

UC Berkeley

Research Reports

Title

The Development Of An Accident Database To Structure Land Use Regulations In Airport Runway Approach Zones Part II

Permalink

<https://escholarship.org/uc/item/4tn1g1m5>

Authors

Cooper, Douglas L.
Chira-chavala, T.

Publication Date

1998

AIR TRANSPORTATION RESEARCH CENTER

Institute of Transportation Studies
University of California at Berkeley

**THE DEVELOPMENT OF AN ACCIDENT DATABASE TO STRUCTURE
LAND USE REGULATIONS IN AIRPORT RUNWAY APPROACH ZONES
PHASE II**

**Douglas L. Cooper
T. Chira-Chavala**

RESEARCH REPORT
UCB-ITS-RR-98-1

January 1998

Prepared For
California Department Of Transportation
Aeronautics Program

Table of Contents

1.0 Introduction	3
2.0 Final Search Procedure	4
3.0 Characteristics of Aircraft Accidents	5
4.0 Accident Plots.....	11
Appendix	16

This document was prepared by the Institute of Transportation Studies at U.C. Berkeley under contract to the California Department of Transportation, Aeronautics Program. The content of this report reflect the views of the Institute of Transportation Studies, who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policy of the Aeronautics Program.

1.0 Introduction

Land use around airports has been, and will continue to be, a source of conflict between airport operators and developers (both public and private). To better understand safety issues regarding land use, the Institute of Transportation Studies (ITS) undertook research in 1993 to determine the availability of information on general aviation accidents that occur near airports and, if possible, to create a database of precise accident locations. The result of the study was a database of 396 points representing accidents that occurred within five miles of the relevant origination or destination airport. These points were divided into several subsets (e.g., arrivals, departures, accidents involving inflight collisions, and accidents in which the pilot had no control) and plotted on a standard runway to get a picture of the dispersion of accidents around an airport. The resulting plots as well as an accident summary were included in the revised Airport Land Use Planning Handbook. A more detailed report was published as ITS Research Report 93-13, titled "The Development of an Accident Database to Structure Land Use Regulations in Airport Runway Approach Zones."

The proposal for the 1993 study called for looking at only those accidents that occurred in California, Texas, Florida, and Arizona, which would include roughly 29% of all accidents. The structure of the NTSB computer database is such that only those accidents that occurred later than 1982 are searchable via computer. In addition, as it often takes several years to complete an accident investigation and assemble the various documents into the final accident report, most of the files on accidents that had occurred after 1989 were incomplete. It soon became apparent that there were not enough accidents from the four states during the years 1983-1989 to meet our criteria for the minimum number of datapoints and the search was expanded, first to eleven states (covering approximately 44% of all accidents), and finally to all fifty. Due to time constraints, however, only the first eleven states were searched for years 1983-1989. The remaining 39 states were searched only from 1983 to 1985 which left 5,474 accidents unreviewed. By the time of this second study, the investigations of accidents that occurred during 1990, 1991, and 1992 were completed, giving approximately 6,500 additional files to be searched.

This report presents and describes the expanded database containing 873 aviation accidents which occurred within five miles of an airport. Section 2 contains a description of the development of the database and a discussion of the criteria used in selecting accidents for the database. Section 3 provides a description of the database itself as well as a set of statistics that provide a comprehensive overview of the accidents. A set of aircraft accident scatter plots developed from the accident data points is presented in section 4. The purpose of these plots is to provide a picture of the distribution of accidents over space.

2.0 Final Search Procedure

The final search procedure and database structure evolved over the course of a review of the NTSB computerized database (which consists of short accident summaries called 'minibriefs') and a week spent in Washington, D.C. looking through complete NTSB accident files where, it was hoped, the required location information could be found buried in parts of the factual report that do not make it to the computer database.

The conclusion drawn from the review was that, while the required information can be found, it is a very labor intensive task to produce it. This is because approximately five 'minibriefs' must be read for every one that meets our location criteria (not on the runway and no more than five miles from either the landing or departure threshold, as appropriate) and out of those that are acceptable only one out of six has sufficient information in the full report (including investigator, pilot, police, and witness statements) to allow us to establish precise location. None of this can be done through a computer search. This low yield (one out of thirty) forced us to go outside our initial four state search area (California, Texas, Florida, and Arizona) in order to get the desired number of datapoints. The final search included all 50 states.

Numerous decisions also had to be made regarding definitions and standardization of data. These decisions included:

- Only accident records will be searched due to lack of information on incidents
- Accidents will be plotted as an X-Y scatterplot with the runway approach threshold as the 0-0 point of the X-Y axes
- Where no other information is available, T/O roll will be assumed to have begun at the beginning of the runway pavement
- Y distances for departures will be computed using distance from T/O roll beginning point to departure end of runway as runway length
- In the case of touch-and-goes and emergency returns to airfield after takeoff, a departure becomes an approach only after the aircraft is established downwind or, in the case of a straight in approach, is established on final
- A missed approach becomes a departure once a controlled climb is established.
- Accident location will be the point of initial impact or touchdown
- Accidents involving inflight collision with an obstruction will be included but will be noted as such
- Pilot control will be recorded so that separate plots can be made, if desired, of those that had no control and those that were able to choose a landing spot
- Helicopter accidents will not be included due to our inability to link them to a specific runway, airport, or even an improved landing site.

The following, then, is the process to determine one datapoint:

- Read NTSB computer records ('minibriefs') to obtain list of accidents that fit criteria
- Request full Factual Accident Report (on microfiche) of selected accidents from NTSB
- Search all documents in microfiche record for information on exact accident locations
- Where necessary, use additional resources (e.g., telephone cross-directories, local street maps, USGS Quadrangle maps, etc.) to determine bearing and distance information
- Add record to accident database.

The Appendix contains a list of all variables included in the accident database and the sources of information for each variable.

3.0 Characteristics of Aircraft Accidents

Table 1 provides a list of the of the average values of the variables contained in the 873 accidents that make up the database. These can be distinguished in terms of a number of characteristics including: accidents were almost equally divided between arrivals (50.9%) and departures (49.1%); the majority of approach accidents occurred during visual approaches (77.8%); approximately 69.2% of accidents took place during the day ; and 79% of all flights were conducted under visual flight rules (VFR).

One of the more important accident parameters is whether the accident involved a loss of pilot control or not. The reason is that under controlled conditions a pilot will utilize open space to land the aircraft which would, in principle, reduce the number of injuries and amount of damage. We found that more than half, 76.1%, of the accidents occurred under conditions of the pilot having no control and 18.8% with the pilot having some control. In the remaining 5% of the accidents, degree of control could not be determined.

Inflight collisions occurred in 166 cases or 31.7% of all accidents in the database. In roughly half of these, the collision was a major factor in the accident. Collisions include contact with trees, wires, fences, and buildings but not other aircraft.

In the vast majority of accidents, injuries, fatalities and damage are associated with the aircraft rather than with people and property on the ground. In 65.1% of the accidents the aircraft was destroyed and over half (53%) of the accidents involved onboard fatalities. Ground fatalities or serious injuries occurred in less than one percent of the accidents.

One important parameter, runway length, can be crucial in determining whether an accident occurs and, given its occurrence, whether or not it fits the criteria for the database. A departure accident which occurs on takeoff from a 2,000 foot runway and is located on

or near the extended centerline 3,000 feet from the departure end would quite possibly not even have been an incident had the runway been 6,000 feet in length. The aircraft could have safely put back down on the runway and taxied or been towed back to the ramp.

Table 1
Average Values of Select Variables in Accident Database

Category	Number*	Percentage
Accidents	873	
Arrivals	445	50.9
Visual Approaches	346	77.8
Precision Approaches	70	15.7
Non-Precision Approaches	28	6.3
Departures	428	49.0
Time		
Day	604	69.2
Night	220	25.2
Dusk	37	4.2
Dawn	11	1.3
Flight Rules		
VFR	688	79.0
IFR	182	20.9
Pilot Control		
None	665	76.1
Some	164	18.8
No Information	44	5.0
Inflight Collision Factor?	277	31.7
Yes	130	46.8
No	147	52.9
Number Of Engines		
Single	636	72.8
Twin	235	26.9
Other	2	0.2
Landing Pattern		
Left	687	84.7
Right	123	15.2
Aircraft Damage		
Destroyed	568	65.1
Substantial	304	34.8
Minor	1	0.1
Accidents With Onboard Fatalities	463	53.0
Accidents With Ground Fatalities	6	0.7
Accidents With Onboard Serious Injuries	227	26.0
Accidents With Ground Serious Injuries	6	0.7
Median Runway Length	4600	

*Numbers in each category may not add up to 873 due to missing data in some files

The median runway length at airports where the accidents occurred was 4,600 feet. Figure 1 illustrates the distribution of runway lengths in the sample while Figure 2 shows the cumulative distribution of runway lengths.

Figure 1
Distribution of Runway Lengths in Database

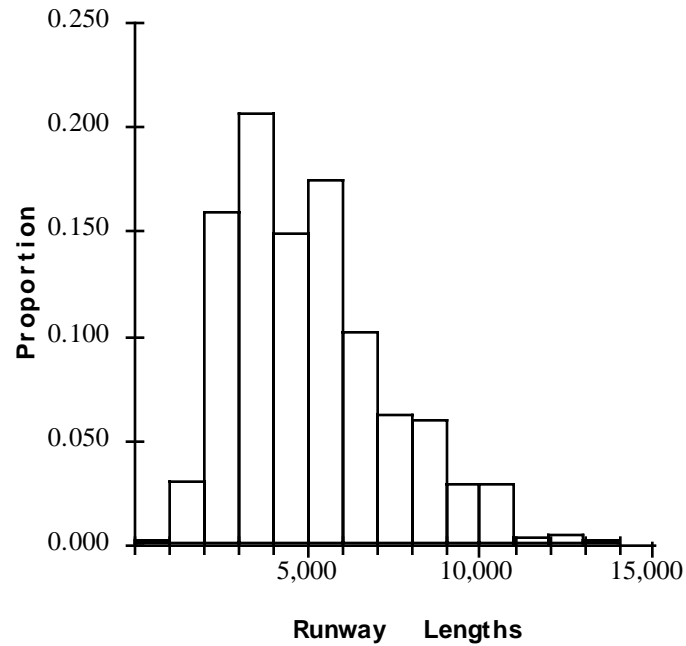
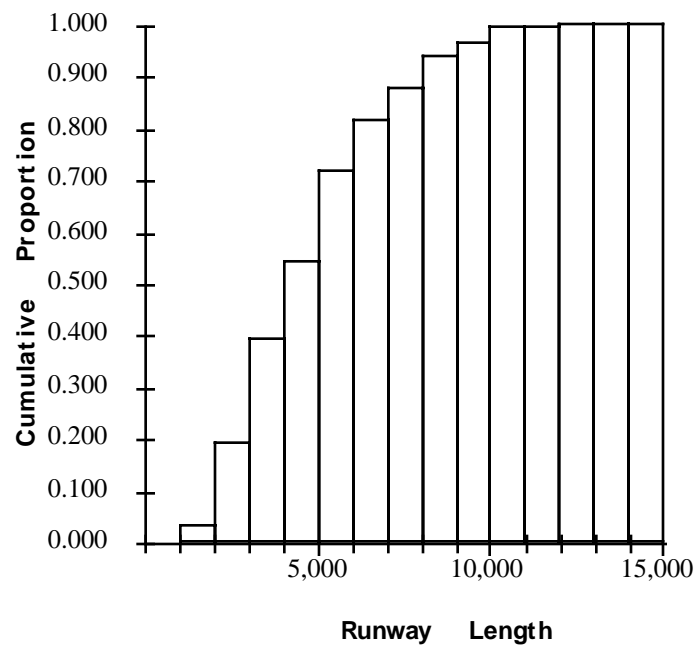


Figure 2
Cumulative Distribution of Runway Lengths in the Database



The spatial distribution of accident locations in relation to both the runway threshold and the runway centerline is important in establishing the spread, or area of greater or less accident occurrence. Figure 3 shows the proportion of arrival accidents occurring from zero to 2500 feet to the left and right (measured along the X axis) of the runway centerline while Figure 4 shows the proportion of arrival accidents from zero to 2500 feet before and after (measured along the Y axis) the runway threshold. The mean accident distance measured along the Y axis from the runway threshold was 3,236 feet with a standard deviation 5,542 feet while the median distance was 1,320 feet. The mean accident distance measured along the X axis from the runway centerline was 941 feet with a standard deviation 2,191 feet and a median distance of 117 feet.

Figure 3

**Distribution of Arrival Accidents Locations
Measured from Runway Centerline**

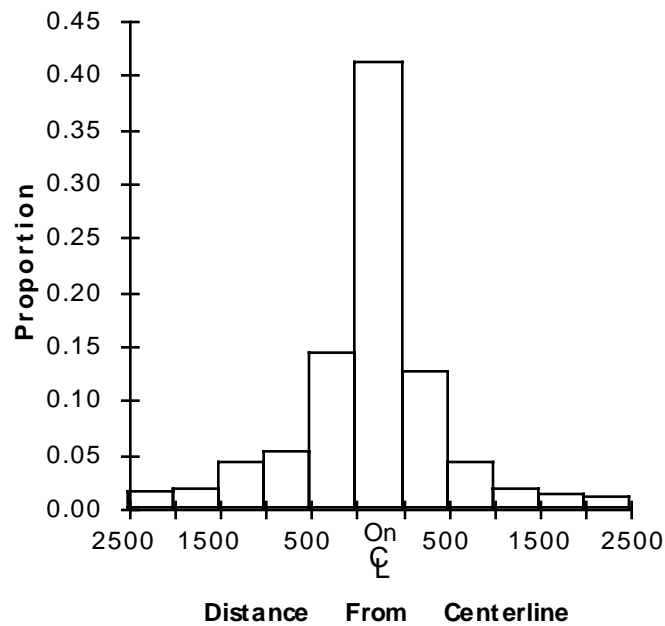
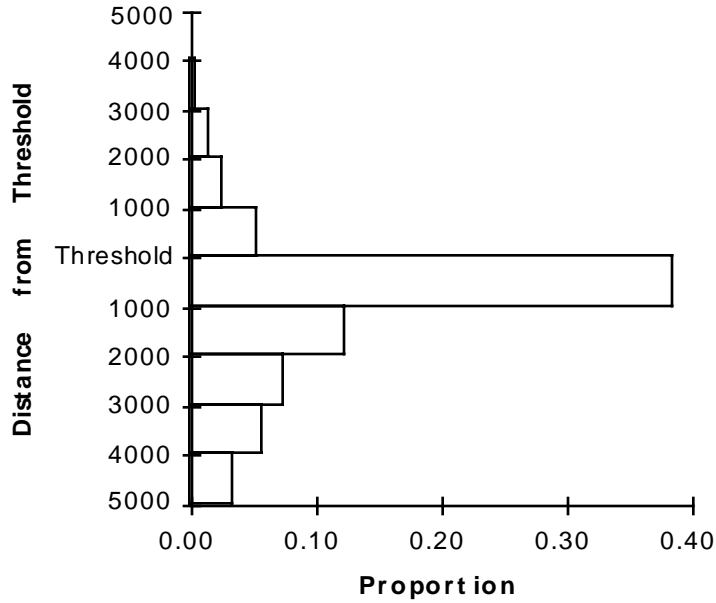


Figure 4

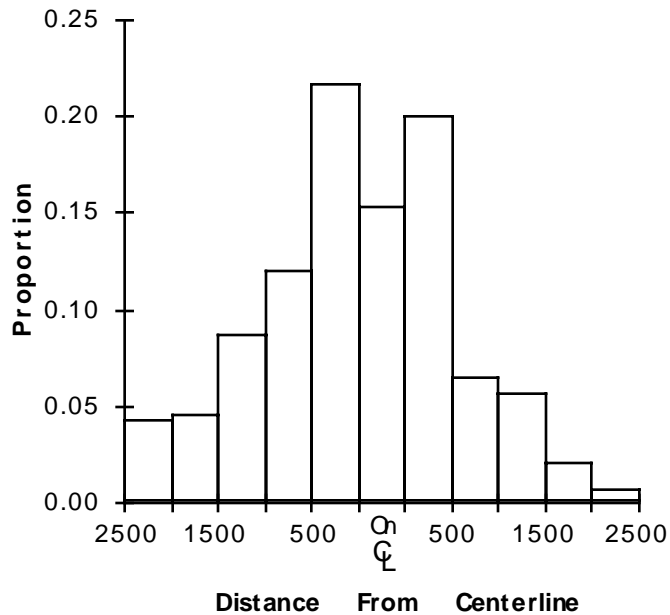
Distribution of Arrival Accidents Locations Measured from Runway Threshold



Departures, as one would expect, have a quite different set of statistics. Measured from the centerline of the accident runway, the average accident distance was 1265 feet with a standard deviation of 2,097 and a median distance of 513 feet.

Figure 5

Distribution of Arrival Accidents Locations Measured from Runway Threshold



In addition to distance, information regarding an accident's relative bearing from the arrival and departure thresholds is useful in understanding accident distribution. This is illustrated for arrival and departure accidents, respectively in Diagrams 6 and 7. For arrival accidents 66% are within an arc 15° on each side of the extended runway centerline. Departure accidents are substantially more dispersed with only 29% of the accidents occurring within a 15° arc on each side of the extended centerline . .

The exhibits illustrate some of the problems of assessing the data in only one dimension. In the following section we develop accident location contours which provide a two dimensional picture of the distribution of accidents over space.

Diagram 6

**Distribution of Arrival Relative Accident Bearings
(Measured from Runway Approach Threshold)**

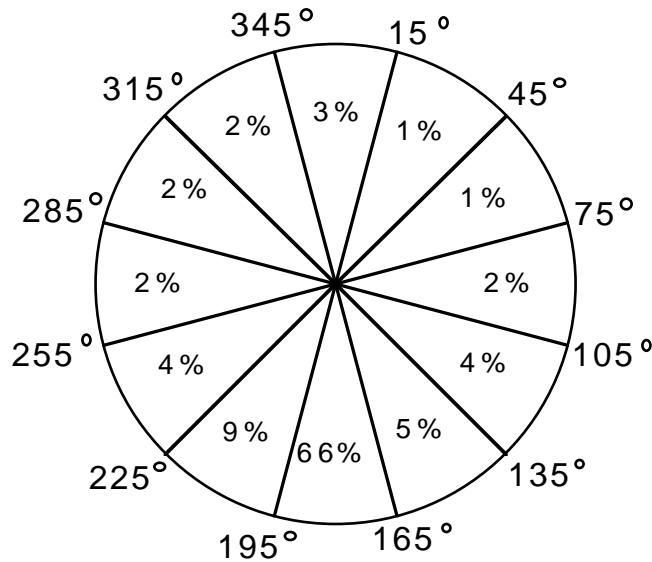
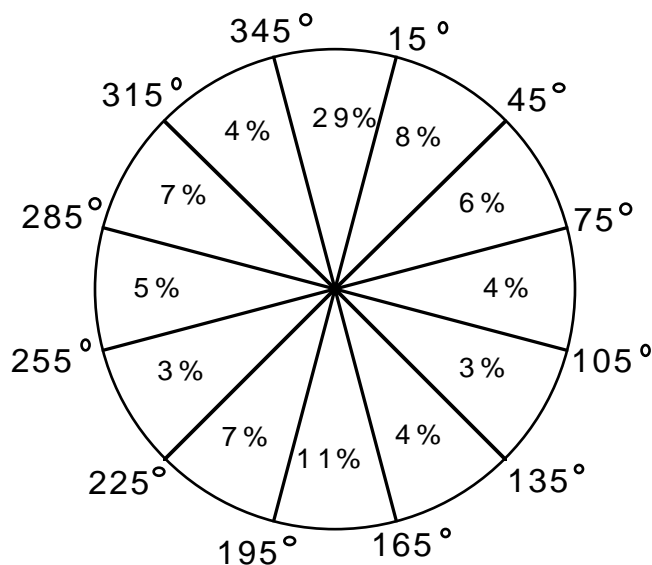


Diagram 7

**Distribution of Departure Accident Relative Bearings
(Measured From Runway Departure End)**



4.0 Accident Plots

Almost all of the accidents in the database lie in an area 40,000 feet long by 20,000 feet wide and most of these points (86%) are within a 20,000 foot by 10,000 foot area. For the sake of clarity and scale, only this smaller area is used for depicting accident scatterplots.

Diagram 8 shows all accident locations regardless of accident type or conditions. Diagrams 9, 10, and 11 provide views of the accident locations by category, covering arrivals, departures, and accidents with no pilot control, respectively.

Diagram 8
Scatter Plot of All Accidents

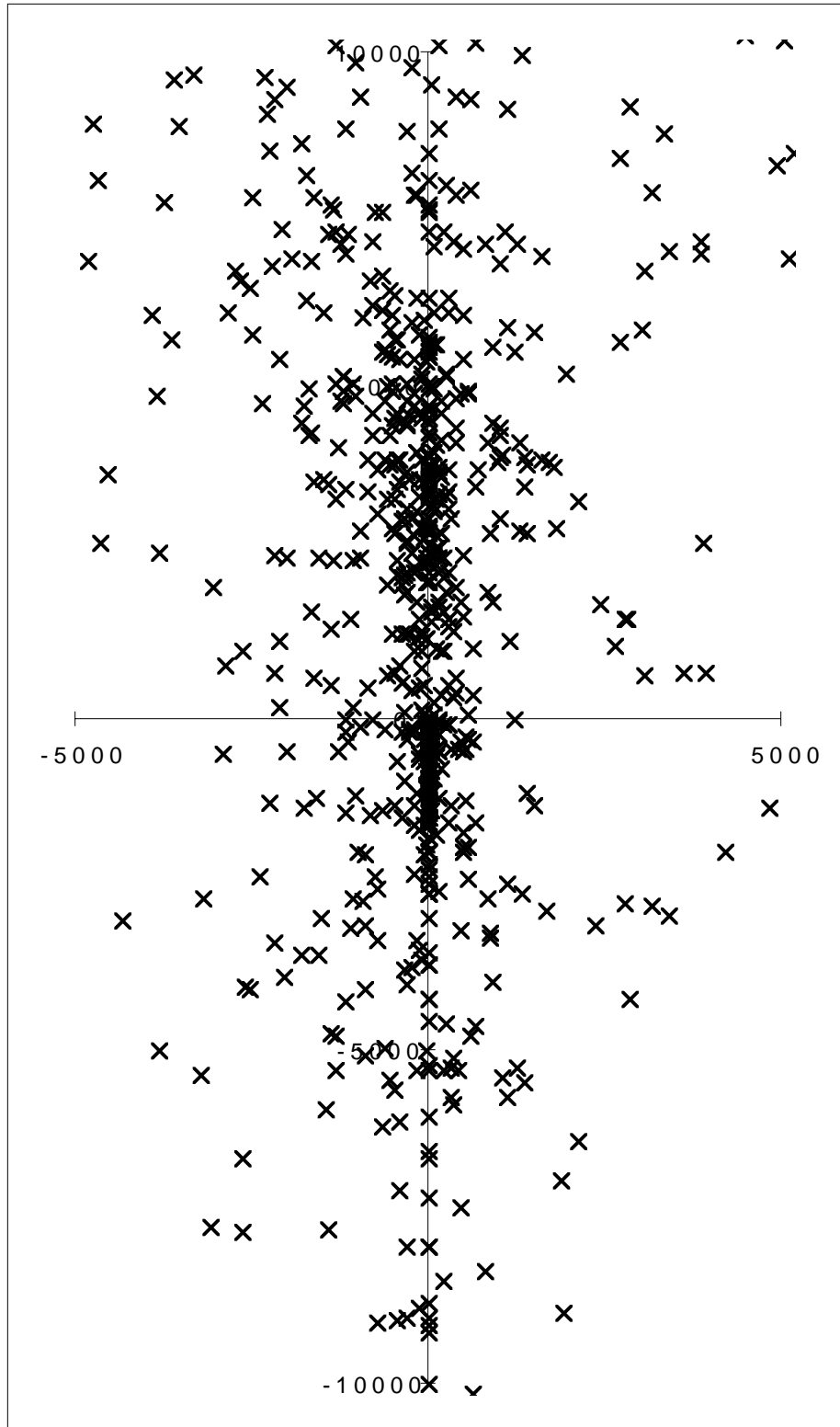


Diagram 9
Scatter Plot of Arrival Accidents

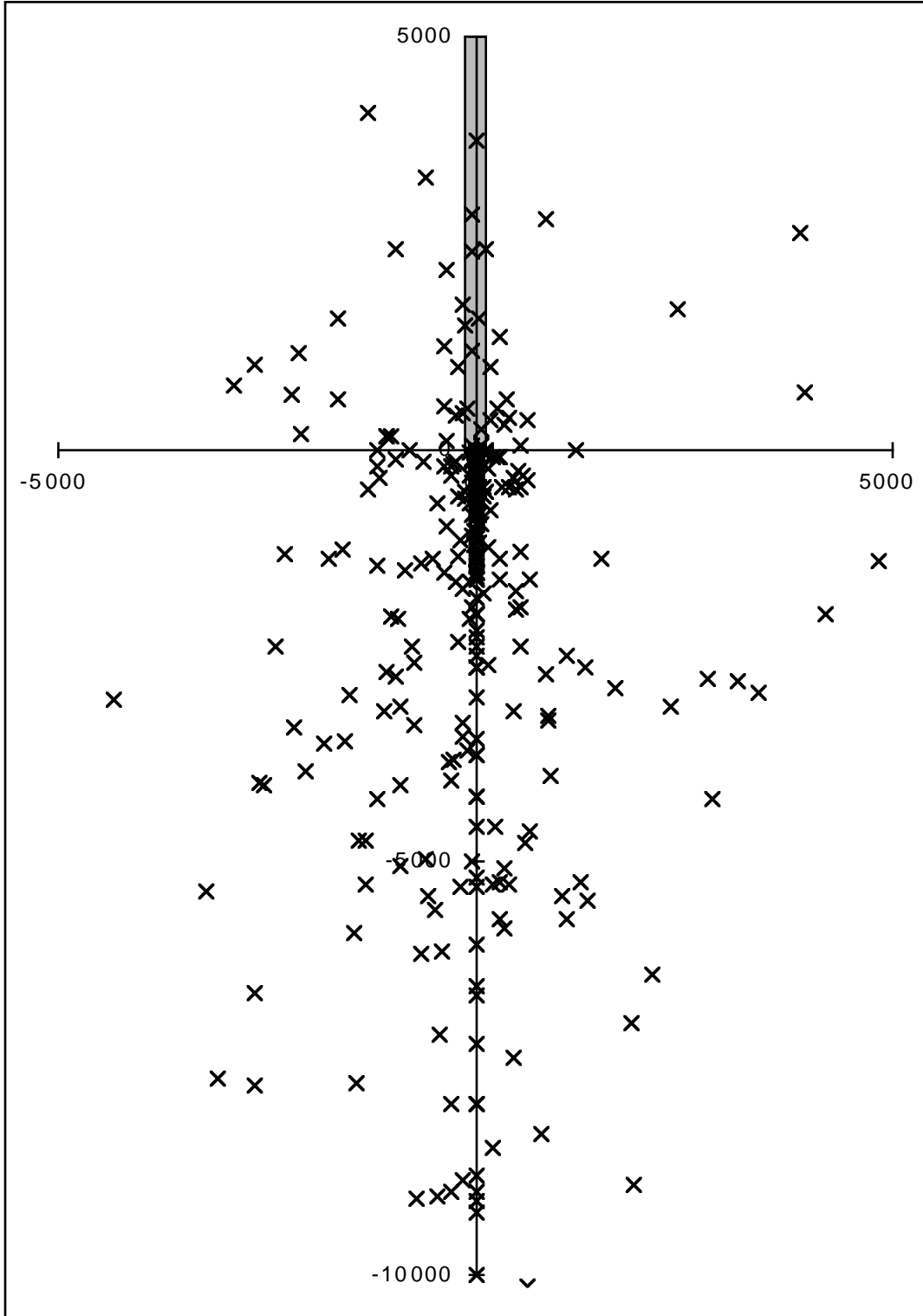


Diagram 10
Scatter Plot of Departure Accidents

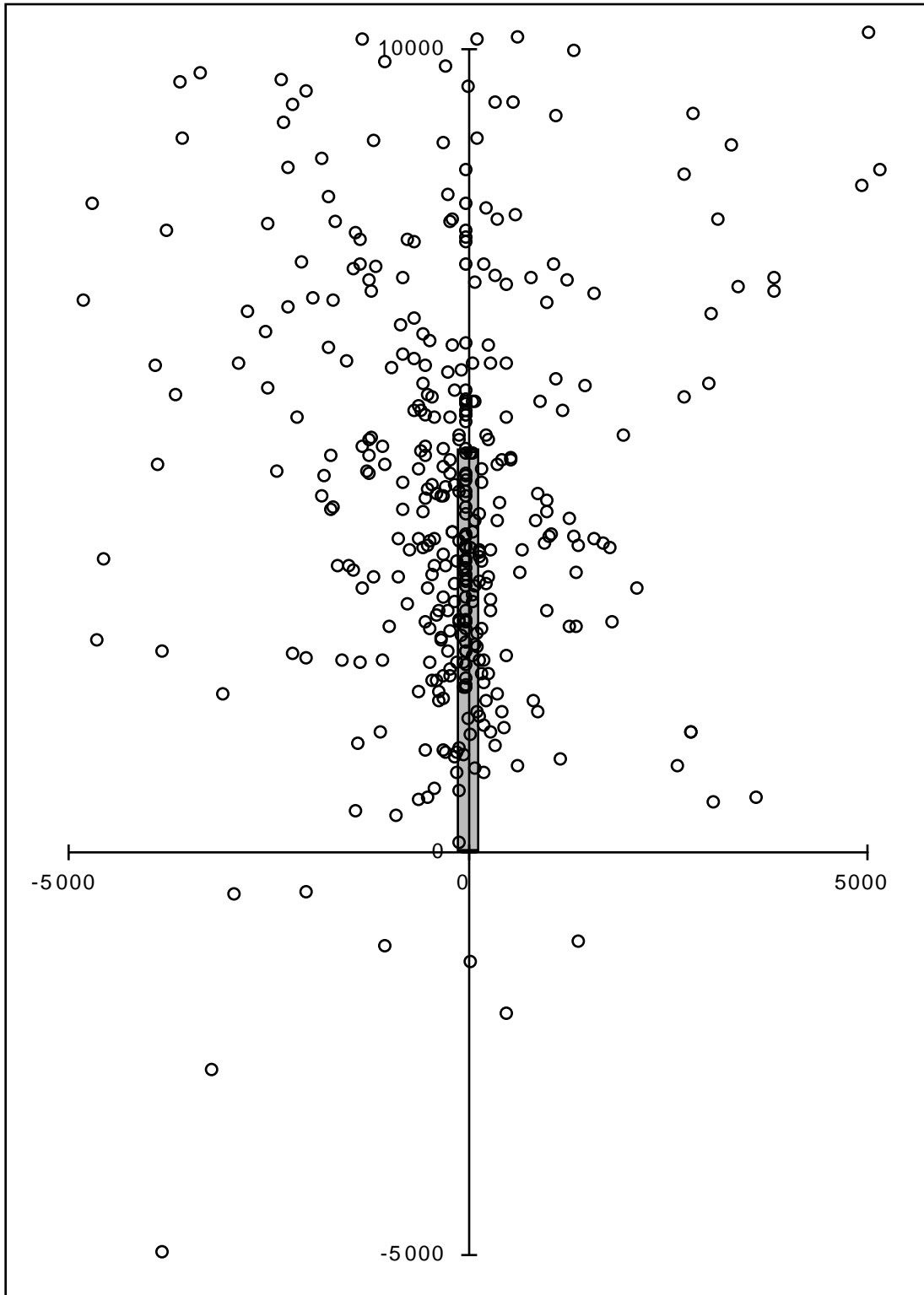
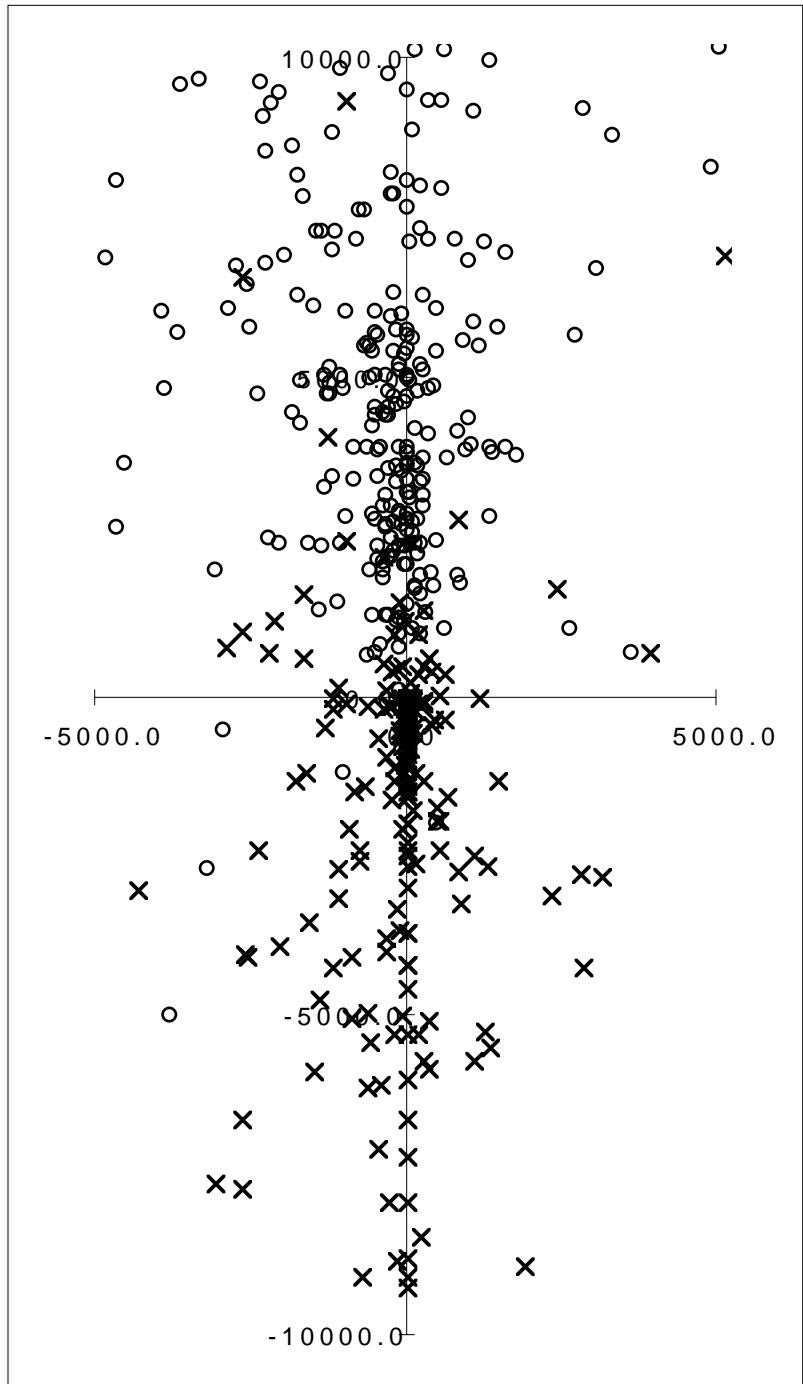


Diagram 11
Scatter Plot of Accidents For Which There Was No Pilot Control
and No Inflight Collision



X - Arrival
O - Departure

Appendix

ACCIDENT DATABASE

The accident database fields, sources and, where necessary, explanations are as follows:

Accident date - NTSB Factual Report
 NTSB file number - NTSB Factual Report
 Airport name - NTSB Factual Report
 Airport location (city and state) - NTSB Factual Report
 Aircraft manufacturer - NTSB Factual Report
 Aircraft model - NTSB Factual Report
 Aircraft weight - NTSB Factual Report
 Number of engines - NTSB Factual Report
 Arrival/departure - NTSB Factual Report
 Takeoff roll beginning point - assumed to be at the runway approach end unless other location given in Factual Report
 Type of approach (visual/precision/non-precision) - NTSB Factual Report
 Time of accident - NTSB Factual Report
 Weather conditions - NTSB Factual Report
 VFR/IFR - NTSB Factual Report
 Weather a factor? -yes if weather listed as a causative factor by NTSB
 Day/night - NTSB Factual Report
 Duty runway - NTSB Factual Report
 Runway type - NTSB Factual Report
 Duty runway magnetic heading - runways are named according to their magnetic heading rounded to the nearest ten degrees. Since most points are plotted on USGS Quadrangle or city maps, bearing and distance are determined relative to the duty runway so exact runway heading is not required and the rounded heading is listed in the database. Where the exact heading is readily available, or if the determination of an accident location requires the extra time necessary to find the exact heading, the field 'Actual?' will so specify.
 Actual? - yes/no
 Duty runway length - NTSB Factual Report
 Duty runway width - NTSB Factual Report
 ILS available - Type of instrument approach available for accident runway. Source of information is Approach Plates

Airport landing pattern (left/right) - Airport Facility Directory. If the accident report shows accident aircraft was flying a pattern different than that which is in the directory, the pattern actually flown will be given.

Accident bearing from arrival/departure threshold - NTSB Factual Report

Accident relative bearing from arrival/departure threshold - calculated using $RB = \text{accident bearing} - \text{runway heading}$.

If $RB < 0$, add 360

Accident distance from arrival/departure threshold - NTSB Factual Report

Distance from centerline (X) - calculated using

$$X = (\text{accident distance}) * (\sin (\text{relative bearing}))$$

Distance from landing threshold (Y) - calculated using

$$Y = (\text{accident distance}) * (\cos (\text{relative bearing}))$$

if accident is departure, add runway length

Pilot control (some/none/unknown) - NTSB Factual Report

Swath length - NTSB Factual Report

Swath direction - NTSB Factual Report

Inflight collision with obstruction - NTSB Factual Report

Factor? - Yes/no. Did the inflight collision cause the accident or did it have a material effect on where the aircraft came down? NTSB Factual Report.

Injuries onboard aircraft - NTSB Factual Report

Injuries on ground - NTSB Factual Report

Damage to aircraft - NTSB Factual Report

Damage on ground - NTSB Factual Report