TAKES EVASIVE ACTION TO AVOID CONFLICT ON APPROACH
COMMENT1: ON CIRCLE TO LAND WITH SHORT FINAL, AC ALMOST HIT ANOTHER AIR-CRAFT ON
COMMENT2: APPROACH. STDNT UNDER HOOD UNTIL SHORT FINAL, CFI SCAN NOT GOOD.

ID: 209433
ASRSSYNO: SMA HAS ENCOUNTER WITH AIR CAR WAKE TURBULENCE DURING INITIAL CLIMB
COMMENT1: CFI AND STDNT SHOOTING T+G. COMMUTER DOING PRACTICE NDB AP-PROACHES TO OTHER
COMMENT2: RUNWAY. ON TKOFF, THE SMA ENCOUNTERED THE WAKE TURB, 45 DEG ROLL + PITCH UP

ID: 209522
ASRSSYNO: HDG TRACK DEV ON IAP ILS APPROACH
COMMENT1: ON LONG FINAL ON ILS (10 MILES) CFI TURNED OFF LOCALIZER DUE TO FAST
COMMENT2: TFC BEHIND. CFI TURNED BACK ONTO COURSE WHEN HE HEARD CLRN FOR OTHER AC

ID: 216413
ASRSSYNO: ALTDEV BY MULTI-ENGINE TRAINEE
COMMENT1: STDNT WAS CLIMBING TO 6500 FT, TOLD TO LEVEL FOR TFC AT 3500.
COMMENT2: MISUNDERSTOOD AND CONTINUED TO CLIMB INTO OPPOSITE TFC PATH.

ID: 217116
ASRSSYNO: LOSS OF RADIO RESULTS IN POSS NMAC, SEVERAL UNAUTH LANDINGS.
COMMENT1: RADIO VOLUME TURNED DOWN WHILE IN PATTERN AT BUSY TWR APT. CFI AND
COMMENT2: STDNT DID NOT NOTICE UNTIL LATER.

ID: 218246
ASRSSYNO: CFI INITIATES SIM ENG FAILURE IN ON BASE LEG AT NONTWR APT.
COMMENT1: CFI INITIATES SIM ENG FAIL IN PATTERN TURNING LEFT BASE WHILE OTHER
COMMENT2: TFC FLYING RIGHT BASE. CUT OTHERS OFF IN PATTERN (AND AWARE OF IT).

ID: 222373
ASRSSYNO: CFI AND STDNT IN TFC PAT ACCUSED OF CLOSE PROX BY FAA OFFCL IN TWIN
COMMENT1: CFI HASSELED BY FAA EXAMINER WHO CLAIMED CFI AND STUDENT GOT TOO
COMMENT2: CLOSE IN PATTERN. CFI'S FBI AND FAA HAD BAD BLOOD OVER PAST EVENT.

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