technical note

Heliport Surface Maneuvering Test Results

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16. Abstract

During late fall 1987 and early spring 1988 flight tests were conducted at the Federal Aviation Administration (FAA) Technical Center's National Concepts Development and Demonstration Heliport. The purpose of these tests was to measure pilot perception of helicopter tip clearances for parking and taxiing maneuvers and to measure pilot performance during these maneuvers.

Over 100 parking and taxiing maneuvers were conducted using a UH-1H helicopter. The parking procedures were conducted under head, tail, and crosswind conditions, both with and without an obstacle in place. The taxiing procedures were carried out with a centerline, with only side markings, and with no ground markings. A ground-based laser tracker system was used to track the taxiing procedures. Pilot subjective data in reference to these maneuvers were collected via a post-flight questionnaire.

Pilot interviews were conducted at heliports across the country. These interviews gathered pilot views concerning rotor tip clearances for parking and hover taxiing maneuvers, ground markings for parking operations, and hover taxiing heights.

This report documents the results of this activity. It describes the data collection and analysis methodology and addresses objective as well as subjective issues. It provides statistical and graphical analysis of pilot performance and perception data and pilot subjective data.

17. Key Words

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Heliport Parking
Heliport Taxiing
Rotor Tip Clearances

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EXECUTIVE SUMMARY

Flight tests, to measure pilot perception and performance during helicopter parking and taxiing maneuvers, were conducted at the Federal Aviation Administration (FAA) Technical Center's National Concepts Development and Demonstration Heliport in late 1987 and early 1988. In addition, pilot interviews were conducted at numerous heliports/airports in New York, New Jersey, Louisiana, and Texas. The purpose of these activities was to obtain pilot input about heliport surface separation criteria in the Heliport Design Advisory Circular (AC 150/5390-2) and to verify these criteria for parking and taxi operations.

Parking and taxiing maneuvers were conducted using a UH-1H helicopter. Over 100 parking and taxiing maneuvers were completed by 13 subject pilots. Parking procedures were conducted both with and without an obstacle in place on the helipad, with head, tail, and crosswind conditions. A ground-based laser tracking system was used to track all taxiing procedures. A post-flight questionnaire was used to gather pilot comments with regards to parking and taxiing maneuvers.

The pilot interviews were conducted at heliports across the country. Pilots were asked their views concerning rotor tip clearances for parking and taxiing maneuvers at heliports. Questions were also asked in reference to ground markings for parking and maneuvering.

This report documents the results of this activity. The parking and taxiing tests are described. The post-flight questionnaire and pilot interview questions are discussed. Histograms and tables were produced for the parking and taxiing data and are included. Histograms and plots describing pilot responses to the interview as well as post-flight questions were also produced.

Wind conditions play a major role in pilot parking and taxiing performance as well as pilot comfort when maneuvering near surface obstacles. Therefore, prevailing winds must be considered in the planning and development of heliports. Pilot performance (as tested with the UH-1H) despite data collection in the presence of high and gusty wind conditions, indicates pilot ability to maintain the 1/3 rotor diameter tip clearance.

It was found that ground marking schemes have an impact on pilot perception and performance. The variability in skid height during taxiing procedures was noticeably larger when no markings were present.

Other concerns raised by the pilots in reference to safe parking and taxiing maneuvers are discussed.

INTRODUCTION

PURPOSE.

The "Heliport Parking, Taxiing, and Landing Area Criteria Test Plan," DOT/FAA/CT-TN87/10, defined issues concerning rotorcraft separation in ground maneuver areas at heliports. These issues involved separation between rotorcraft and objects or other rotorcraft, measurement of rotorwash due to rotorcraft maneuvering in parking and taxiway areas, and pilot performance during ground taxiing and hovering operations.

This report examines the issues of rotor tip clearances from obstacles, (e.g., parked vehicles, structures, etc., but not another helicopter), and pilot performance during taxiing operations. The nature of the procedures used to investigate these issues at the Federal Aviation Administration (FAA) Technical Center's National Concepts Development and Demonstration Heliport and at other operational heliports is discussed.

The following test objectives were addressed:

1. To determine the variations in a helicopter's lateral and vertical position during surface maneuvers under various wind conditions.

2. To measure pilot performance with reference to parking and taxiing maneuvers at a heliport.

3. To verify the current Heliport Design Advisory Circular (AC 150/5390-2) separation criteria for parking areas and taxi operations.

4. To obtain pilot input concerning heliport parking and taxiing separation criteria.

BACKGROUND.

The focus of this test was on the issue of separation criteria on the heliport surface. AC 150/5390-2 states:

In relation to parking: "Parking may be accomplished on a paved or unpaved apron, a helipad, or a helideck. ..... Except for helipads and helidecks located in the Final Approach and Takeoff Area (FATO) or takeoff and landing area, the parking area shall be located such that parked helicopters are clear of the approach and departure surfaces and have at least 1/3 rotor diameter but not less than 10 foot (3 m) clearance from a takeoff and landing area or a fixed or movable object."

In relation to the taxi route, "A cleared right-of-way for taxiing shall be provided between a takeoff and landing area and a parking area.... The taxi route width shall be at least the larger of:

1. twice the rotor diameter of the largest helicopter which is expected to hover taxi, or

2. one and one-half rotor diameters of the largest helicopter which is expected to ground taxi, plus 14 feet (4 m).

The centerline-to-centerline separation distance shall be at least the larger of:

1. one and one-half rotor diameters of the largest helicopter which is expected to hover taxi, or

2. one and one-quarter rotor diameters of the largest helicopter which is expected to ground taxi, plus 7 feet (2 m).

When a hard surface taxiway is provided, it shall be centered within a taxi route and shall be at least twice the width of the undercarriage of the design helicopter."

This criteria is based on operational judgement. There is little actual flight data to validate it. It may or may not reflect the clearances actually needed or desired for surface operations or, in fact, currently in use at heliports.

The data collected during these tests were designed to measure pilot performance during parking and taxiing operations and to obtain pilot perception and preferences with reference to rotor tip clearances and hover heights. The specific issues examined were parking separation, i.e., clearances, ground markings for parking, and lateral and vertical deviations during taxi operations.

The UH-1H helicopter was selected because its size is equivalent to or larger than the vast majority of aircraft using heliports today. It also is a skid gear helicopter. As a result, all maneuvering is done at a hover. Aircraft that have wheel gear need not hover and can ground taxi. This does not require the same skill level as hovering does. Therefore, parking and tip clearance requirements are probably larger for a hovering helicopter than for a ground taxiing helicopter of the same size.

METHODS

DATA COLLECTION.

TEST LOCATIONS. The flight tests were conducted at the FAA Technical Center's National Concepts Development and Demonstration Heliport, Atlantic City International Airport, New Jersey. This facility is located within the coverage of extensive and accurate instrumented flight tracking systems. The pilot interviews were conducted at numerous heliports/airports in the New York City and northern New Jersey areas as well as at heliports in Louisiana and Texas.

PROCEDURES. For the parking tests the pilots were asked to park the helicopter on the heliport both with and without an obstacle in place under varied wind conditions. Prior to positioning the helicopter during the first half of the test, the subject was asked to state the rotor tip clearance with which he would be comfortable for a given wind condition. After making this statement the pilot was then instructed to park parallel to the obstacle or a ground marking with the rotor tip clearance he stated previously. When the helicopter was in place, the pilot was then asked to estimate his actual rotor tip clearance from the obstacle or ground marking. An onboard technician was responsible for placing markers at the edge of the skids. Measurements of the marker locations were taken by ground personnel after the helicopter departed the helipad to prepare for the taxiing maneuvers. During the second part of the parking activity, the pilot was instructed to park the helicopter with a 12-foot tip path clearance. Again, the technician positioned the markers and measurements were taken. These maneuvers were conducted under headwind, crosswind, and tailwind conditions.

Each of the subject pilots completed at least six maneuvers during each part of the parking tests. The only limiting factor was the 30-knot tailwind limit of the aircraft in use. Table 1 presents the actual wind conditions during data collection. Subject pilot experience levels is also reported in this table to show that wind conditions and pilot experience are independent of each other and appear to be of random sampling.

The taxiing tests measured hover taxi performance under various taxi route marking conditions with headwinds, tailwinds, and crosswinds. Three situations were tested: when the taxi route had a centerline; when it had only edge markings; and over a grass area with no markings available. During this test the pilot was instructed to hover a distance of 300 feet longitudinally, reverse course and hover back to the start point. Figure 1 depicts these three taxiing scenarios. One-half of the taxiing tests were performed at a hover height selected by the pilot. For the second half of the taxiing tests, the pilot was directed to maintain a 3-foot skid height during hover. Throughout the hover the pilot was asked to maintain a constant altitude, ground track, and rate of movement.

PARTICIPANTS. A cross section of subject pilots from the private sector, military, and FAA were used during the parking/taxiing tests. The majority of the pilots interviewed during the trips to New York/New Jersey (NY/NJ), Louisiana (LA), and Texas (TX) were from the private sector. Table 2 shows the breakdown by experience of those pilots participating in the parking/taxiing work conducted at the Technical Center. The breakdown of the pilots interviewed in NY/NJ, LA, and TX, by affiliation is shown in table 3.

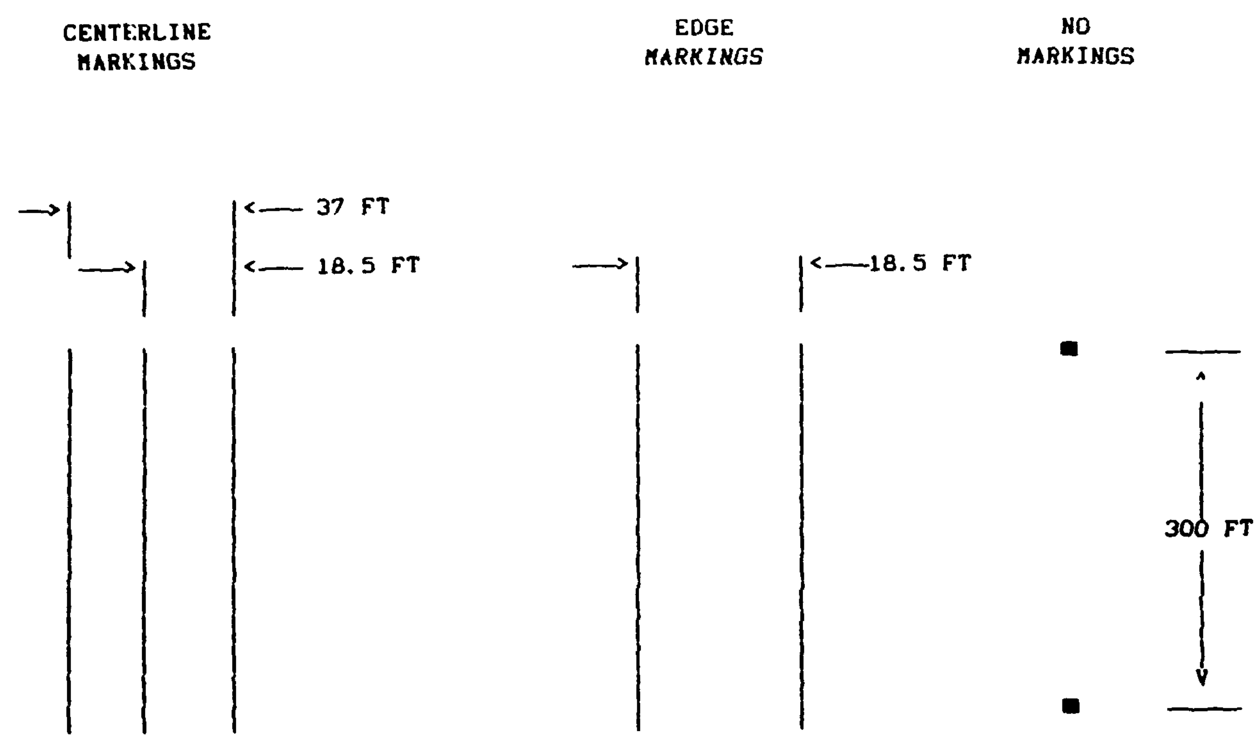
Flight experience for the pilots participating in the parking/taxiing tests is presented in table 4 by total flight hours, total helicopter hours, total time in type, and total helicopter hours over the past 6 months. Nine of the 13 pilots had more than 1500 total flight hours. Only seven, however, had more than 1500 hours in helicopters. Of those seven, six had greater than 1500 hours in type. The median number of helicopter hours for these pilots was 2300 hours.

Of the pilots interviewed in NY/NJ, LA, and TX, 83 percent had greater than 3000 hours of total flight time, with 78 percent having greater than 3000 hours in helicopters. The median number of helicopter hours for this sample was 5500 hours. Table 5 presents the flight experience data for these pilots.

TABLE 1. WIND CONDITIONS AND PILOT EXPERIENCE FOR PARKING/TAXIING TESTS CONDUCTED AT THE TECHNICAL CENTER

Flight Number	Wind Condition Direction (deg)	Wind Condition Speed (kt)	Subject Pilot Rotorcraft Flt Time (hr)
1	230	12	550
2	120	6	550
3	250	12	2300
4	320	25	900
5	250	20	3000
6	280	8	3000
7	060	12	3200
8	040	12	3200
9	310	12	900
10	290	10	900
11	280	20	3000
12	320	14	900
13	310	12	8100
14	300	10	2300
15	280	15	5100
16	290	15	5100
17	260	8	2900
18	350	14	550
19	340	15	550

deg = degrees
kt = knots
hr = hours



Note: The taxiway tests were conducted on taxiway Alpha at Atlantic City International Airport. This taxiway is 37 feet wide with a centerline marking. The scenarios with only side markings were conducted using half of taxiway A, thus giving a width of 18.5 feet. Both the 37.0- and 18.5-foot widths are larger than the taxiway widths required in the Heliport Design Advisory Circular for UH-1H maneuvers.

FIGURE 1. SCENARIOS FOR TAXIWAY TESTS

TABLE 2. NUMBER OF PILOTS BY AFFILIATION AND EXPERIENCE FOR PARKING/TAXIING TESTS CONDUCTED AT THE TECHNICAL CENTER

Affiliation	Experience
FAA	FAA/Industry
FAA	FAA/Military
Military	Military
Industry	Industry/Military
FAA	FAA/Industry
FAA	FAA/Military
Military	Industry/Military
Military	Military
FAA	FAA/Military/Industry
Industry	Industry/Military
Military	Military
Military	Military

TABLE 3. NUMBER OF PILOTS INTERVIEWED IN THE FIELD BY AFFILIATION AND STATE

Affiliation	NY/NJ	LA	TX	Other	Total
Private Industry (other than Oil)	70	0	0	0	70
Oil Corporations	0	93	17	0	110
Medical	0	0	1	0	1
State Government	0	0	20	0	20
Other	0	0	1	1	2
Total					203

TABLE 4. FLIGHT EXPERIENCE FOR PILOTS IN THE PARKING/TAXIING TESTS

Total Flight Hours	Number of Pilots
0-500	1
501-1500	3
1501-3000	1
>3000	8
Total Helicopter Hours	**Number of Pilots**
0-500	1
501-1500	5
1501-3000	4
>3000	3
Total Time in Type	**Number of Pilots**
0-500	3
501-1500	4
1501-3000	4
>3000	2
Total Helicopter Hours Last 6 Months	**Number of Pilots**
<10	0
10-50	8
>50	5

TABLE 5. FLIGHT EXPERIENCE FOR PILOTS INTERVIEWED IN NY/NJ, LA, AND TX

Total Flight Hours	Number of Pilots
0-500	4
501-1500	12
1501-3000	18
>3000	169
Total Helicopter Hours	**Number of Pilots**
0-500	4
501-1500	19
1501-3000	22
>3000	158

FACILITIES AND INSTRUMENTATION.

TEST AIRCRAFT.

Bell UH-1H. The UH-1H used for this project is assigned to, and maintained by the Department of the Army, U.S. Army Communications and Electronics Command (CECOM), Fort Monmouth, NJ. This aircraft was obtained through an Interagency Agreement. It is a single engine helicopter equipped with electromechanical displays representative of civil instrument flight rules (IFR) certified helicopters. The aircraft was designed to carry a pilot, up to 14 passengers, and is capable of speeds up to 120 knots. The rotor diameter is 48 feet.

The parking/taxiing testing with the UH-1H was conducted between October 1987 and January 1988. During these tests the aircraft was flown at gross weights ranging from 8300 to 9100 pounds.

GROUND TRACKING. The taxiing maneuvers were tracked by a GTE Sylvania Laser Precision Automated Tracking System (PATS). The PATS is a mobile tracking and ranging system. It measures azimuth (AZ), elevation (EL), and range automatically by transmitting a laser pulse to a target and measuring the angle of return and the round trip time. These data are recorded on a Digital Equipment Corporation (DEC) PDP 11/34 system. The PATS maximum reliable range is 25 nautical miles (nmi). Its accuracy is 1 foot for target ranges up to 5 nmi, 2 feet for target ranges from 5 to 10 nmi, and 5 feet for target ranges at 25 nmi. Coverage for AZ is 540°, while EL coverage is from -5° to 85° with an accuracy of 20 arc seconds at all ranges for both AZ and EL.

DATA PROCESSING AND ANALYSIS

SOURCE OF DATA.

Data used in this project came from numerous sources: parking/taxiing log with pilot distance/height estimates, pilot comments during parking/taxiing maneuvers, ground measurements taken at the heliport, post-flight pilot questionnaires, laser tracking tapes, and pilot interviews and expert observations from the heliports in NY, NJ, LA, and TX.

PARKING/TAXIING LOG. Prior to each parking maneuver the subject pilots were asked to estimate the rotor tip clearance with which they would feel comfortable. After parking they estimated the actual rotor tip clearance achieved. During the taxiing tests they were asked to state their skid height above ground. These figures were recorded on the log sheet by the flight observer. Appendix A has a sample log sheet.

PILOT COMMENTS. Pilot comments made during the parking and taxiing tests were recorded on the log sheet by the observer.

GROUND MEASUREMENTS. The distances were measured from two corners of the helipad to the midpoint between the two markers positioned by the onboard observer. This midpoint was considered to be the location of the mast of the aircraft. Using simple geometric procedures, the X and Y coordinates of that point were calculated. With these coordinates it was possible to calculate the shortest distance from the mast to either the obstacle or the ground marking. The rotor tip clearance was computed by subtracting the rotor radius from that distance.

POST-FLIGHT QUESTIONNAIRE. Upon completion of the parking/taxiing test, each subject was given a post-flight questionnaire to complete. Appendix B contains a sample questionnaire. This questionnaire asked for the subject's opinion about issues such as comfort level when parking with ground markings and near obstacles, safe rotor tip clearances when parking and taxiing near objects, skid heights for hover taxiing, and perception of taxiing performance and lateral path deviation with the different ground markings. Also, this questionnaire collected pilot background information such as number of flight hours and aircraft experience. This post-flight information was examined in relation to performance.

TRACKER DATA. The laser tapes contained data that had been converted from slant range, AZ, and EL to X, Y, and Z coordinates (using the Technical Center's grid) by the Technical Center's Honeywell 66/60 computer facility. The tapes were then converted from Honeywell format to the VAX/VMS format and processed accordingly on a VAX 11/730 computer.

PILOT INTERVIEWS. The pilot interviews conducted in NY, NJ, LA, and TX used some of the same questions found in the parking/taxiing activity's post-flight questionnaire. Figure 2 is a sample questionnaire used during the pilot interview activity. Included in this questionnaire was a question concerning ground markings for parking operations. Pilot background information, such as total flight hours, total helicopter hours, and aircraft experience, was also collected. In addition, pilots made many comments concerning local heliports. A data base was created on a Zenith personal computer (PC) containing all interview responses.

OBSERVATIONS. Drawings were made and photographs were taken of many of the NY heliports. Numerous photographs were taken of the LA and TX facilities. The drawings included surface markings with distances between parking areas and the landing area recorded. Expert observations were noted of the operations conducted at these heliports.

ANALYSIS PROCEDURES.

PARKING DATA. Two types of errors were computed for the parking tests: perception error and performance error.

The perception error was calculated by comparing the actual rotor tip clearance, as determined by the geometric computations performed on the ground measurements, to the pilot's estimated clearance. Performance error was computed by comparing the actual rotor tip clearance to the requested 12-foot clearance.

PILOT QUESTIONNAIRE

HELIPORT: ____________________________

AIRCRAFT TYPE: ____________________________

TOTAL FLIGHT HOURS: ____________________________

TOTAL HELICOPTER HOURS: ____________________________

1. When parking in close proximity to an object or another aircraft what do you consider the minimum safe rotor tip clearance: (in feet)

	An Object	Another Aircraft
a. with a headwind?		
b. with a tailwind?		
c. with a crosswind?		

2. What type markings do you prefer for parking operations?

   a. A circle

   b. A straight line

   c. Other- please describe

3. What is your prefereable skid height for hover taxiing? (in feet)

4. A 20 foot rotor tip clearance from an object for hover taxiing is:

   a. no problem-ok

   b. Can do it with care

   c. Can do it, but prefer not to

   d. Too close- won't do it

5. In your opinion what is the minimum safe rotor tip clearance from an obstacle while hover taxiing? (in feet)

FIGURE 2. QUESTIONNAIRE USED FOR PILOT INTERVIEWS IN NY/NJ, LA AND TX

LOTUS 1-2-3 was used to create histograms for these errors with and without the obstacle, partitioned by wind conditions and regardless of winds. Histograms of the actual tip clearances with and without an obstacle were also produced. Mean and standard deviations of the pilot's stated tip clearances were calculated and presented in table form for the three wind conditions, both with and without the obstacle. The error mean and standard deviations are also presented in table form.

TAXIING DATA. From the tracker data it was possible to compute taxiing perception, performance, and crosstrack errors, as well as altitude and ground speed for these tests. The perception errors were calculated by comparing the actual taxi hover height to the goal, as stated by the pilot. Performance errors were computed by subtracting the requested 3-foot height from the actual height. Tables of the mean and standard deviations of these errors are presented.

Computer listings of the crosstrack error, altitude, ground speed, perception error, and performance error were generated using the VAX 11/750.

PILOT INTERVIEW DATA. Responses from each of the five questions used for the pilot interviews in the field were analyzed on a PC using DBASE 3+ and LOTUS 1-2-3. Other plots were produced using the California Computer's Calcomp 1051 drum plotter with Calcomp 907 software for the VAX. Histograms were produced for the responses concerning ground markings, preferable skid heights, and tip clearances for hover taxiing. Scatter plots were produced to aid in the analysis of the replies concerning tip clearances during parking operations under head, tail, and crosswind conditions. To alleviate overlapping of numbers on the scatter plots due to the large number of observations in a narrow range, letters were used to indicate the number of observations. For example, an "A" indicates 1 observation for a particular distance, a "B" = 2 observations, ... a "O" indicates 15 observations, etc. See the Results section for these plots.

OBSERVATIONS. Drawings and photographs of the facilities visited are included in appendix C. The operations were compiled and are included in the following Results section.

RESULTS

PARKING DATA.

PILOT CHOICE MANEUVERS. All of the stated pilot preferences for tip clearances from an obstacle, as well as from the ground marking, were less than the 1/3 rotor diameter value spelled out in the Design Advisory Circular. For the UH-1H this value is 16 feet. Table 6 lists the means and standard deviations of the pilot stated preferred tip clearances. Of the responses, 56 percent were between 10 and 12 feet, while the remaining 44 percent were less than 10 feet. However, when the pilots attempted to perform to their stated comfort levels, the resulting tip clearances averaged between 1.1 to 1.6 times the stated comfort levels.

TABLE 6. PILOT PREFERRED TIP PATH CLEARANCE

In Feet

	Headwind	Crosswind	Tailwind
With Obstacle			
Mean	8.69	8.88	9.25
SD	2.93	2.93	3.09
N	16	16	16
Without Obstacle			
Mean	7.25	7.10	7.65
SD	3.51	3.62	3.68
N	20	20	20

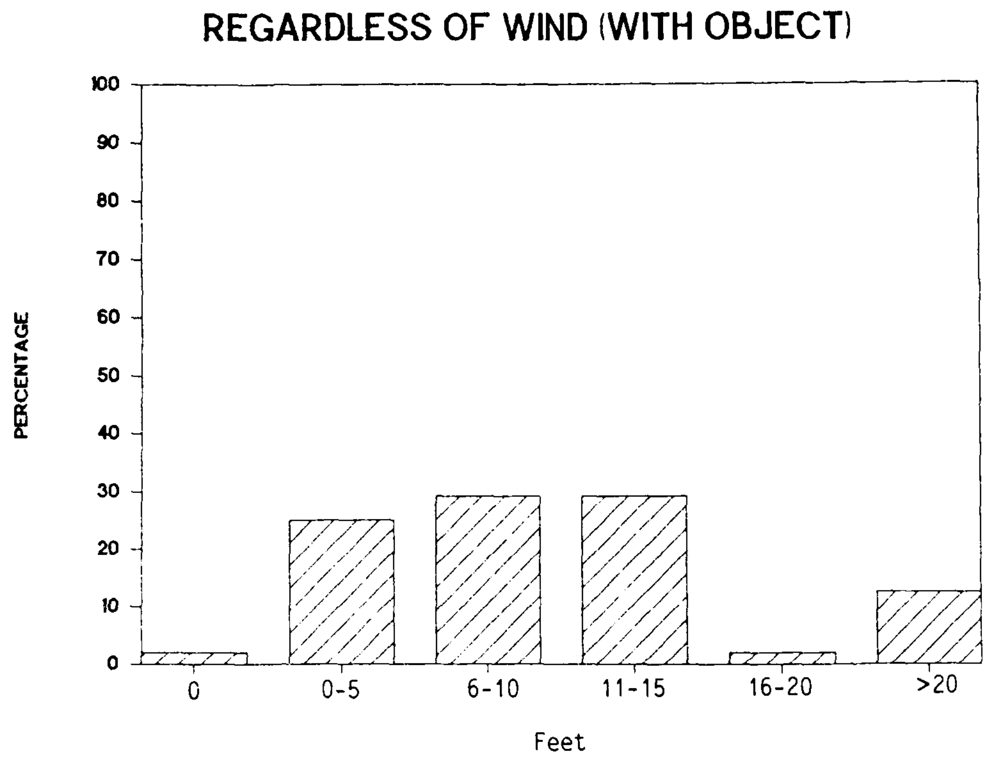
(The 1/3 rotor diameter criteria for a UH-1H is 16 feet.)

With an obstacle under tailwind condition, 97.5 percent of the responses were less than 15.43 feet. This was the largest for all tested conditions. Figure 3 shows plots of the actual clearances regardless of wind conditions for the pilot choice maneuvers. Greater than 85 percent of the observations with an obstacle present were less than or equal to 1/3 rotor diameter of the UH-1H. The remaining 15 percent of the observators ranged from 21 to 39 feet. Without the object, more than 95 percent of the observations were less than or equal to the 1/3 rotor diameter criteria, with the remaining observations ranging from 1.5 to 2.5 times the criteria. These clearances, broken down by wind conditions, are plotted in figure 4.

For maneuvers with an obstacle, percentages similar to those found when winds were not taken into consideration were seen for headwind and tailwind conditions, while only 81 percent of the clearances with crosswind conditions were less than or equal to the criteria. For crosswind conditions, the larger observations ranged from 30 to 40 feet. For no obstacle maneuvers under the three wind conditions, the clearances were similar to those seen when the data were not broken down by wind direction.

The means and standard deviations of the actual tip clearances regardless of wind conditions are found in table 7 and by wind conditions in table 8. Although all means are less than the 1/3 rotor diameter criteria, when the variability is taken into account, however, the data indicate that, for the population, the actual clearances may be larger.

Perception errors were computed by subtracting the pilot's estimated tip clearance from the actual measured clearance for the pilot choice maneuvers. The statistics for these perception errors are found in table 9. Plots of the perceived clearances versus actual clearances are found in figures 5 and 6. Approximately 44 percent of the perceived clearances from the obstacle, regardless of winds, were underestimated; that is, the pilot's perceived distance was less than the actual clearance. In addition, 35 percent of the estimates were overestimated by 3 feet or less. The perceived tip clearance for the maneuvers with only a ground marking was underestimated 43 percent of the time. This is similar to that seen with the obstacle. For this procedure, however, only 19 percent of the perceived clearances were overestimated by 3 feet or less, while 38 percent were overestimated by greater than 3 feet.



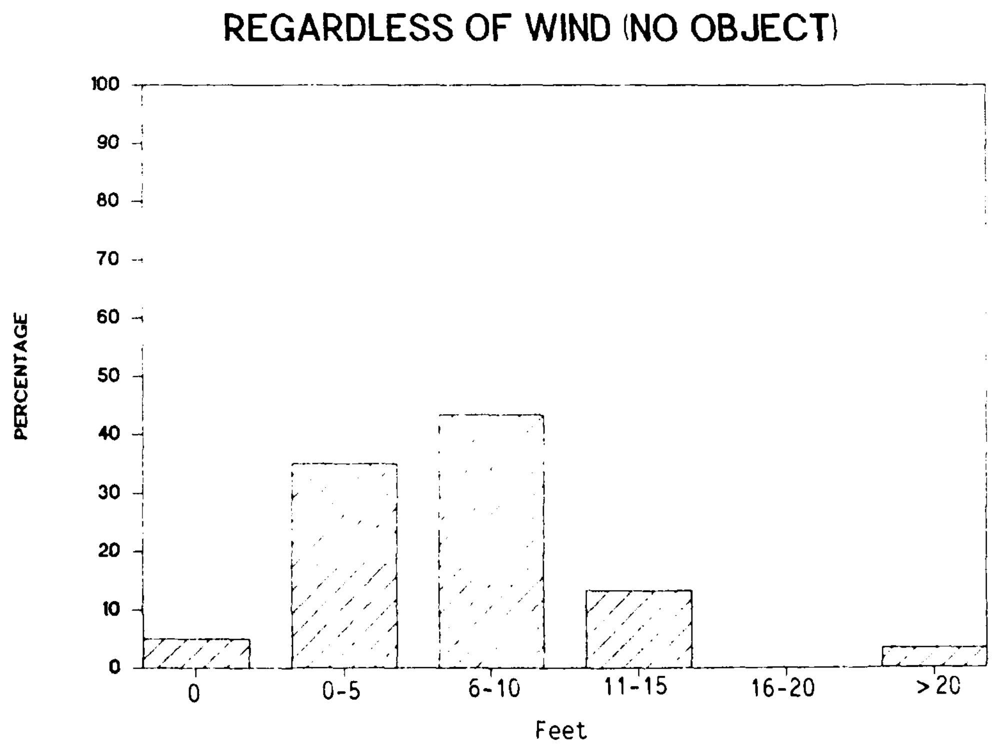


FIGURE 3. ACTUAL TIP CLEARANCES FOR PILOT CHOICE PARKING MANEUVERS REGARDLESS OF WINDS

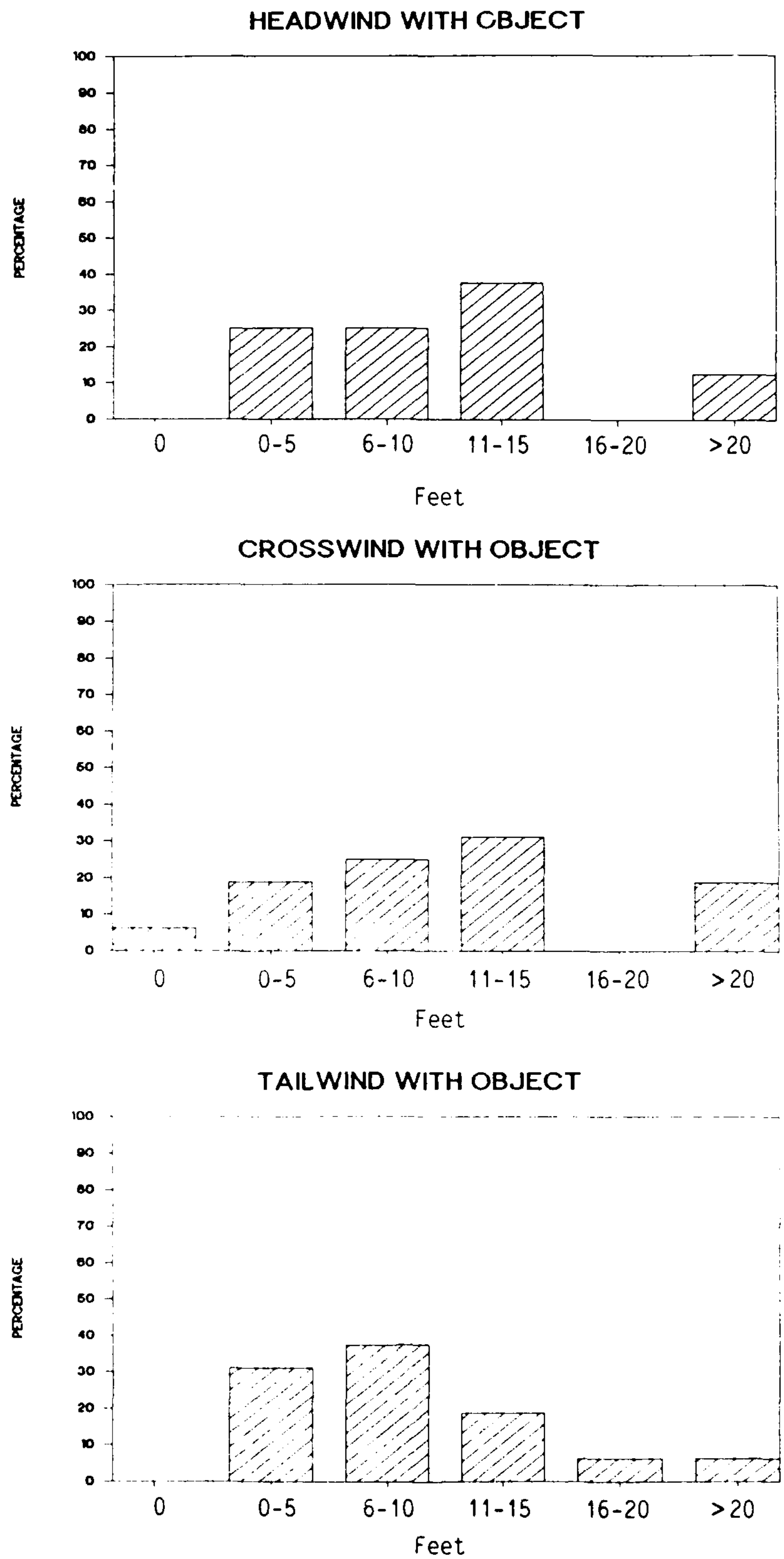
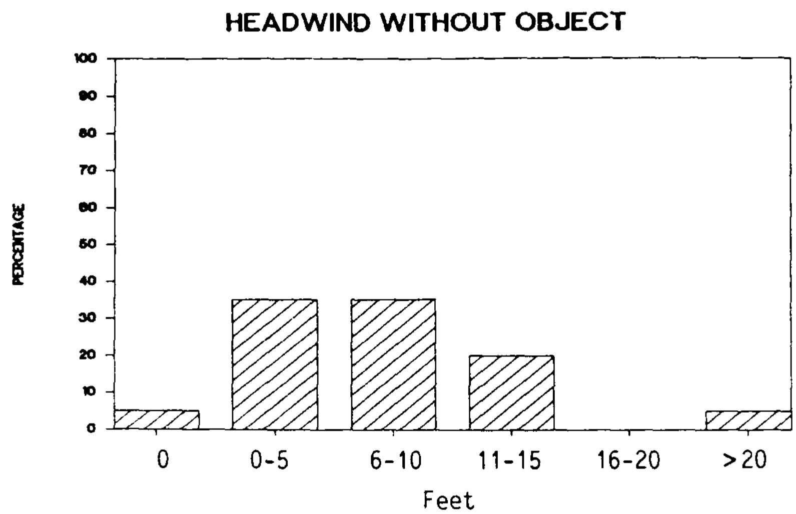
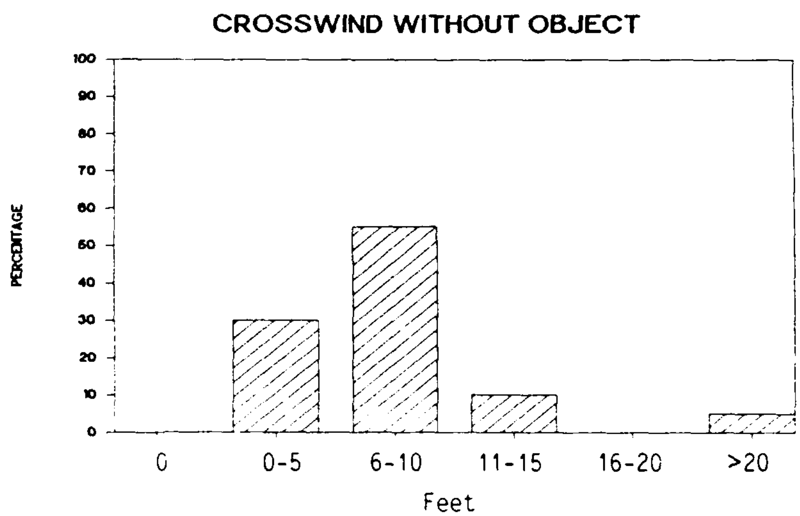


FIGURE 4. ACTUAL TIP CLEARANCES FOR PILOT CHOICE PARKING MANEUVERS BROKEN DOWN BY WINDS (SHEET 1 OF 2)





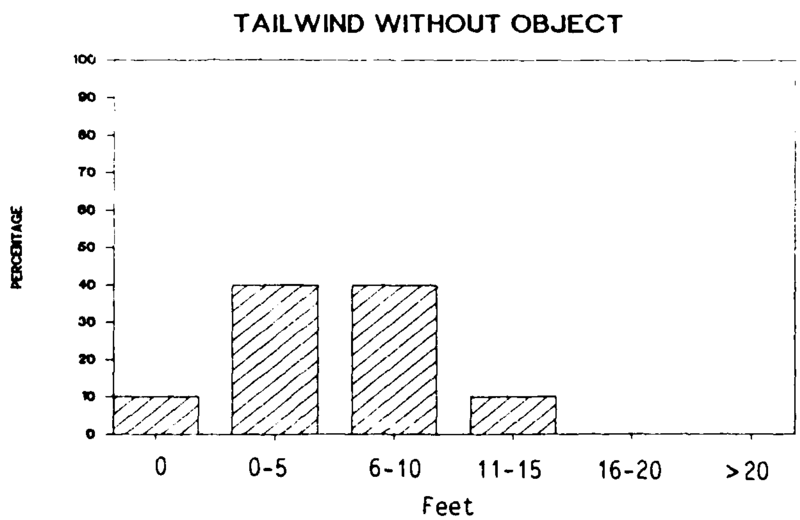


FIGURE 4. ACTUAL TIP CLEARANCES FOR PILOT CHOICE PARKING MANEUVE
BROKEN DOWN BY WINDS (SHEET 2 OF 2)

TABLE 7. ACTUAL ROTOR TIP CLEARANCES REGARDLESS OF WIND DIRECTION - PILOT'S CHOICE

	In Feet	
	With Obstacle	Without Obstacle
Mean	10.85	7.29
97.5 Percentile Point	26.87	19.47
N	48	60

(The 1/3 rotor diameter criteria for a UH-1H is 16 feet)

TABLE 8. ACTUAL ROTOR TIP CLEARANCES BY WINDS

	In Feet		
	Headwind	Crosswind	Tailwind
With Obstacle			
Mean	11.16	11.70	9.68
97.5 Percentile Point	25.18	30.76	22.44
N	16	16	16
Without Obstacle			
Mean	8.52	7.61	5.74
97.5 Percentile Point	24.04	18.66	13.86
N	20	20	20

(The 1/3 rotor diameter criteria for a UH-1H is 16 feet.)

TABLE 9. PERCEPTION ERRORS

	(Actual Clearance - Pilot Estimate in Feet)		
	Headwind	Crosswind	Tailwind
With Obstacle			
Mean	3.04	2.70	.12
SD	6.57	9.13	5.61
N	16	16	16
Without Obstacle			
Mean	1.26	.86	-1.09
SD	8.48	6.43	4.42
N	20	20	20

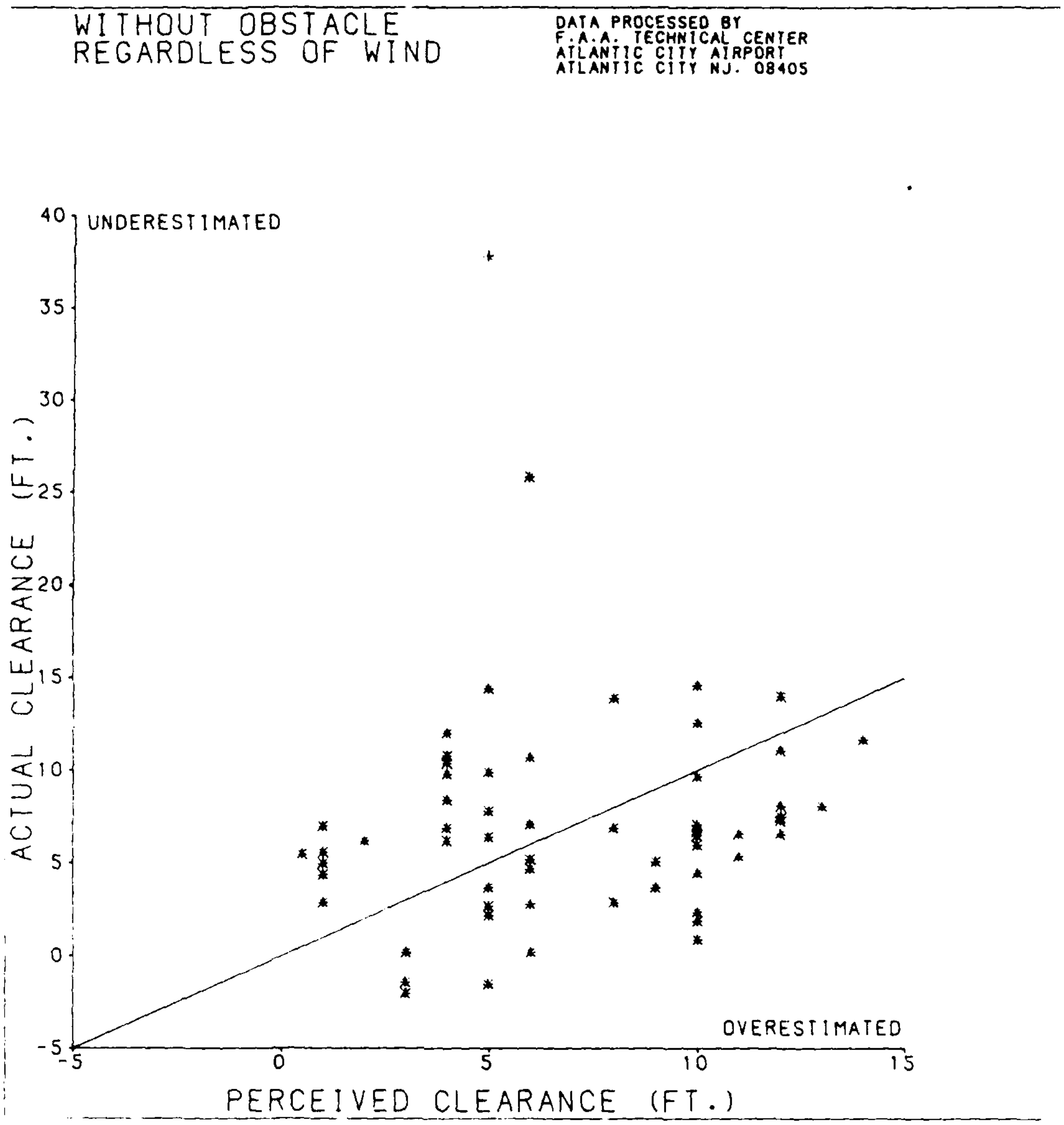


FIGURE 5. PILOT CHOICE PARKING MANEUVERS; PERCEPTION ERRORS REGARDLESS OF WINDS (SHEET 1 OF 2)

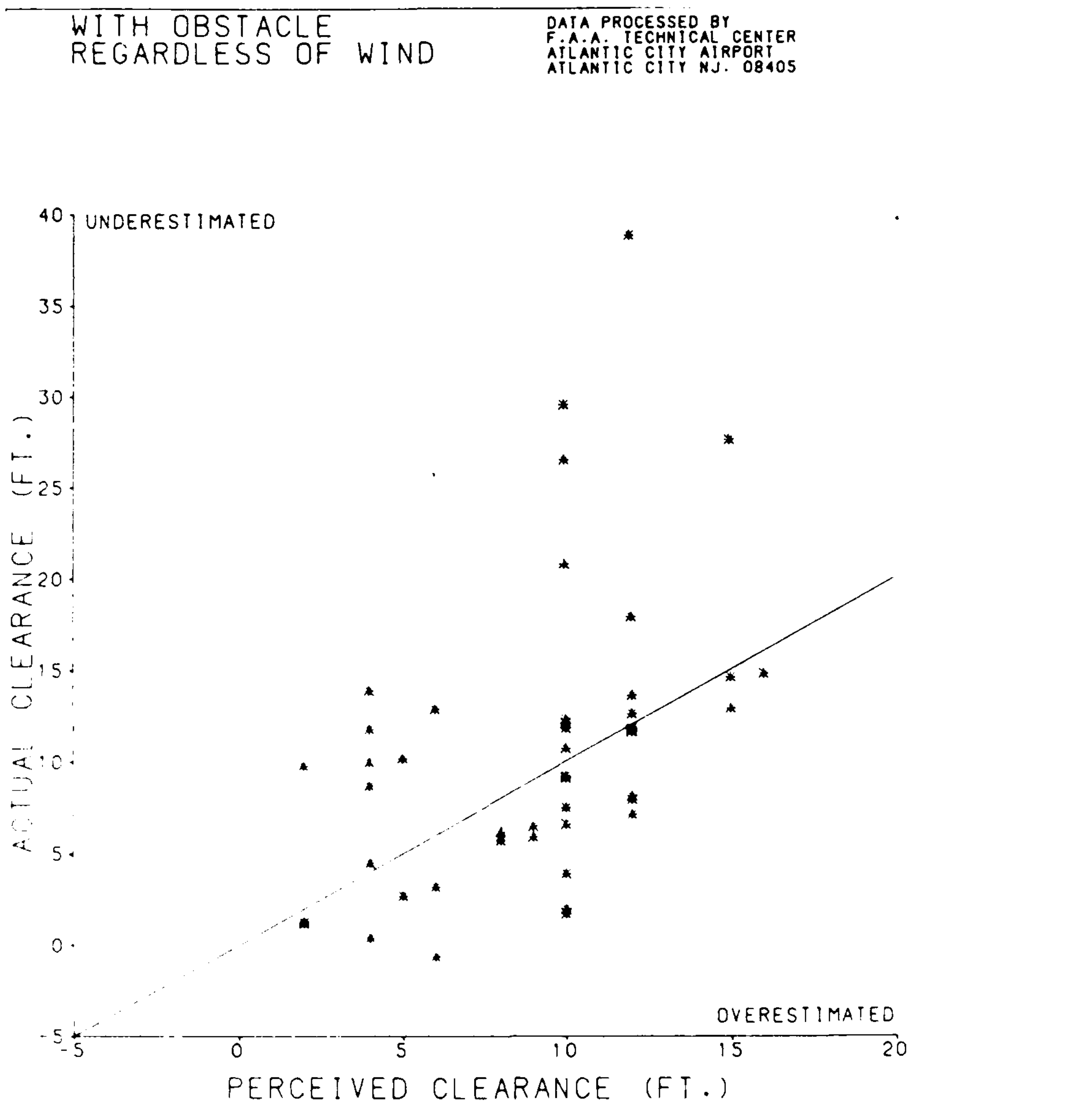


FIGURE 5. PILOT CHOICE PARKING MANEUVERS; PERCEPTION ERRORS REGARDLESS OF WINDS (SHEET 2 OF 2)

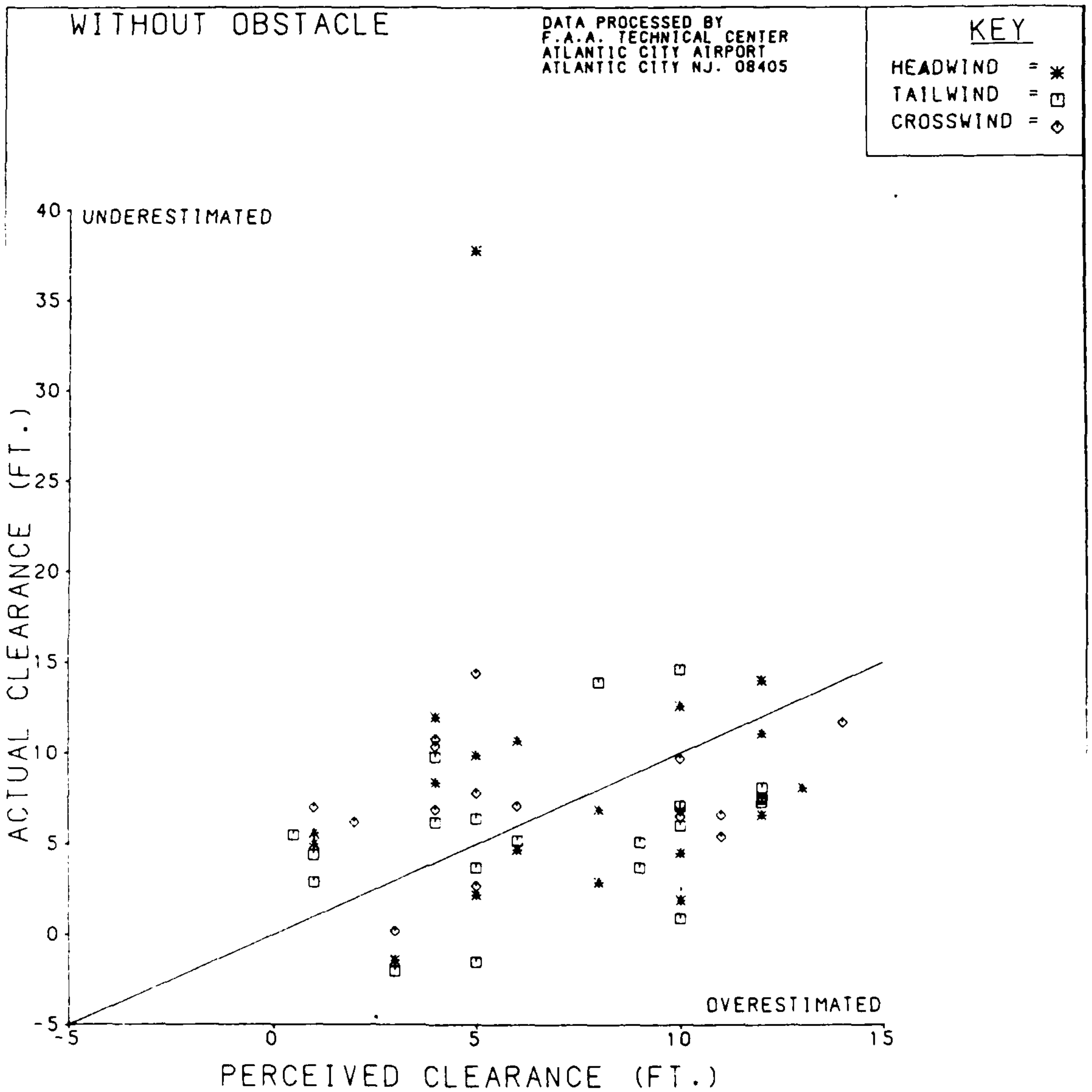


FIGURE 6. PILOT CHOICE PARKING MANEUVERS; PERCEPTION ERRORS BY WIND (SHEET 1 OF 2)

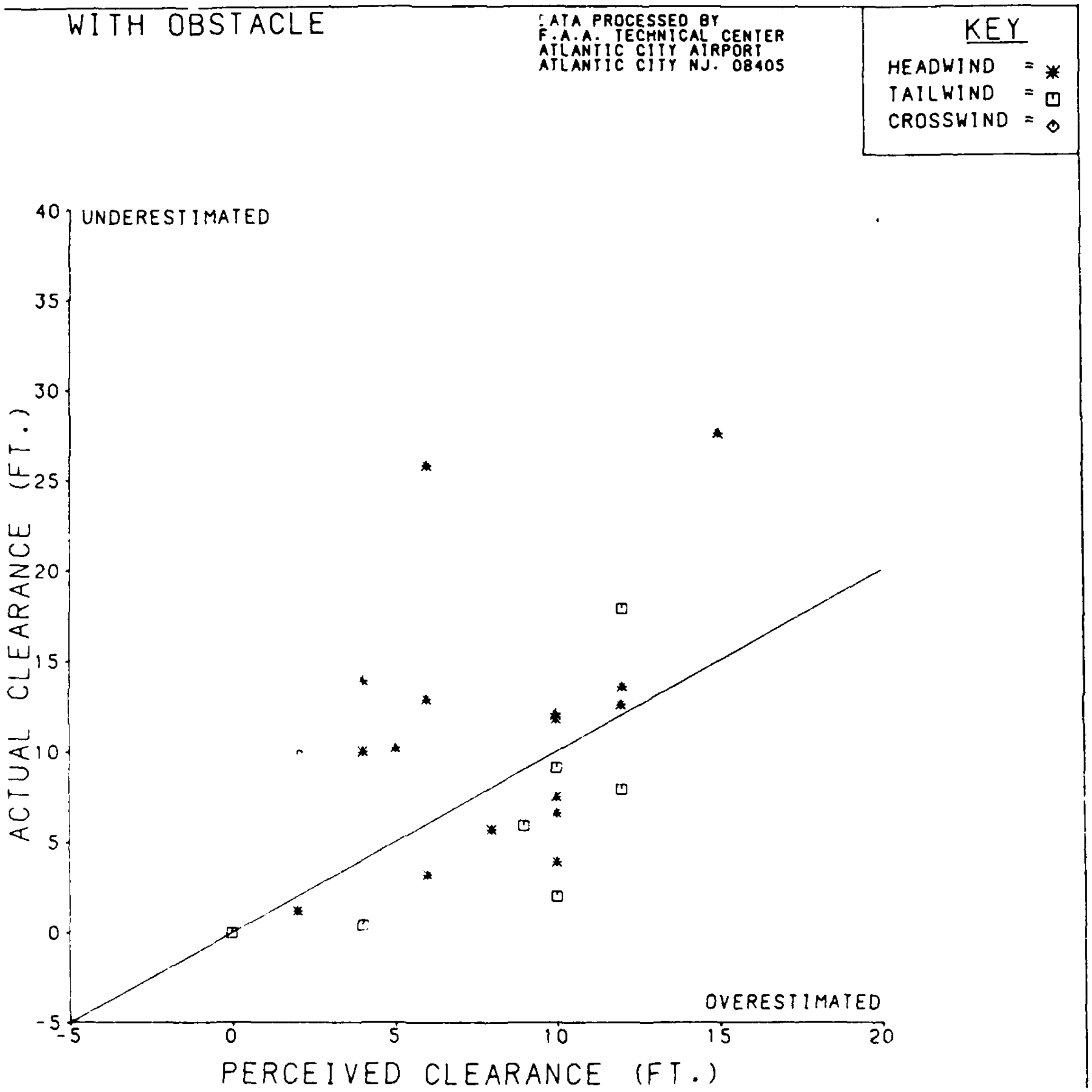


FIGURE 6. PILOT CHOICE PARKING MANEUVERS; PERCEPTION ERRORS BY WIND (SHEET 2 OF 2)

The perception errors were also examined based on the three wind conditions. Clearances from the obstacle were underestimated a larger percentage of the time under headwind conditions, while the percentages of underestimated and overestimated clearances for tailwind and crosswind conditions were similar.

As expected, with no obstacle, the pilots overestimated the tip clearances by more than 3 feet a larger percent of the time under tailwind conditions. For the no obstacle maneuvers, the percentage of observed clearances that were overestimated as well as underestimated, with crosswinds and headwinds, were the same.

REQUESTED 12-FOOT CLEARANCE. When the pilots were asked to park the helicopter with a 12-foot rotor tip clearance from the obstacle or from the line, they tended to underestimate the clearances. Means of the actual tip separations achieved under this restriction are found in table 10.

TABLE 10. ACTUAL CLEARANCES WHEN ATTEMPTING 12-FOOT CLEARANCE

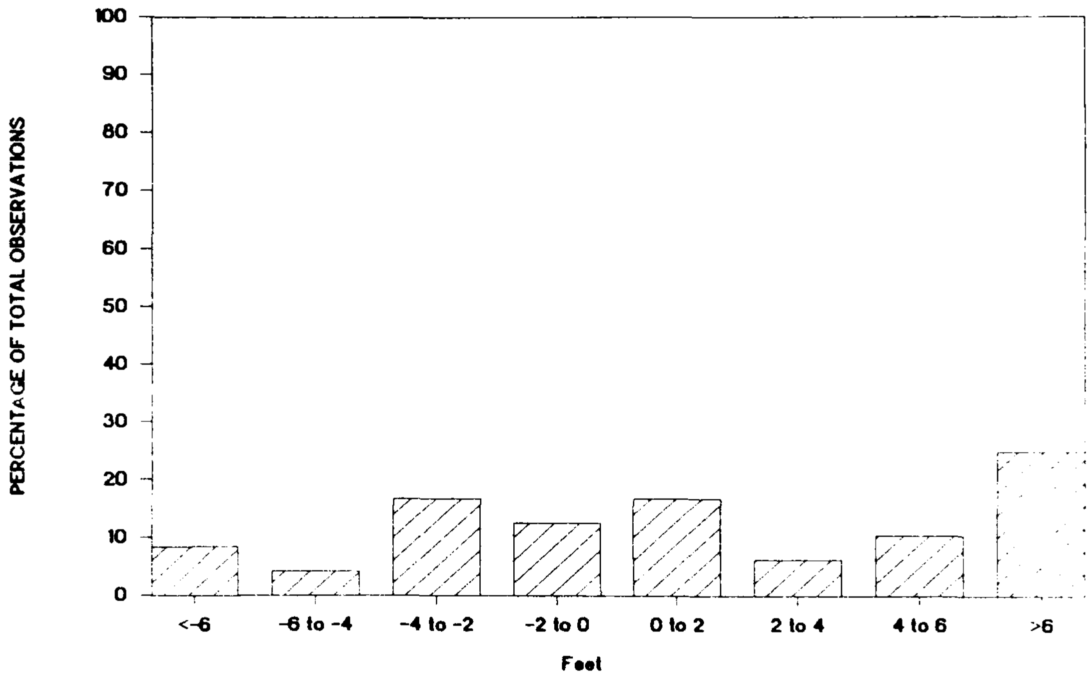
	Headwind	Crosswind	Tailwind	Overall
With Obstacle				
Mean	14.37	14.24	13.49	14.03
SD	6.08	6.76	5.87	6.26
N	16	16	16	48
Without Obstacle				
Mean	14.10	13.40	12.55	13.35
SD	7.32	5.82	6.52	6.61
N	20	20	20	48

Although all means indicate a tendency to underestimate the separation under all three wind conditions, both with and without the obstacle, the variability of the clearances was very consistent from one condition to the next.

Performance errors were generated by subtracting the 12-foot requested clearance from the actual clearance. Histograms of these errors are found in figures 7 and 8. Examination of the performance errors, regardless of wind conditions, revealed that the pilots parked the helicopter 12 feet or more from the obstacle 58 percent of the time. This indicates they tended to underestimate their clearances and were conservative in their performance. In addition, 25 percent of the pilots overestimated the clearances by 3 feet or less. Similarly, when there was no obstacle, the actual clearances, regardless of winds, were underestimated approximately 52 percent of the time, with 18 percent overestimated by 3 feet or less. Again, their performance was conservative. When the data were broken down by wind conditions, the best performance was seen with headwinds. The percentage (69 percent) of clearances 12 feet or more from the obstacle with headwinds was 13-19 percent larger than either of the other two conditions. Without the obstacle, the performance was 15-20 percent larger for headwind conditions.

Means of these performance errors, found in table 11, support the tendency for pilots to underestimate their performance.

REGARDLESS OF WIND- WITH OBJECT



REGARDLESS OF WIND- WITHOUT OBJECT

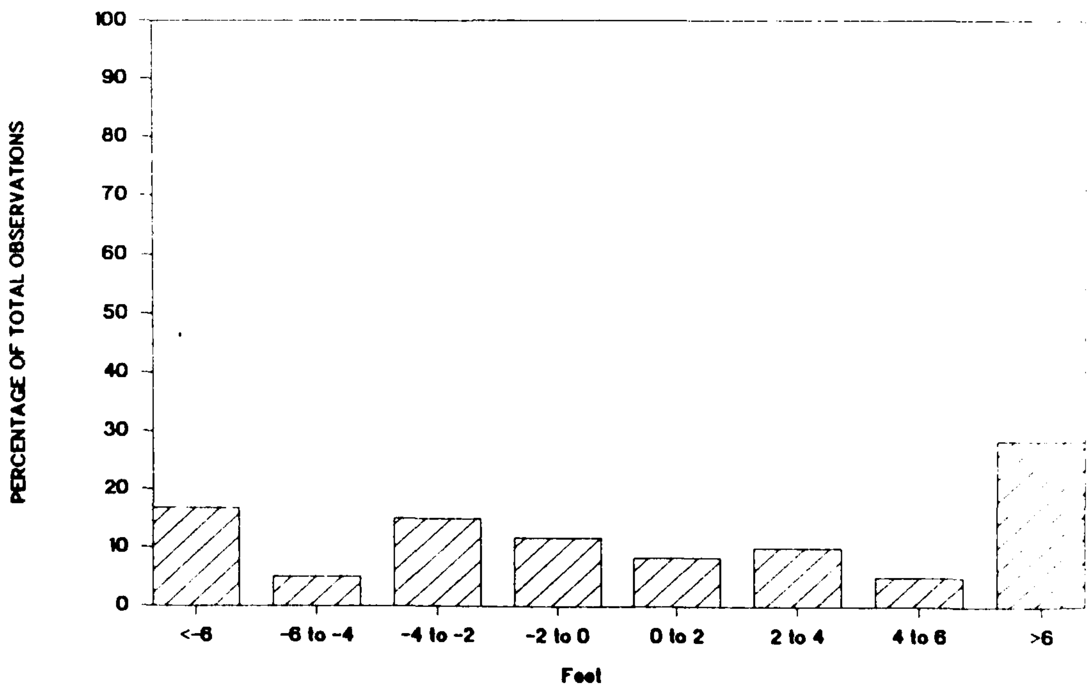


FIGURE 7. REQUESTED 12-FOOT PARKING CLEARANCES; PERFORMANCE ERRORS REGARDLESS OF WIND DIRECTION

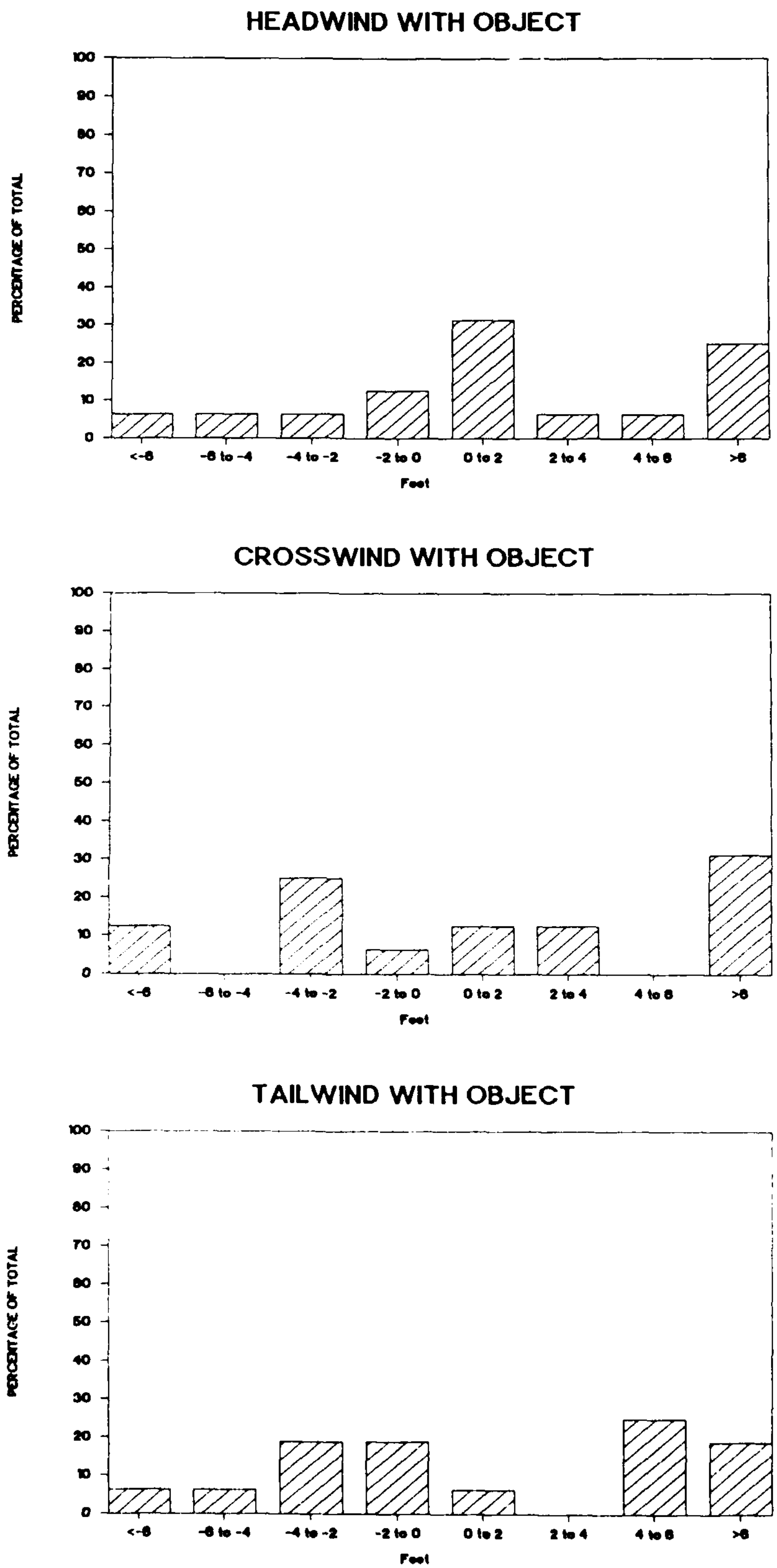


FIGURE 8. REQUESTED 12-FOOT PARKING CLEARANCES; PERFORMANCE ERRORS BY WIND DIRECTION (SHEET 1 OF 2)

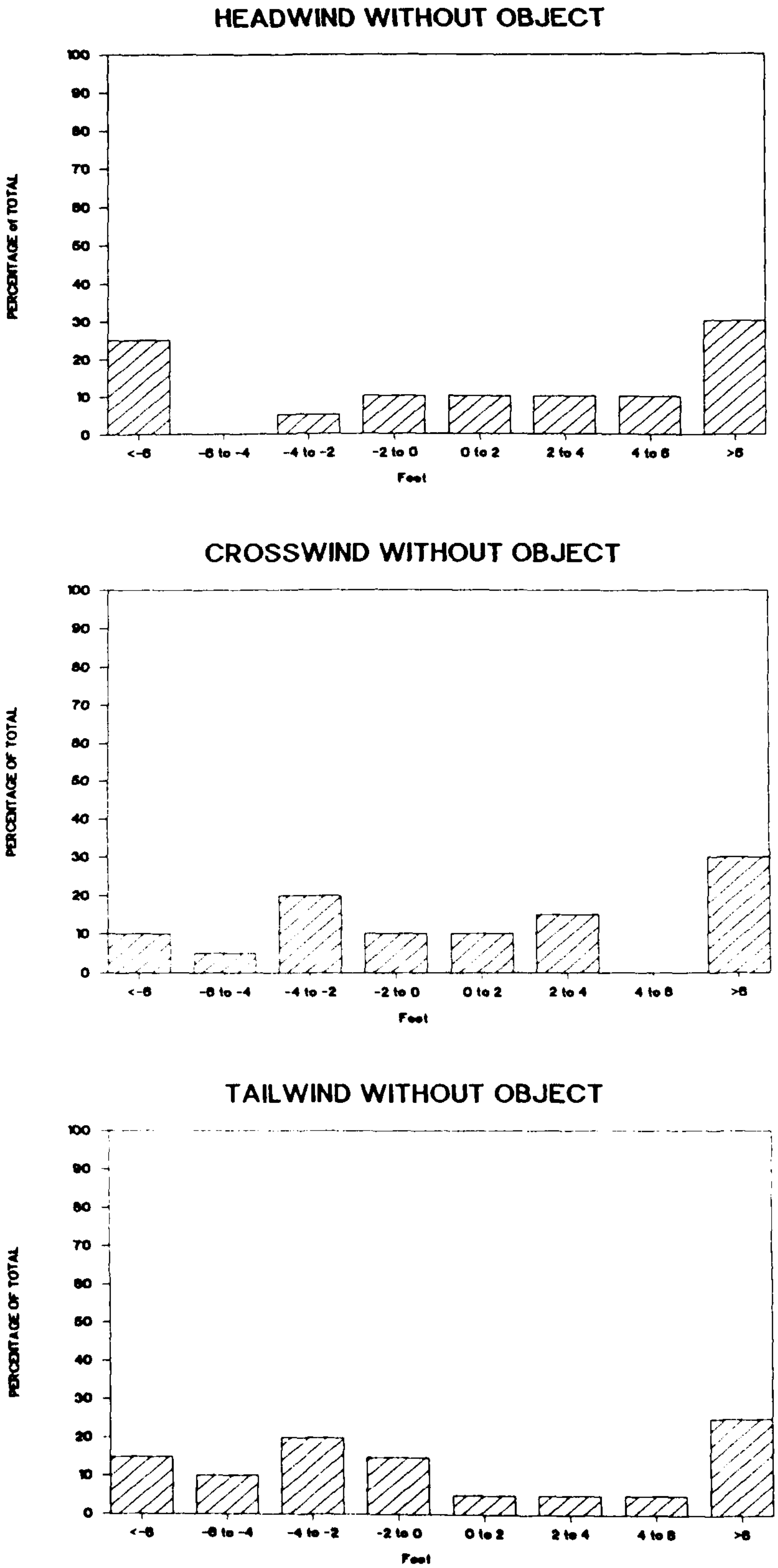


FIGURE 8. REQUESTED 12-FOOT PARKING CLEARANCES; PERFORMANCE ERRORS BY WIND DIRECTION (SHEET 2 OF 2)

TABLE 11. PERFORMANCE ERRORS

(Actual Clearance - 12 Feet in Feet)

	Headwind	Crosswind	Tailwind
With Obstacle			
Mean	2.37	2.24	1.49
SD	6.08	6.76	5.87
N	16	16	16
Without Obstacle			
Mean	2.10	1.40	0.55
SD	7.32	5.82	6.52
N	20	20	20

TAXIING DATA. The taxiing tests involved three marking schemes, centerline markings, side markings only, and no markings, while hover taxiing over grass. Each taxi test was conducted in two directions. Directions for the taxiing with the centerline and with the side markings were 220° and 40°. For the grass taxiing procedures the directions were approximately 240° and 60°. As with the parking tests, performance and perception errors were generated. Perception errors were calculated by subtracting the pilot's estimated hover height from the actual hover height; while performance errors were calculated by subtracting the requested 3-foot hover height from the actual height. Other parameters were analyzed for the taxi tests. These parameters include: crosstrack error, altitude, and ground speed.

Means and standard deviations for these parameters are found in tables 12 through 16.

TABLE 12. CROSSTRACK ERROR

In Feet

	Taxiing Scheme + Direction					
	CL Markings		Side Markings		No Markings	
	(220°)	(40°)	(220°)	(40°)	(60°)	(240°)
Mean	1.57	1.97	2.21	2.54	2.94	1.67
SD	1.02	1.33	1.57	1.80	1.89	1.34
N	7703	9823	7484	9183	8590	7708

TABLE 13. ALTITUDE

Feet, Above Ground Level

	Taxiing Scheme + Direction					
	CL Markings		Side Markings		No Markings	
	(220°)	(40°)	(220°)	(40°)	(60°)	(240°)
Mean	6.38	6.05	6.66	6.24	8.10	8.03
SD	2.51	2.60	2.70	2.84	4.28	4.17
N	7703	9823	7484	9183	8590	7708

TABLE 14. GROUND SPEED

Knots

	Taxiing Scheme + Direction					
	CL Markings		Side Markings		No Markings	
	(220°)	(40°)	(220°)	(40°)	(60°)	(240°)
Mean	6.72	5.53	7.09	5.83	6.45	6.42
SD	2.31	2.14	2.26	2.04	2.94	2.81
N	7730	9848	7564	9235	8606	7761

TABLE 15. TAXIING PERCEPTION ERROR

Feet
(Actual Hover Ht - Pilot Estimate)

	Taxiing Scheme + Direction					
	CL Markings		Side Markings		No Markings	
	(220°)	(40°)	(220°)	(40°)	(60°)	(240°)
Mean	1.81	1.64	2.22	2.09	2.95	3.13
SD	1.95	1.84	1.83	2.16	3.16	3.03
N	4760	6281	4166	5309	5838	5288

TABLE 16. TAXIING PERFORMANCE ERROR

Feet

(Actual Hover Ht - 3-Foot Request)

	Taxiing Scheme + Direction:					
	CL Markings		Side Markings		No Markings	
	(220°)	(40°)	(220°)	(40°)	(60°)	(240°)
Mean	2.65	2.32	3.37	3.30	5.58	4.91
SD	2.48	3.02	3.07	3.14	5.27	5.66
N	2184	2564	2004	2169	2017	1835

With the exception of the crosstrack error and ground speed data, the means of the parameters for the unmarked maneuvers were noticeably larger than those conducted with the centerline and with side markings. Examination of the standard deviations shows that, with the exception of only crosstrack error data, the variabilities of the taxiing procedures with no markings were much larger than the other procedures. For the crosstrack error data using the centerline scheme, the six standard deviation envelopes (in feet) fall within the taxi route and taxiway width criteria.

The most noticeable differences are seen in the hover height, perception error, and performance error data. Mean and standard deviations for the altitude data were similar for the procedures with a centerline as well as those with only side markings; while the means for the no marking taxi procedures were 1 to 2 feet higher and the standard deviations were 1.3 to 2 feet larger.

The pilot perception and performance error means for the unmarked route are higher than the means for the other schemes. The variability for perception error was 0.8 to 1.4 feet larger. For performance error, the variability is from 2.13 to 3.18 feet higher for the unmarked route.

PILOT POST-FLIGHT QUESTIONNAIRES.

The first two questions dealing with the 12-foot tip clearance parking maneuvers employed a 1 to 5 scale, where 1 is not comfortable, 3 is somewhat comfortable, and 5 is comfortable. Ratings for both 12 foot required clearance maneuvers, with the obstacle and without the obstacle, were noticeably higher for the headwind conditions. Ratings for crosswind conditions were the next highest, followed by tailwind condition ratings. None of the ratings with headwind and crosswind conditions was less than a 4 for maneuvers with only ground markings. The tailwind condition ratings for both type maneuvers ranged from one pilot rating of 2 to five ratings of 5. Figures 9 and 10 provide histograms of these responses. See comments below that aid in explanation of these ratings.

Although experience was thought to be a factor influencing how comfortable the pilot was with the maneuvers requested, the correlation studies conducted on the post-flight questionnaire responses versus helicopter time does not support this.

When asked for their opinion concerning the minimum safe rotor tip clearance for parking near an object, 100 percent of the responses were 15 feet or less for headwind conditions. For both tailwind and crosswind conditions, 92 percent responded with a distance of 15 feet or less. These responses closely correspond to the 1/3 rotor diameter criteria which is 16 feet for the UH-1H. See figure 11 for the histograms of these responses. Based on the correlation coefficients calculated, experiences that are total helicopter hours does not appear to be an influencing factor in their responses.

Pilot preferences for skid height during hover taxi operations ranged from 2 to 5 feet. Again, total helicopter hours doesn't appear to influence their responses. These responses are depicted in figure 12.

As seen in figure 13, none of pilots felt there was a problem with a 20-foot tip clearance for hover taxiing. When asked for their preferred tip clearance, their responses ranged from 5 to 30 feet. Four pilots stated a preference for greater than 20-foot tip clearance. Experience does not appear to have a significant influence on the responses See figure 14 for the plots of these preferences.

In comparing their performance among the three taxiing schemes, 8 of the 13 pilots felt their performance decreased when there was no centerline.

They perceived that their lateral path deviation increased as markings decreased. With a centerline the majority felt their lateral path deviated no more than 2 feet; while with side markings, as well as with no markings, they perceived their deviation to be as large as 10 feet. The number of pilots who felt their lateral deviation was, at most, 2 feet, decreased to 5 (of the 13) for the side

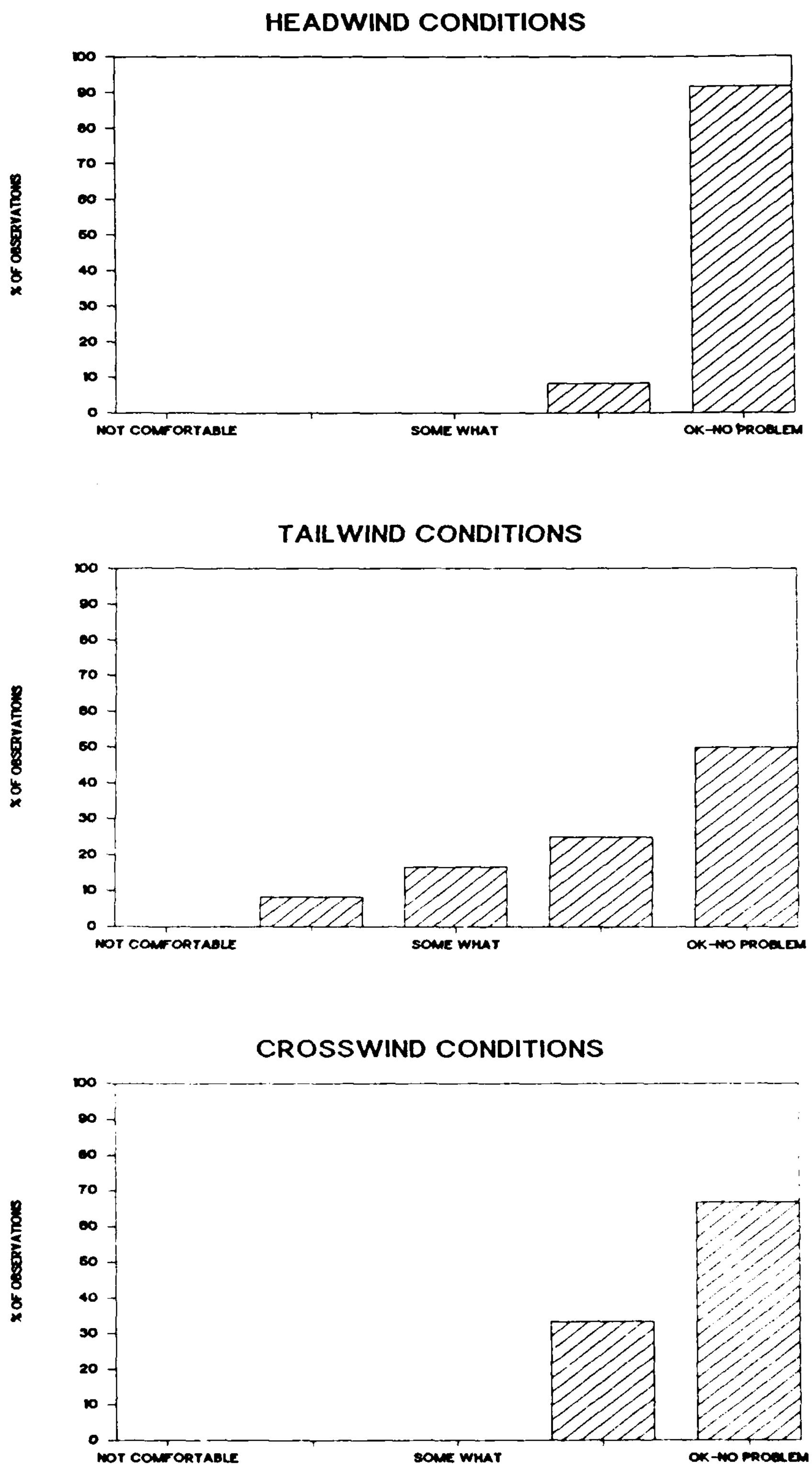


FIGURE 9. PILOT RATINGS FOR REQUESTED 12-FOOT PARKING CLEARANCE FROM A GROUND MARKING

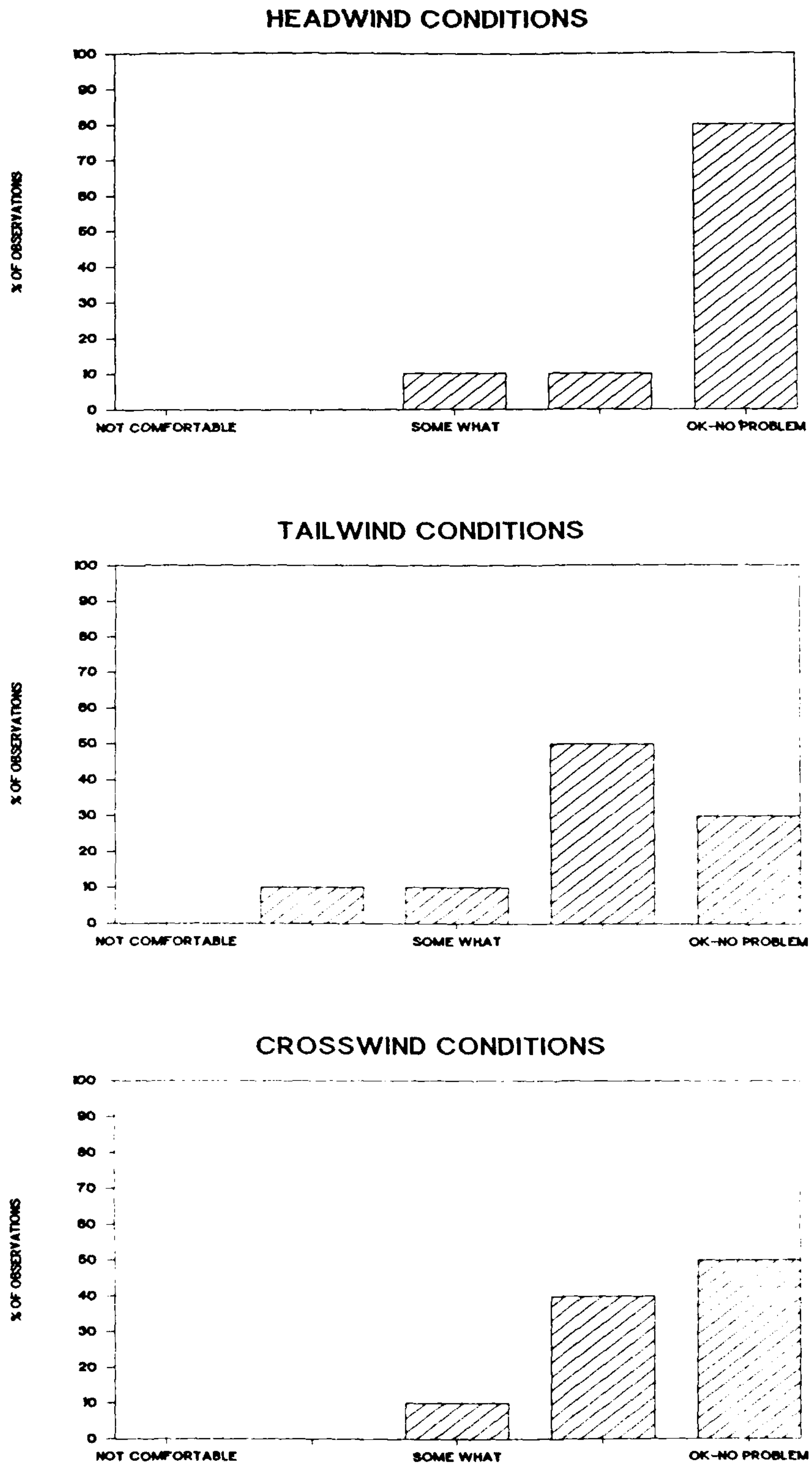


FIGURE 10. PILOT RATINGS FOR REQUESTED 12-FOOT PARKING CLEARAN
FROM AN OBSTACLE

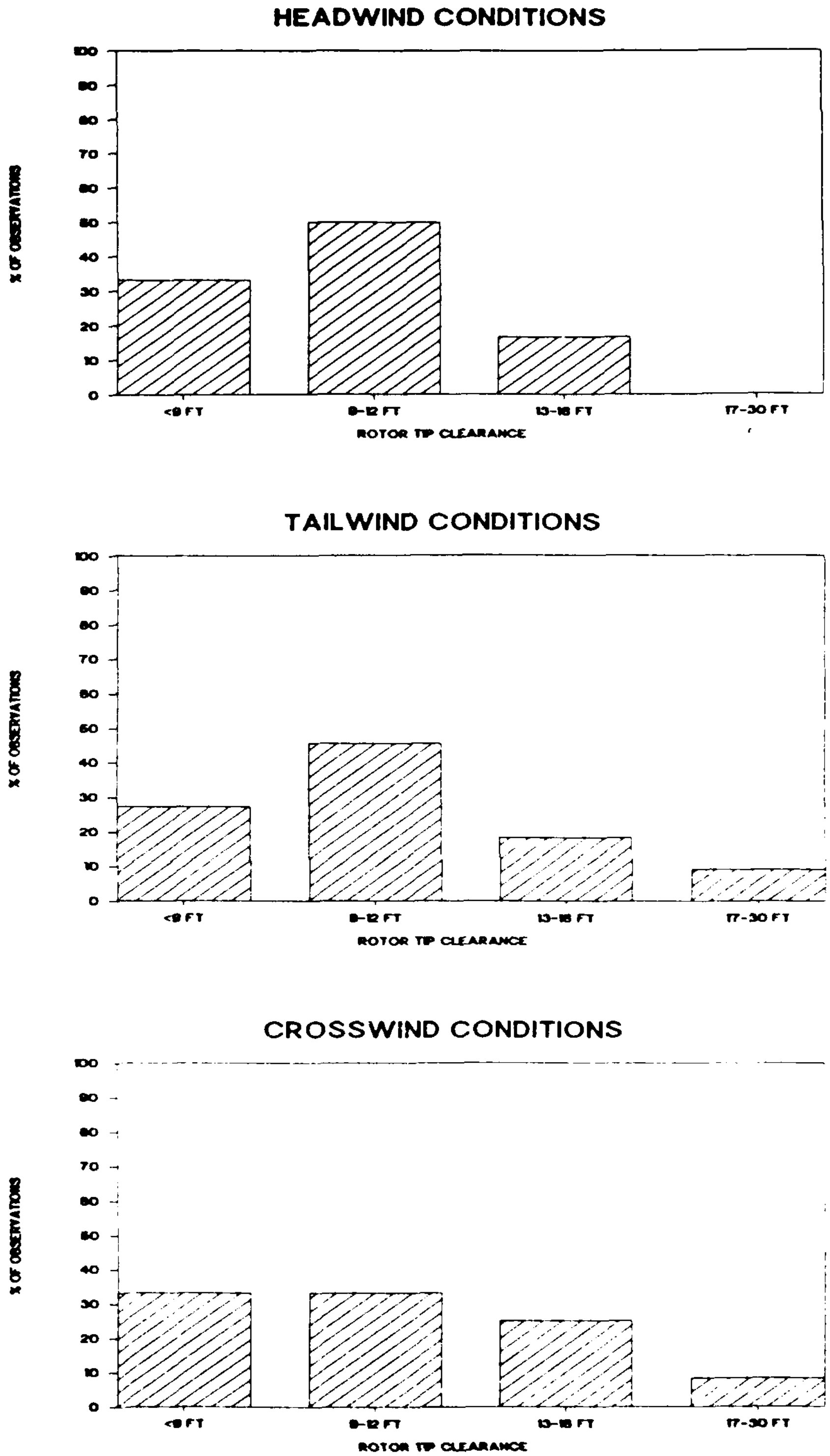
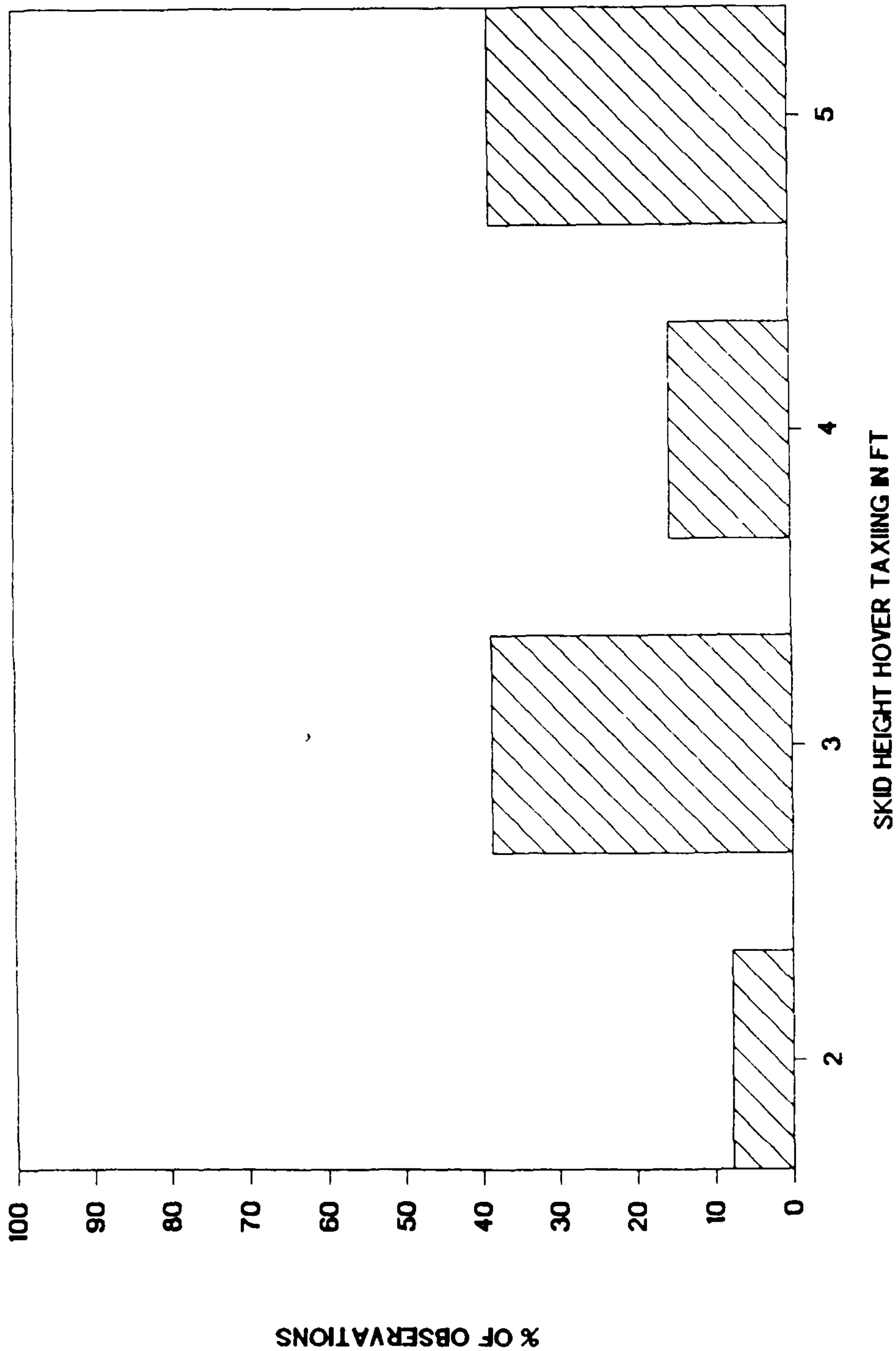


FIGURE 11. PILOT RESPONSES TO MINIMUM SAFE TIP CLEARANCE FROM AN OBJ


% OF OBSERVATIONS
0
10
20
30
40
50
60
70
80
90
100
2
3
4
5
SKID HEIGHT HOVER TAXIING IN FT

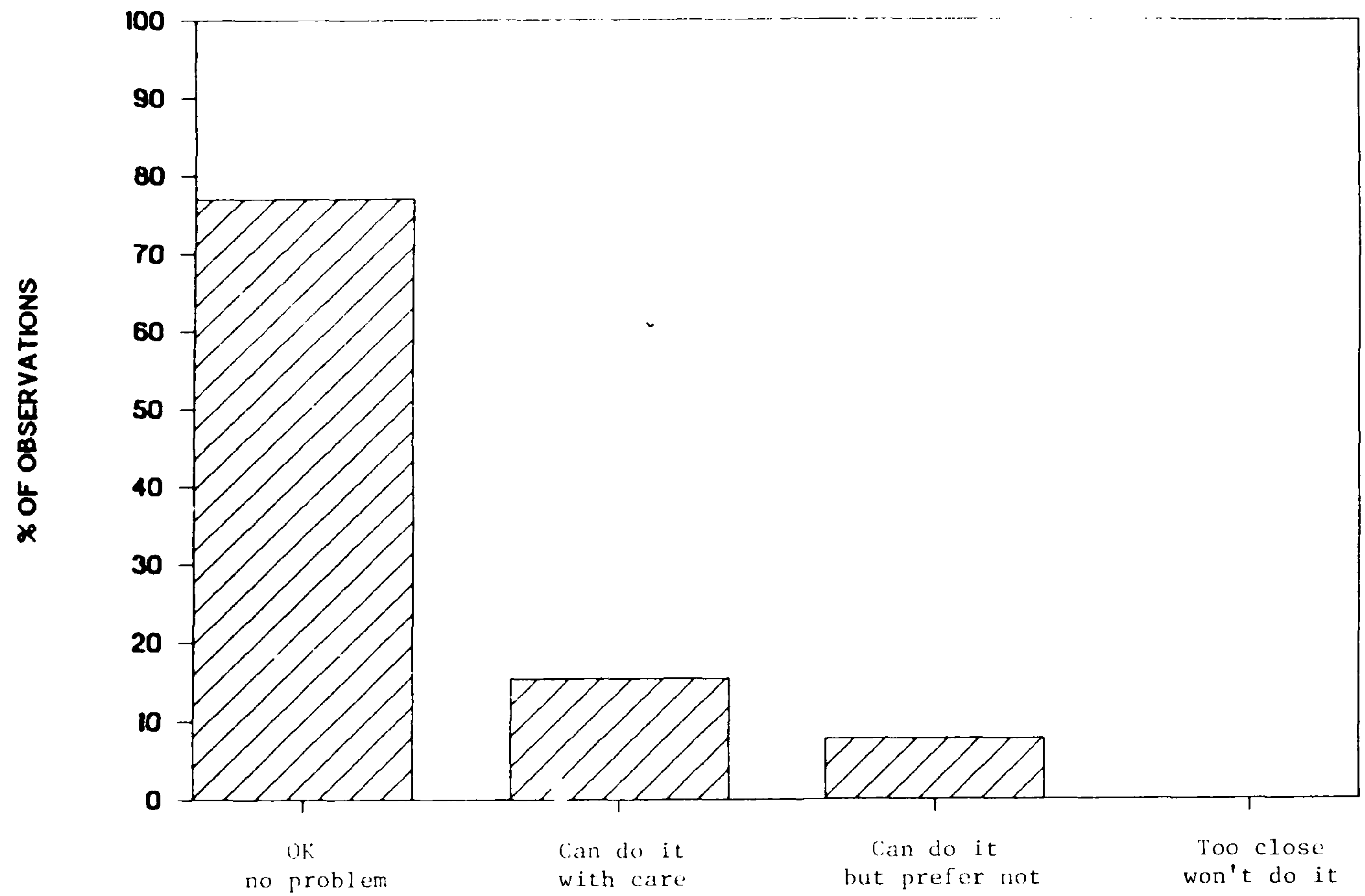


FIGURE 13. PILOT RESPONSES TO TAXIING WITH 20-FOOT TIP CLEARANCE FROM AN OBJECT

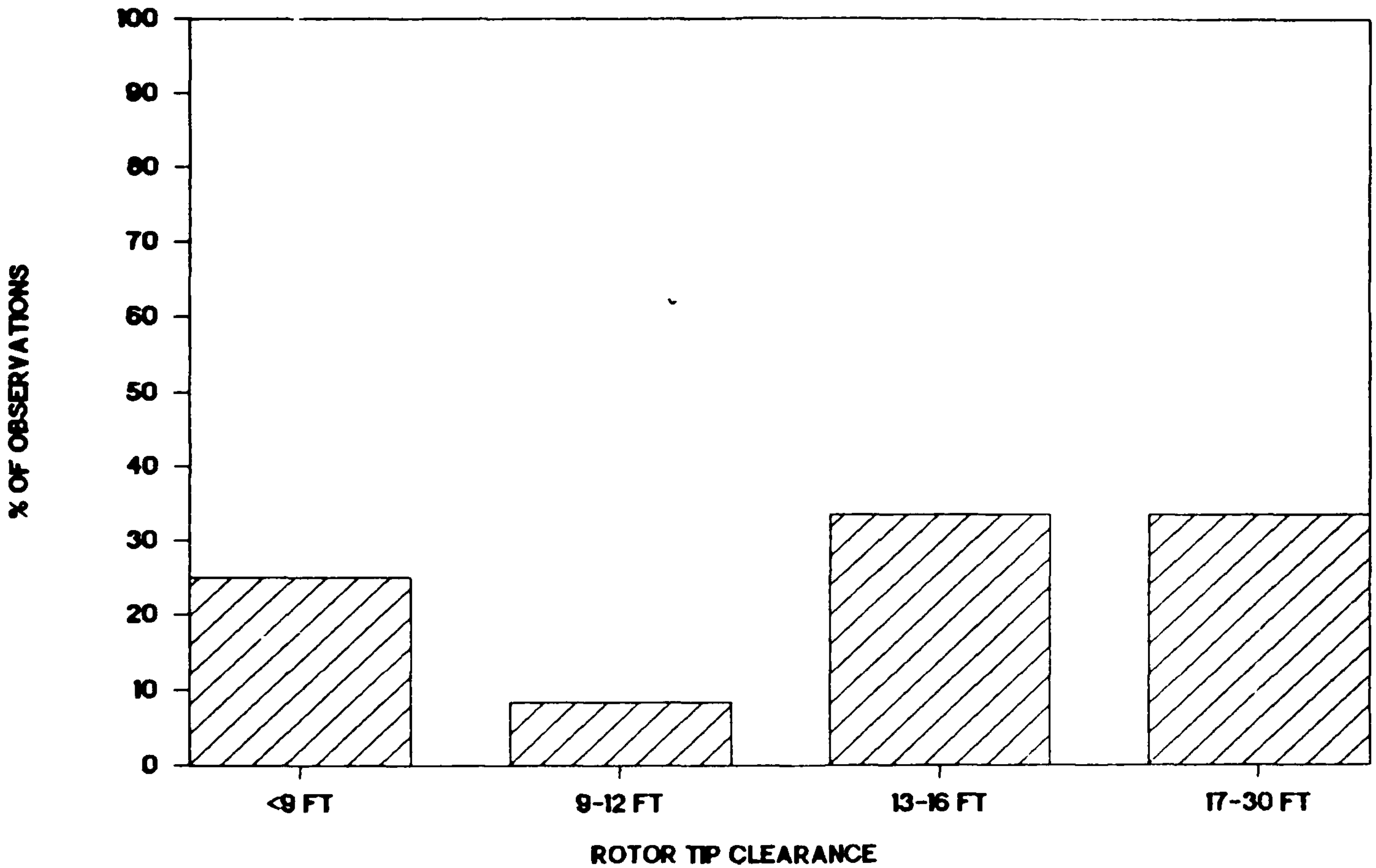


FIGURE 14. PILOT RESPONSES TO PREFERRED TIP CLEARANCE FOR HOVER TAXIING

marking procedure, and to 2 (of the 13) for the no marking procedure. These responses are found in figure 15.

Pilot comments received both during and following the flights involved maneuvering with the different wind conditions. Some commented they would not, under normal circumstances, park their aircraft next to an object with a tailwind. It was also felt that the crosswind procedures increased the workload and created more of a potential hazard. Other comments raised the issue of the obstacle's height. That is, it was felt that if the obstacle was much lower than tip path plane, then the pilot would feel comfortable parking closer. Additional concerns involved judging hover heights when hovering on a dark surface with no markings, and whether the obstacle was located to the right or left of the pilot.

PILOT INTERVIEW DATA.

Questions similar to those asked of subject pilots participating in the flight tests were asked of the 203 pilots interviewed across the country.

Responses to the question about tip clearances from an aircraft and from objects, relative to the subject's helicopter under head, tail, and crosswind conditions, are plotted in figures 16 and 17.

These plots indicate that the majority of the pilots interviewed preferred tip clearances greater than 1/3 rotor diameter under all three wind conditions. Only 19-31 percent of the responses indicate comfortable clearances of 1/3 rotor diameter or less from another aircraft. Comfortable clearances from an object were slightly less than those reported from an aircraft. Twenty-five through 41 percent of these responses were 1/3 rotor diameter or less. As expected, they reported comfortable clearances with a tailwind were greater than with head and crosswinds.

The histogram in figure 18 shows the responses to the question about markings for parking operations. Forty percent preferred a circle, while 21 percent preferred a straight line. Of the remaining: 11 percent preferred a circle with additional markings inside such as toe or shoulder lines, a straight line, a "T" or an "H"; 8 percent preferred a straight line along with additional markings such as a shoulder line, a nose line, a wheel mark, side markings, or distances listed; and 14 percent had other suggestions. Some of these other suggestions included, a T, an H, a square, a square with an H, a triangle with an H, or a cross. Appendix D contains drawings of some of these suggestions.

Preferences for skid height during hover taxiing ranged from 2 to 15 feet. However, as seen in figure 19, 88 percent of the responses fell between 3 and 5 feet.

None of the pilots interviewed felt a 20-foot tip clearance from an object during hover taxiing would present a problem. As seen in figure 20, only 9.5 percent answered they could maneuver with a 20-foot clearance, but would prefer not to. The preferred tip clearances given by these pilots ranged from 8 to 90 feet. Almost 60 percent of the pilots stated a tip clearance preference of 20 feet or greater. These figures are presented in figure 21.

Pilot comments concerning these questions addressed other factors such as aircraft type, weight and size, pilot experience, and pilot familiarization with

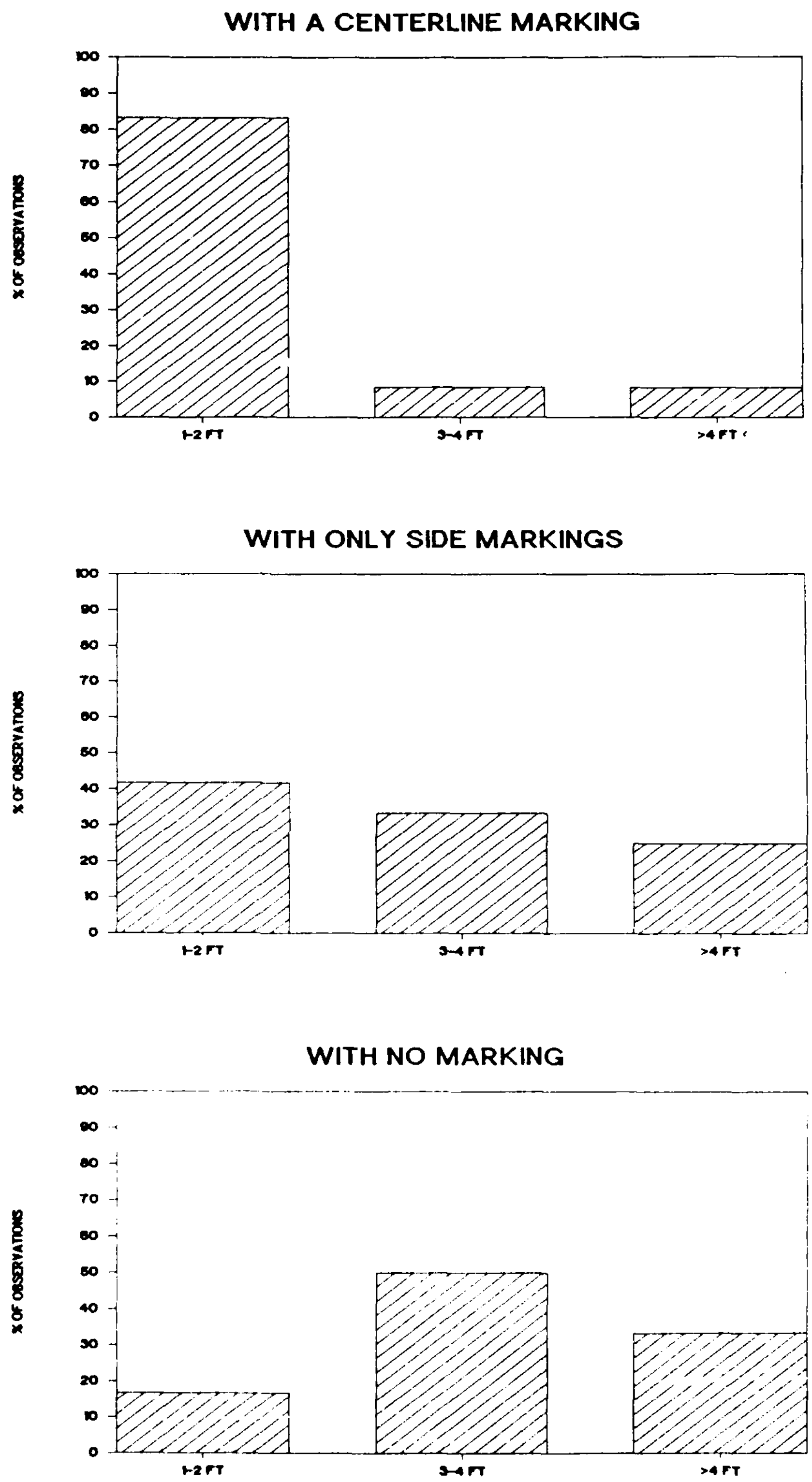


FIGURE 15. PILOT RESPONSES TO PERCEIVED LATERAL PATH DEVIATION USING DIFFERENT MARKINGS

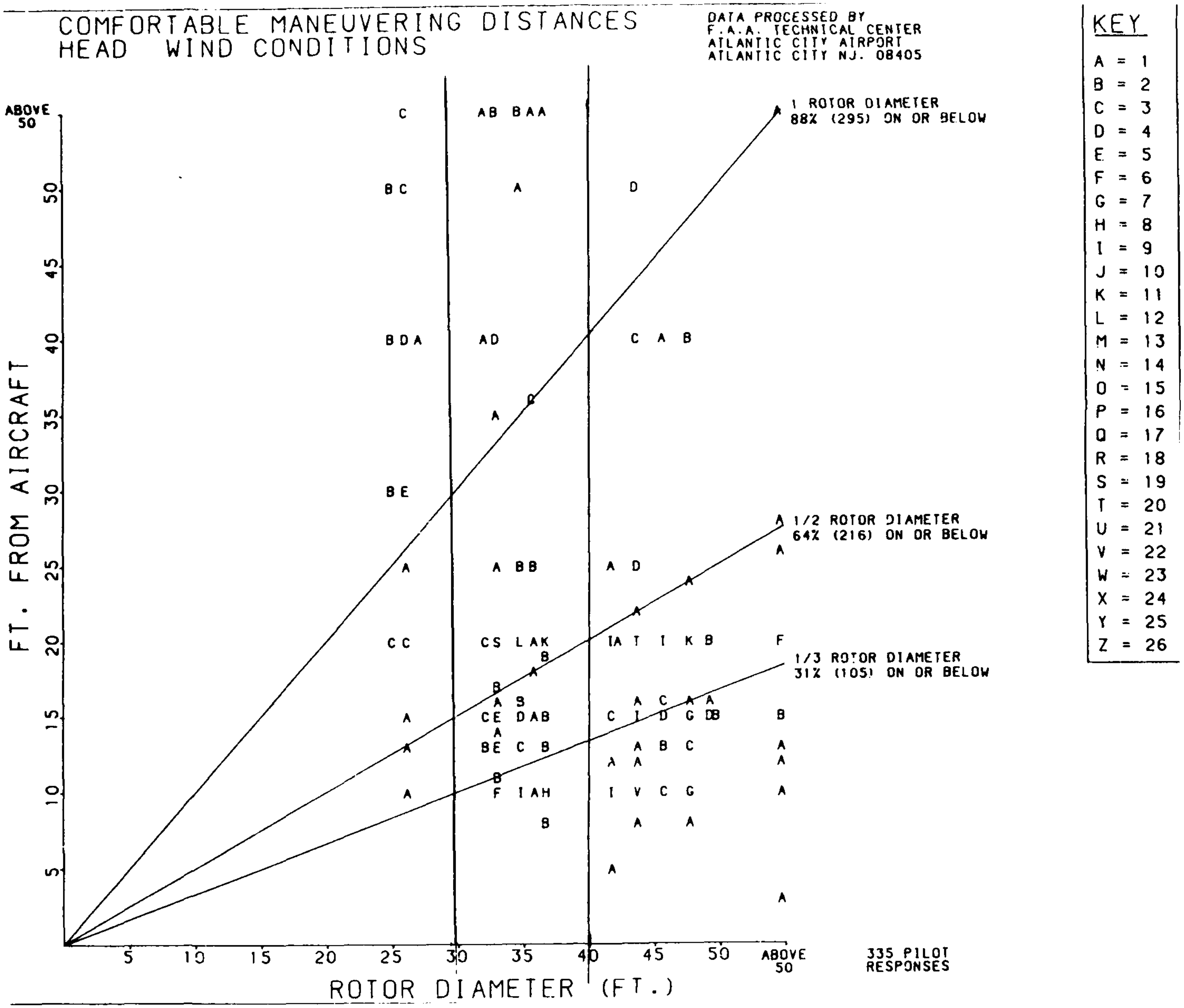
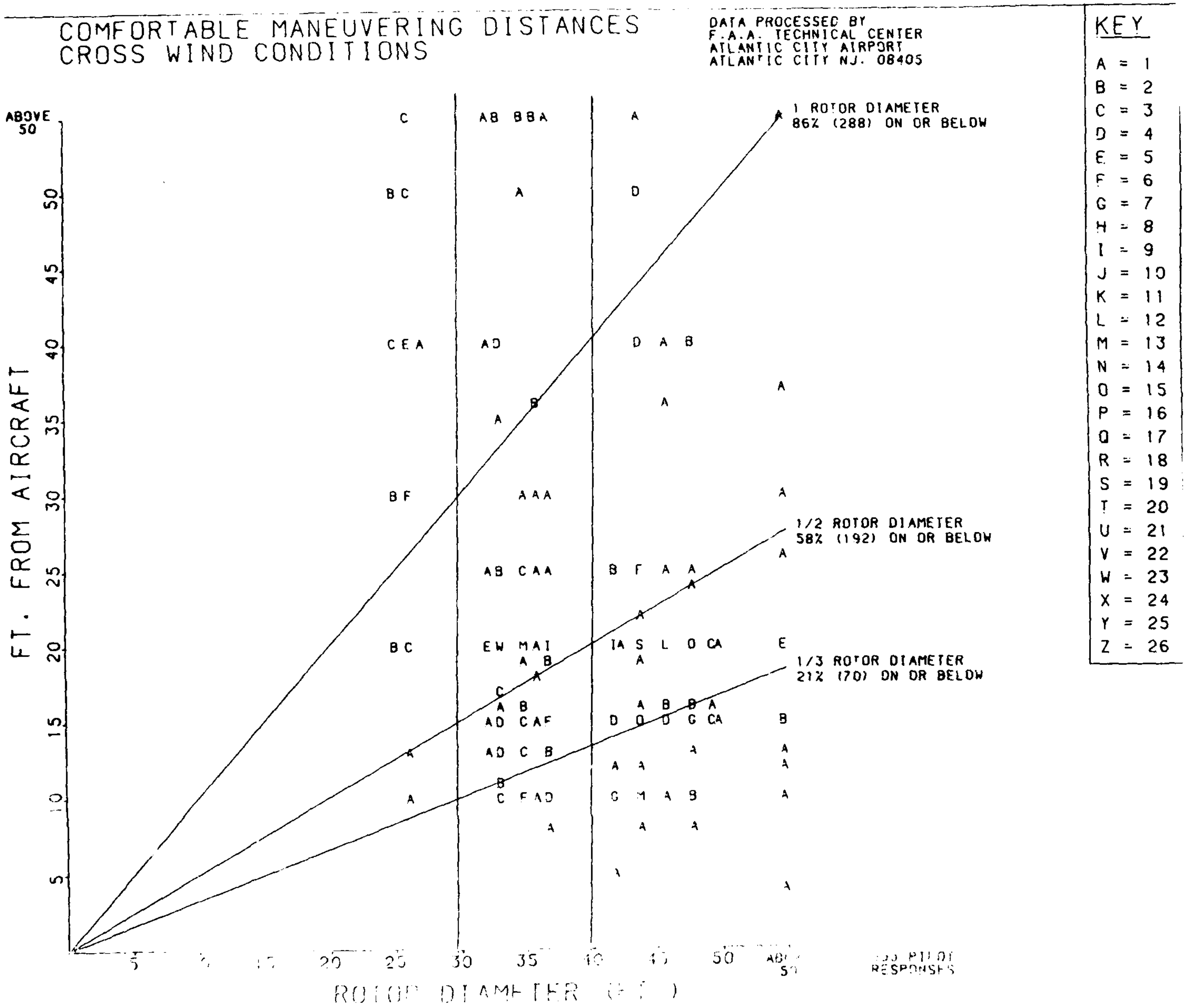


FIGURE 16. PILOT INTERVIEW RESPONSES TO SAFE ROTOR TIP CLEARANCES FROM AN AIRCRAFT (SHEET 1 OF 3)

COMFORTABLE MANEUVERING DISTANCES
CROSS WIND CONDITIONS



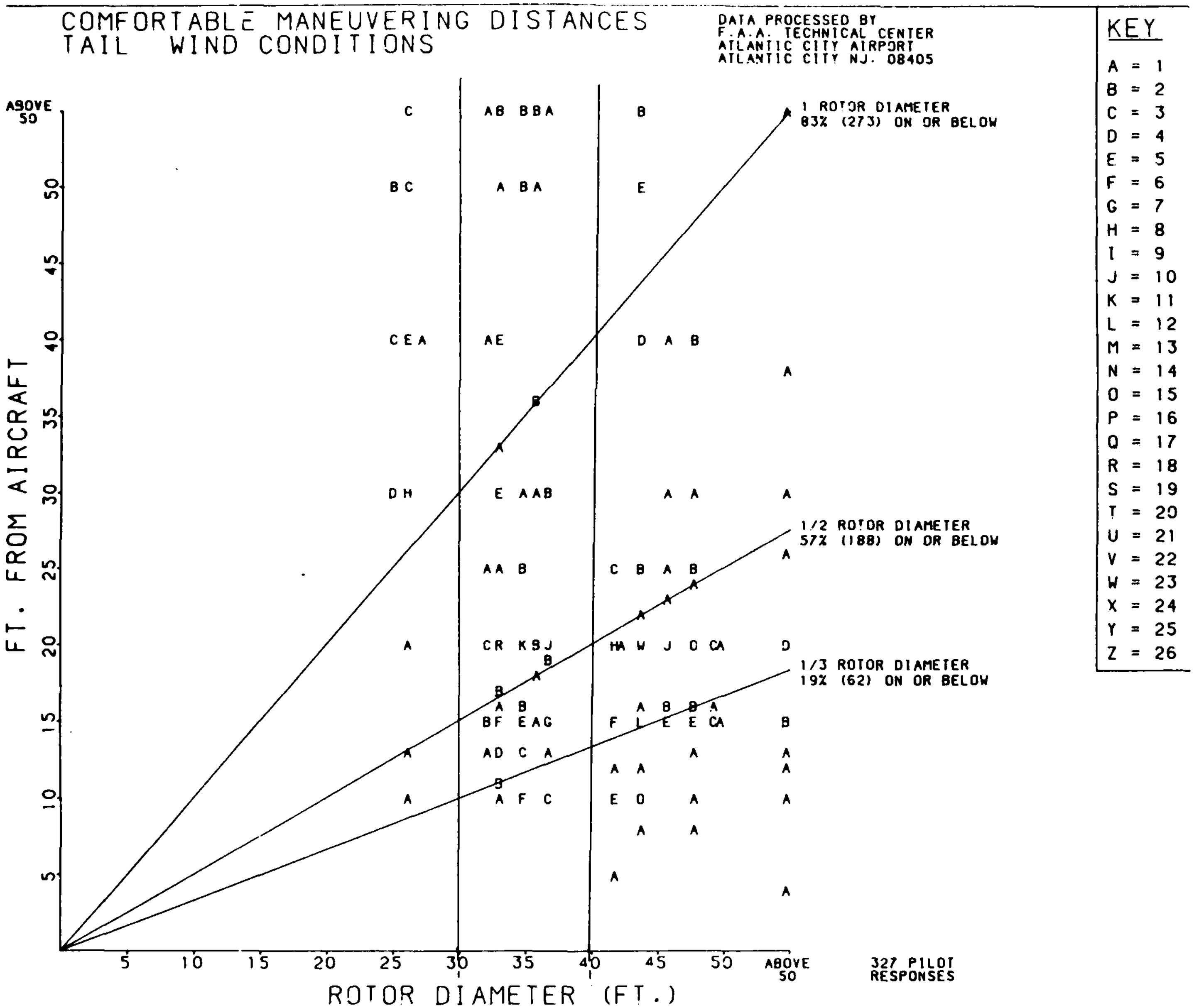
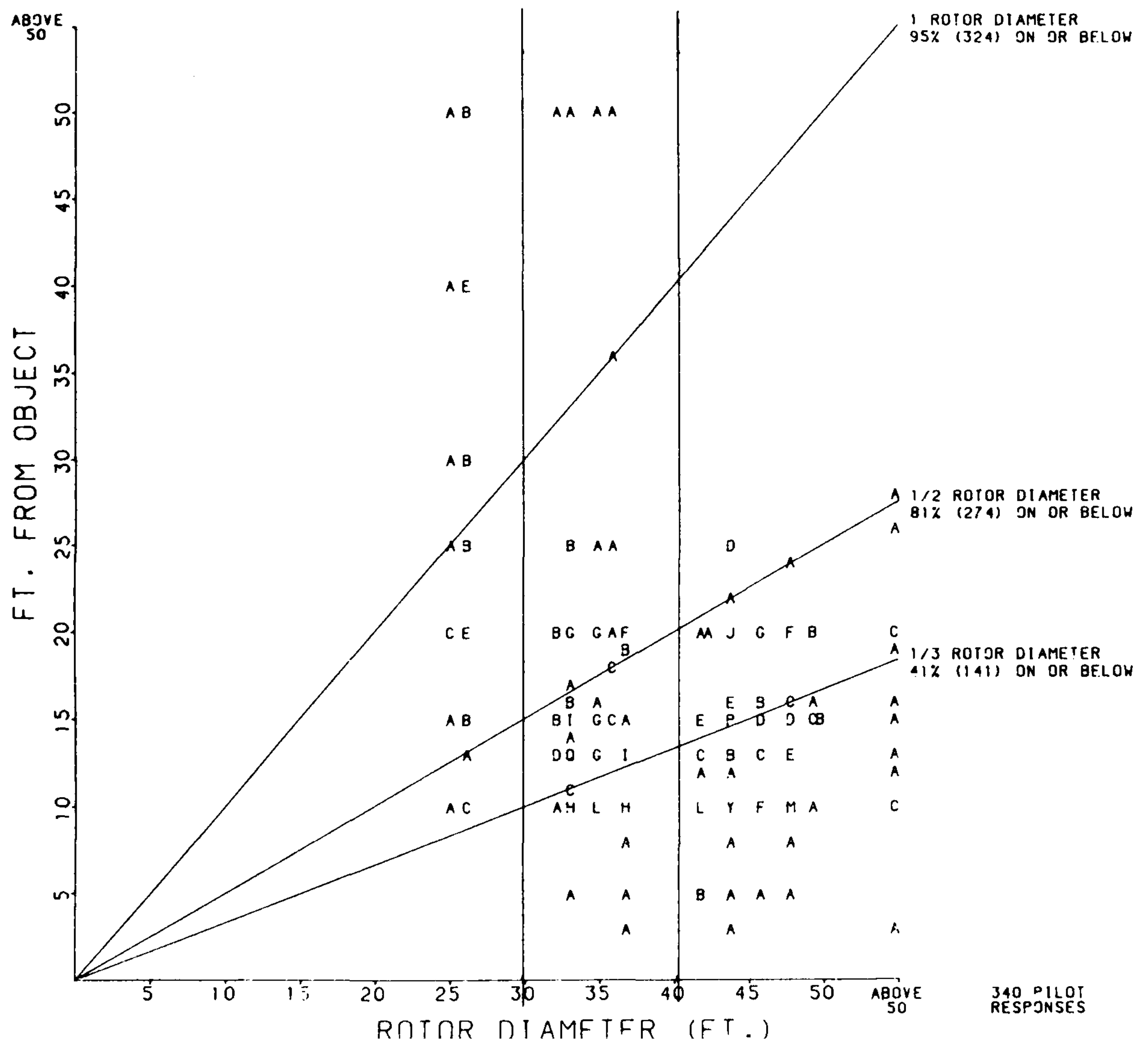


FIGURE 16. PILOT INTERVIEW RESPONSES TO SAFE ROTOR TIP CLEARANCE FROM

COMFORTABLE MANEUVERING DISTANCES
HEAD WIND CONDITIONS

DATA PROCESSED BY
F.A.A. TECHNICAL CENTER
ATLANTIC CITY AIRPORT
ATLANTIC CITY NJ. 08405



KEY

A = 1	N = 14
B = 2	O = 15
C = 3	P = 16
D = 4	Q = 17
E = 5	R = 18
F = 6	S = 19
G = 7	T = 20
H = 8	U = 21
I = 9	V = 22
J = 10	W = 23
K = 11	X = 24
L = 12	Y = 25
M = 13	Z = 26

FIGURE 17. PILOT INTERVIEW RESPONSES TO SAFE ROTOR TIP CLEARANCES FROM AN OBJECT (SHEET 1 OF 3)

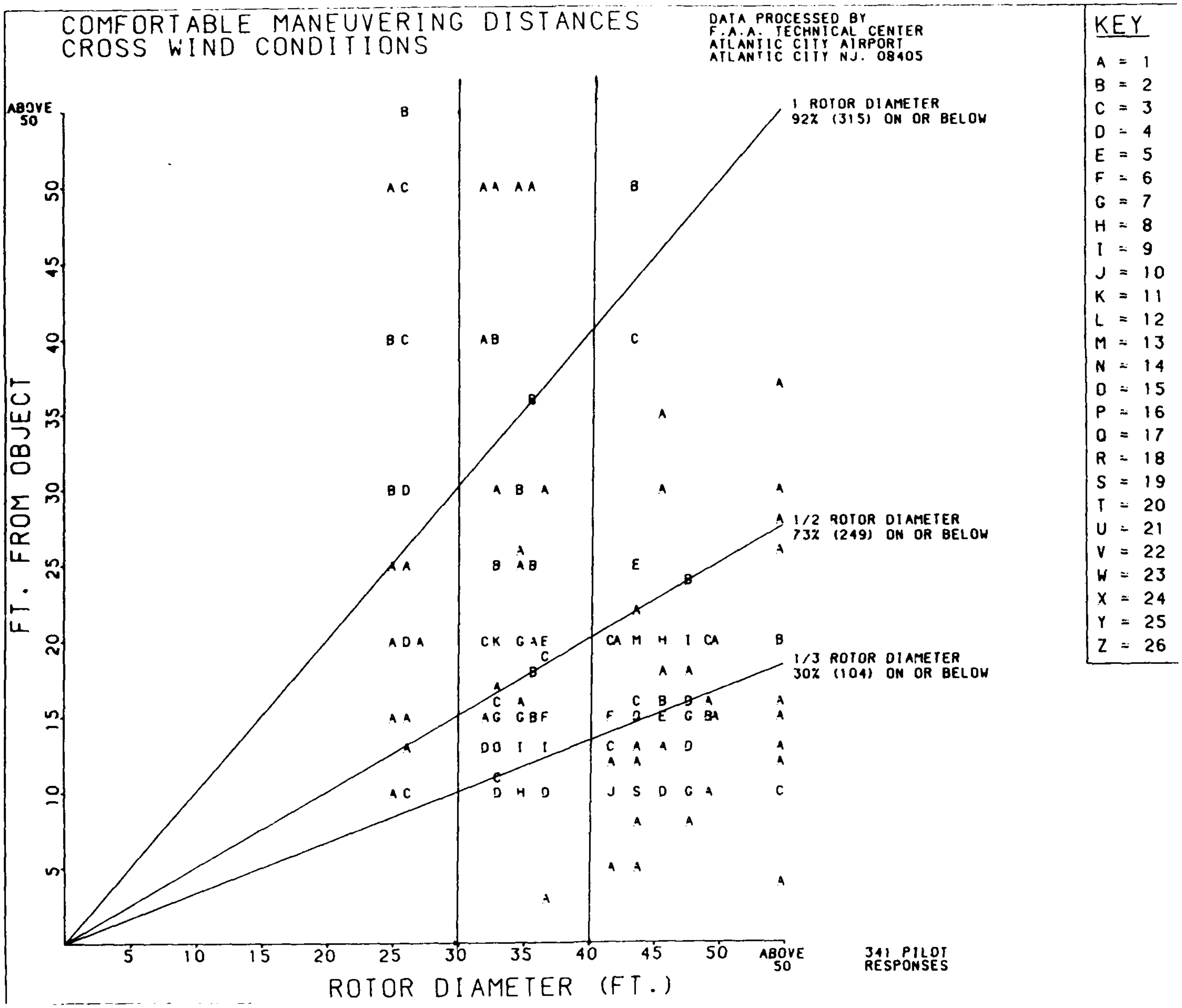


FIGURE 17. PILOT INTERVIEW RESPONSES ...
AN OBJECT (SHEET 2 OF 3)

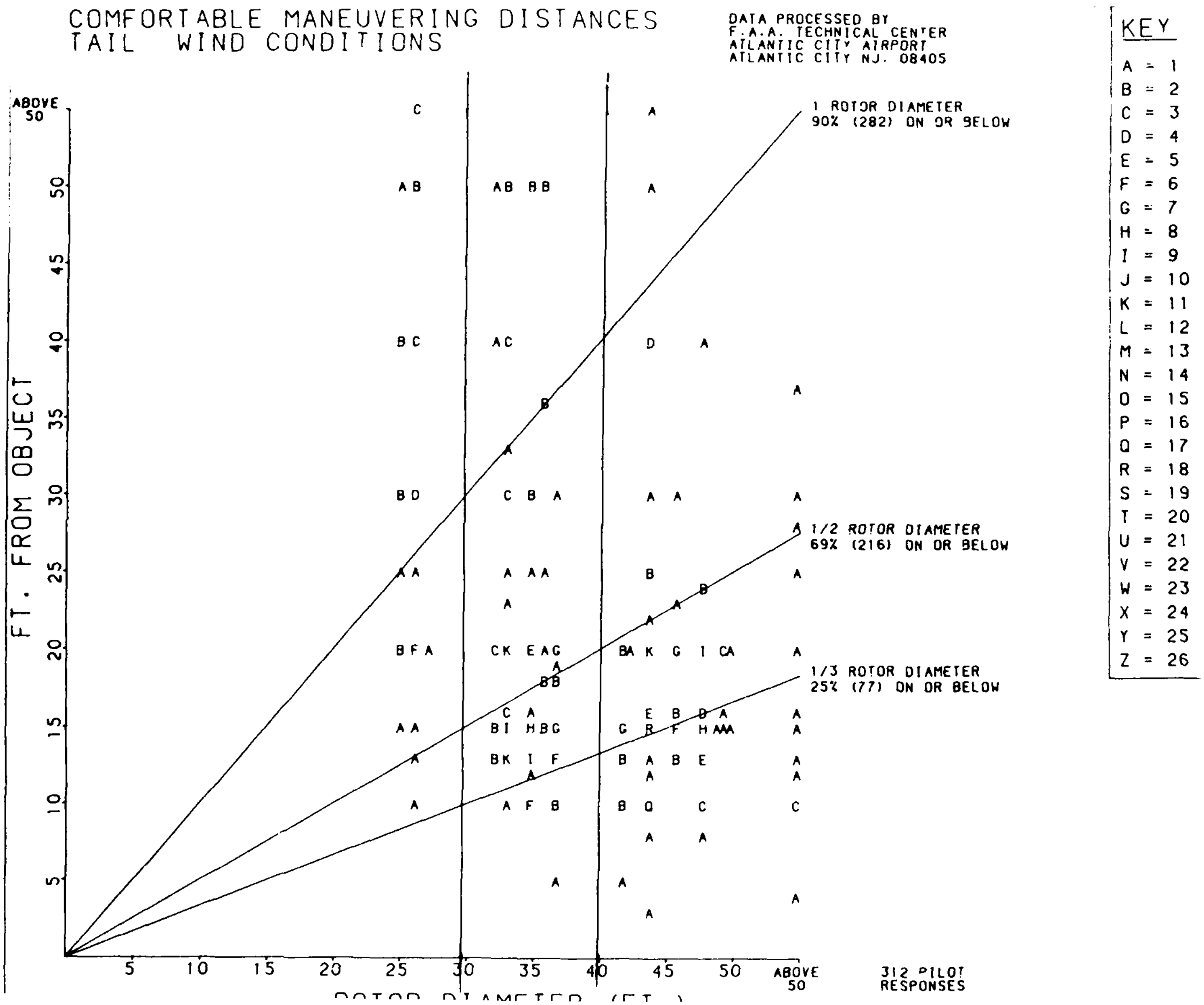


FIGURE 17. PILOT INTERVIEW RESPONSES TO SAFE ROTOR TIP CLEARANCES FROM AN OBJECT (SHEET 3 OF 3)

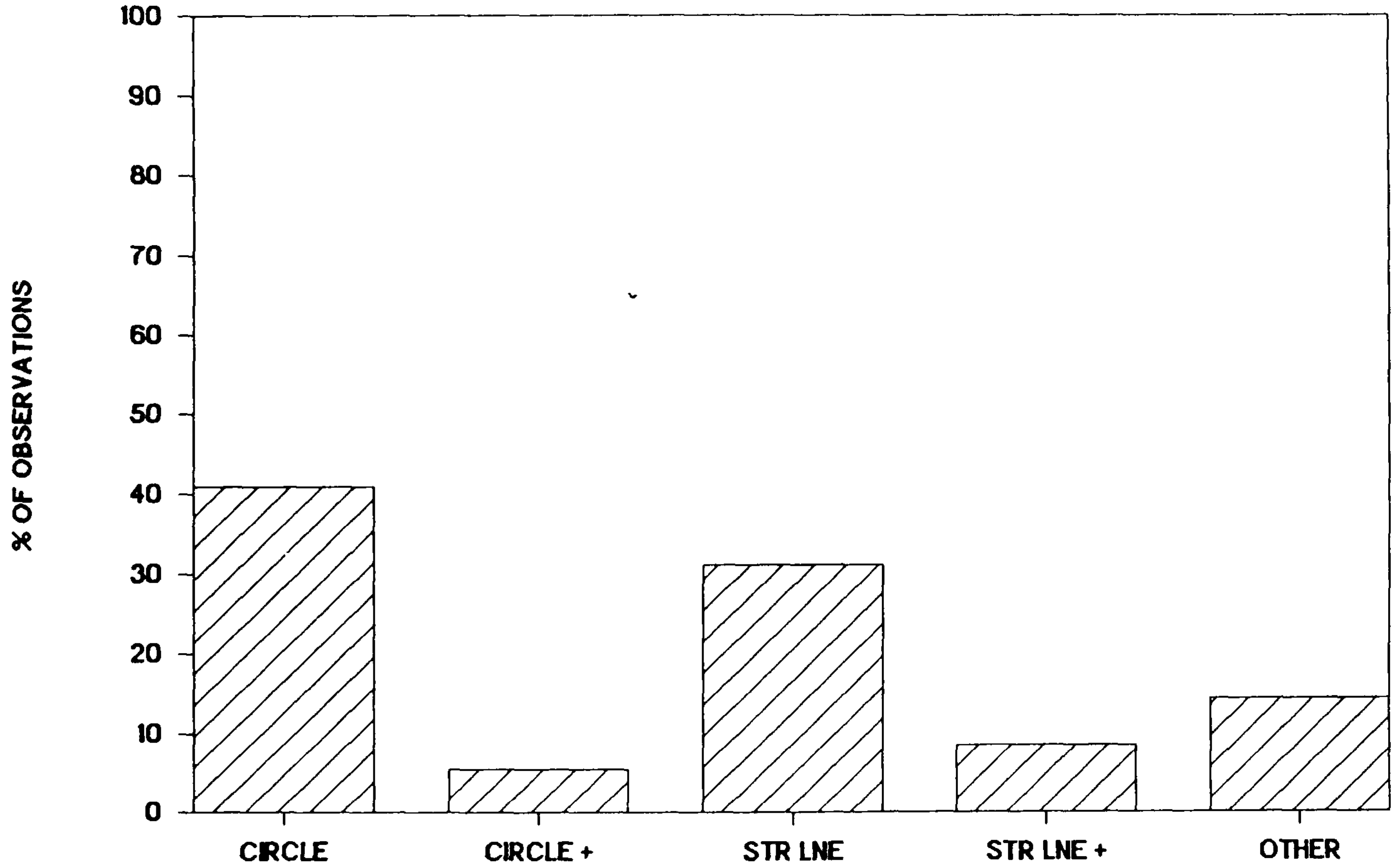


FIGURE 18. PILOT INTERVIEW RESPONSES TO PREFERRED GROUND MARKINGS

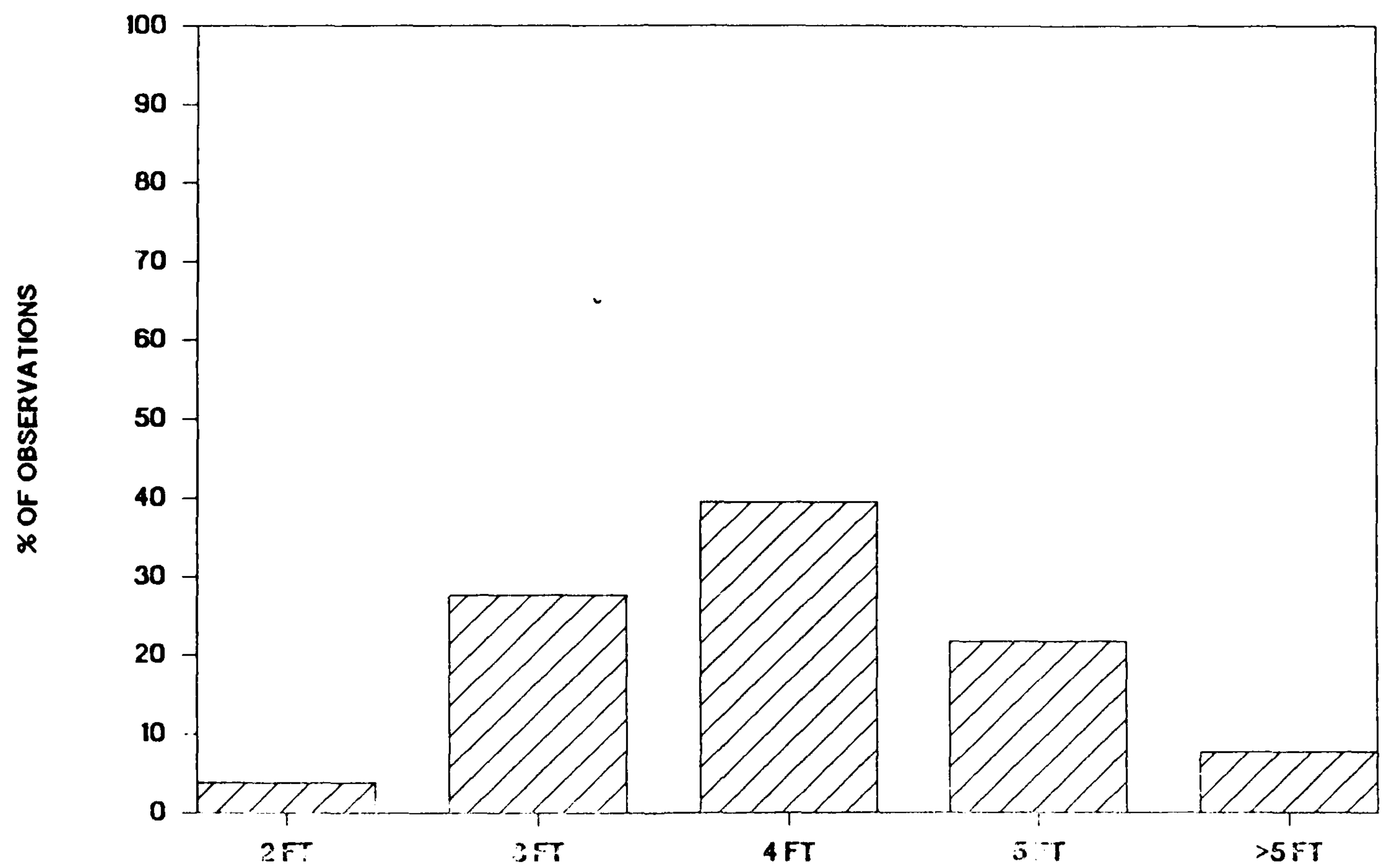


FIGURE 10. PILOT INTERVIEW RESPONSES TO PREFERRED SKID HEIGHTS DURING [illegible]

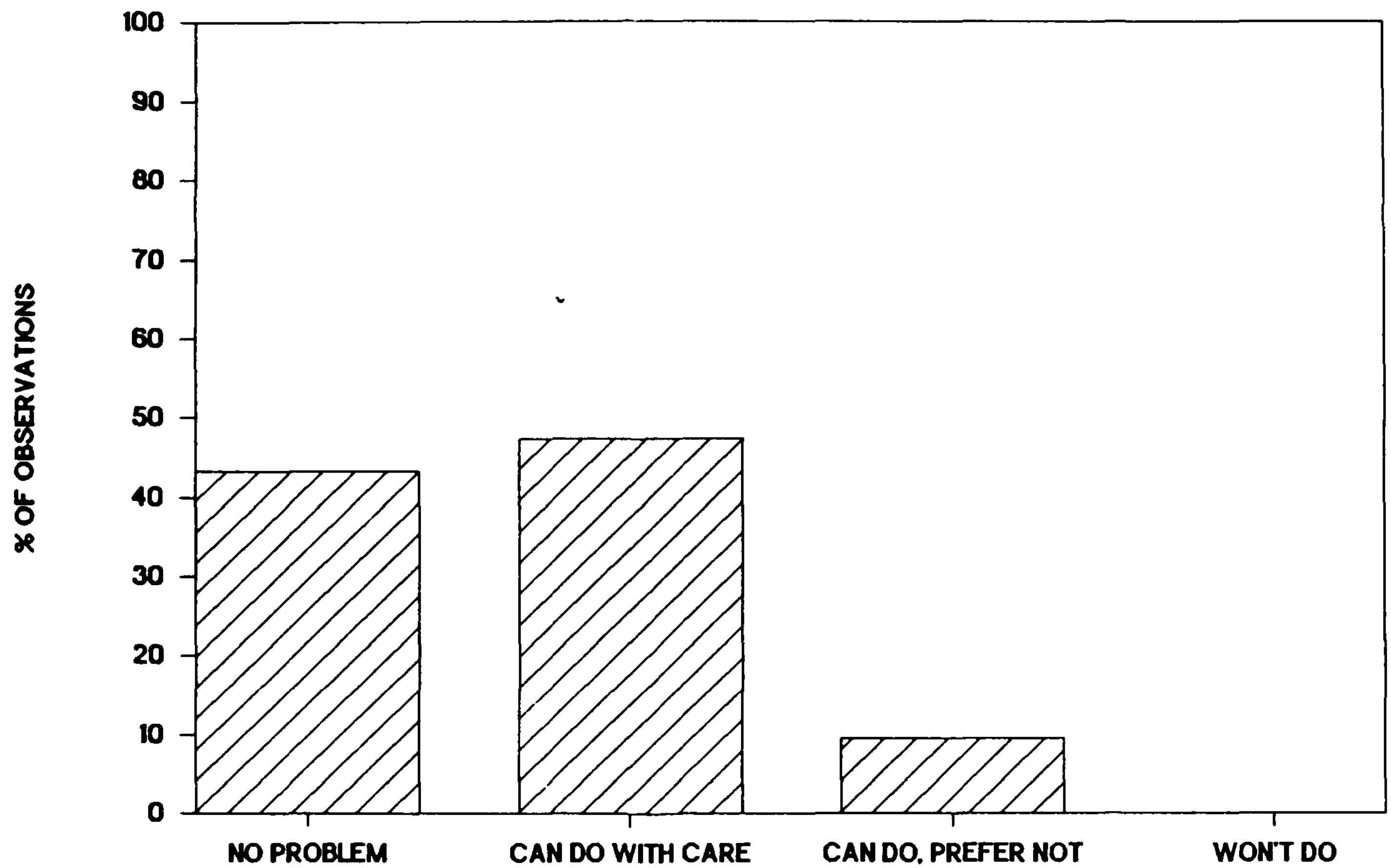
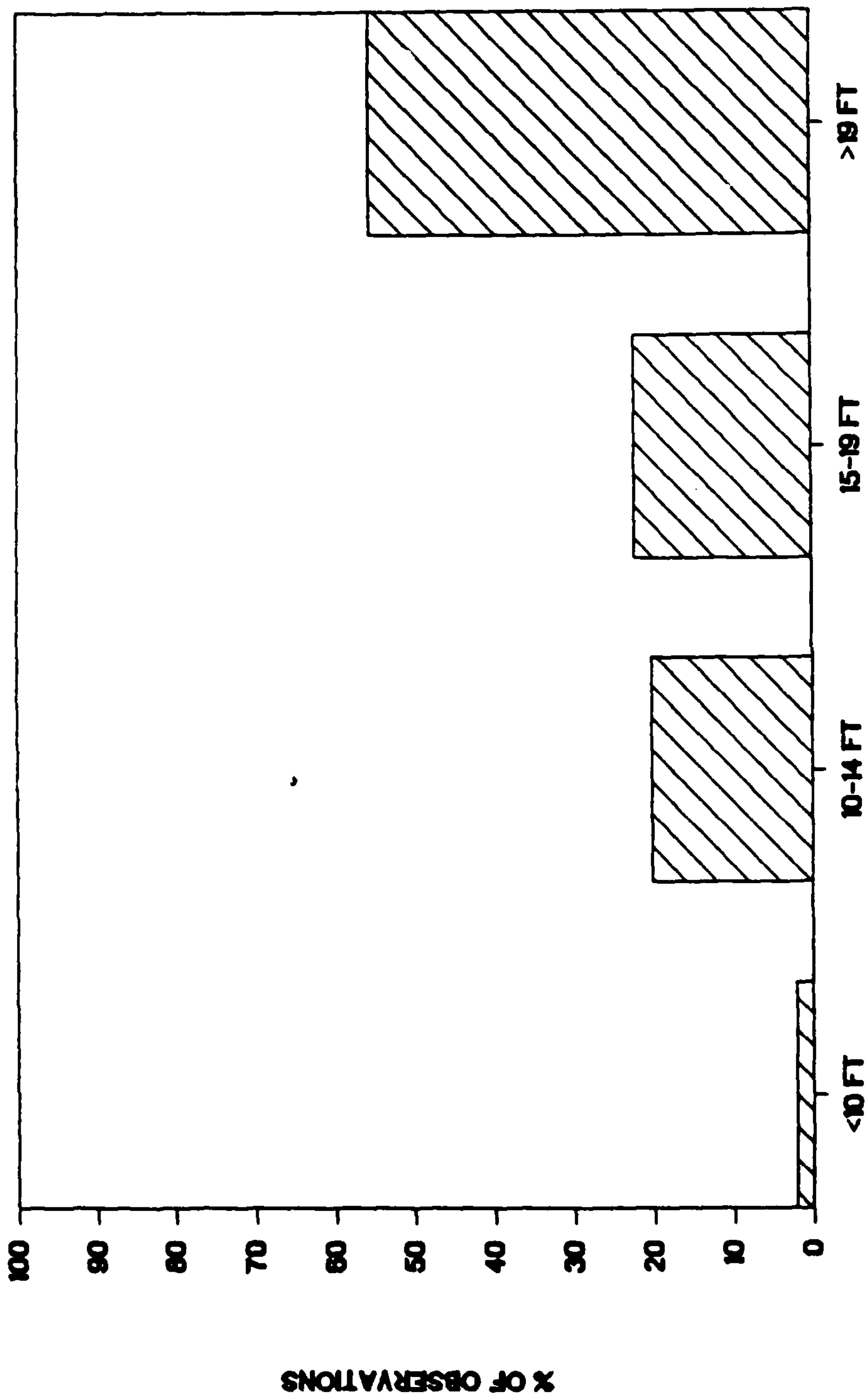


FIGURE 20. PILOT INTERVIEW RESPONSES TO TAXIING WITH 20-FOOT ROTOR TIP


% OF OBSERVATIONS
0
10
20
30
40
50
60
70
80
90
100
<10 FT
10-14 FT
15-19 FT
>19 FT

the heliport. These variables were discussed primarily in reference to the safe tip clearance for parking and for hover taxiing. The type heliport surface was also mentioned as influencing the tip clearance for parking along with the type obstacle, its location in reference to the aircraft, and how well the obstacle is secured.

Additional issues raised pertaining to type ground markings included the adequacy and standardization of the markings. It was felt the parking spots should be adequately marked so a pilot will not encroach on the space of the next parking spot. Pilots also felt it would be helpful to have lines indicating the direction of parking as well as lines indicating the direction of movement to and from the parking areas.

In relation to tip clearances for parking and taxiing, several pilots felt it was important to have sufficient clearance to perform a 360^{o} pedal turn without infringing on another aircraft, obstacle, or parking space.

It must be remembered that no matter what marking schemes are used for parking or taxiing, it is still up to the pilot to make sure the aircraft is clear of objects.

HELIPORT OBSERVATIONS.

Many observations concerning ground markings and operations were noted during the heliport visits in NY, NJ, LA, and TX. One feature seen at a few of the facilities was the walkway markings for pedestrian movement in and around the helicopters. At three of the heliports these paths were in front of the aircraft's nose, which provided for good pilot visibility of passenger ingress/egress from the parking area.

Another observation concerned the operations area found at most of the heliports. The value of complete visibility for safe directing of aircraft on the ground as well as in the approach/departure airspace was noted, particularly at facilities with multiple approach and departure paths or with separate approach and departure paths.

A feature considered a problem by pilots was the obstructions placed on or near the landing and parking areas. It was felt that the chain linked fences and buildings at some facilities were too close to the marked parking and taxiing areas for normal ground maneuvers. At another heliport the curbing placed around the parking area was considered a hazard to the aircraft's tail. Of the heliports visited, no two had the same ground marking schemes. In some cases, the ground markings were not consistent at different areas of the same heliport.

CONCLUSIONS

1. Given the requirement of 1/3 rotor diameter tip clearance from an obstacle, the majority of the 13 subject pilots would be comfortable with the criteria when parking a UH-1H. However, the 203 pilots interviewed were considerably more conservative in their preferences for rototip clearances than the 13 UH-1H subject pilots. Depending on wind conditions and on whether or not the object was an aircraft, between 5 - 17 percent said that they were uncomfortable with tip clearances less than one rotor diameter.

2. Prevailing winds play a major role in pilot parking and hover taxiing performance. Pilots felt the crosswind procedures tended to increase their workload and was perceived as a potential hazard. These winds must be accounted for when developing spacing requirements for ground maneuvering at any particular heliport when hovering rather than ground taxiing into parking is required.

3. When maneuvering near an obstacle, pilots tend to be conservative in their estimate of tip clearance from that object. With only a ground mark to judge by, the pilots tended to overestimate their clearances. Again, wind conditions play a major role in their estimates.

4. When required to maneuver a given distance from an obstacle, the pilots tended to underestimate their tip clearances, i.e. they were further from the object than was called for. They also tended to underestimate their clearances from the ground mark, but not to the same extent as with the obstacle in place. The variabilities in their performance both with and without the obstacle, however, were large, indicating a need for conservative clearance requirements at heliports.

5. Taxiway marking schemes have an impact on pilot perception and performance. There is a noticeable difference in the skid heights maintained between the schemes with either a centerline or side markings and the scheme with no markings. The variability in skid height, ground speed, perception error, and performance error were much larger when there were no markings present.

6. When hover taxiing over the grass area with no markings, the pilots depth perception was affected and they perceived their skids as being significantly lower than their actual measured height. This perception problem must be considered in the planning of taxiroutes at heliports, particularly if the taxiroute is unpaved.

7. Pilots felt their performance, in terms of their lateral path, decreased when taxiing with no ground markings for guidance.

8. A significant number of pilots expressed a preference for 20-foot or greater tip clearance for hover taxiing. This indicates a need to be conservative in the planning of taxiroutes in the vicinity of obstacles.

9. Regardless of the markings used to direct parking operations, it is vital that the areas designated be consistently marked so all pilots will understand what is being depicted. When possible, it would also be valuable to have direction lines placed near the parking areas to aid in the directing of traffic flow.

10. Another consideration when planning the heliport must be the height and type of obstructions that will be near the taxi routes, parking areas, and landing/takeoff areas. These areas must be as obstruction free as possible and any equipment or necessary safety devices that must be in the area should be kept to a minimum.

11. Not only must the prevailing winds be taken into consideration when planning the heliport environment, but the type and size aircraft for which it is intended must also be given priority. This could mean that the access to the heliport will be limited based on size and type.

12. All conclusions drawn from the parking and taxiing tests are based on flights conducted under daylight conditions only without the possible effects of rotorwash from other maneuvering helicopters. Further testing under night or limited visibility conditions need to be conducted to either validate or modify the conclusions drawn here.

13. Since the parking and taxiing tests were conducted using only the UH-1H, additional tests should be carried out using a helicopter of at least 10,000 pounds maximum gross weight, such as the Sikorsky S-76, to verify or modify these conclusions.

APPENDIX A

TEST FLIGHT LOG

VMC TAXI/PARK-T0701R

DATE: SUBJ PILOT: A/C # (LEAD BAGS)

FLT #: VMC ___ .576 .UHT SAFETY PILOT: LASER TKR—TAXI ONLY

RUN #	TYPE	WINDS	# SPOT	START TIME	STOP TIME	YOUR SAFE DIST	YOUR EST. DIST	ACTUAL DIST/HOVER	SPOT M-DIST	SPOT M DIST
1	H/W TRUCK				X					
2	C/W				X					
3	¢ TAXI		DIRECTION			YOUR HOVER HIGH			X	
4	¢ TAXI		DIRECTION			YOUR HOVER HIGH			X	
5	T/W TRUCK				X					
6	H/W				X					
7	OFF/¢		DIRECTION			YOUR HOVER HIGH			X	
8	OFF/¢		DIRECTION			YOUR HOVER HIGH			X	
9	C/W TRUCK				X					
10	T/W				X					
11	TIRE ¢		DIRECTION			YOUR HOVER HIGH			X	
12	TIRE ¢		DIRECTION			YOUR HOVER HIGH			X	
						OUR CHOICE	YOUR GUESS			
13	H/W TRUCK				X	12'				
14	C/W				X	12'				
15	¢ TAXI		DIRECTION			OUR HOVER 6'			X	
16	¢ TAXI		DIRECTION			OUR HOVER 6'			X	
17	T/W TRUCK				X	12'				
18	H/W				X	12'				
19	OFF ¢		DIRECTION			OUR HOVER 6'			X	
20	OFF ¢		DIRECTION			OUR HOVER 6'			X	
21	C/W TRUCK				X	12'				
22	T/W				X	12'				
23	TIRE ¢		DIRECTION			OUR HOVER 6'			X	
24	TIRE ¢		DIRECTION			OUR HOVER 6'			X	

APPENDIX B

POST-FLIGHT QUESTIONNAIRE

HELICOPTER VISUAL METEOROLOGICAL CONDITIONS (VMC)

PARKING/TAXIING QUESTIONNAIRE

AIRCRAFT TYPE: ______________________________

OPERATIONAL PILOT QUALIFICATIONS

NAME: ______________________________

AFFILIATION: ______________________________

ADDRESS: ______________________________

CITY: ______________ STATE: ________ ZIP: ________

PHONE (OPTIONAL) ______________________________

FAA HELICOPTER RATINGS: ______________________________

____

TOTAL FLIGHT HOURS: ______________________________

TOTAL HELICOPTER HOURS: ______________________________

TOTAL TIME IN TYPE: ______________________________

TOTAL HELICOPTER HOURS LAST 6 MONTHS: ______________________________

TIME IN TYPE LAST 6 MONTHS: ______________________________

QUESTIONS

PARKING:

1. How comfortable did you feel parking 12 feet from the line:

a. with a headwind?

1	2	3	4	5
NOT COMFORTABLE		SOMEWHAT		OK- NO PROBLEM

b. with a tailwind?

1	2	3	4	5
NOT COMFORTABLE		SOMEWHAT		OK- NO PROBLEM

c. with a crosswind?

1	2	3	4	5
NOT COMFORTABLE		SOMEWHAT		OK- NO PROBLEM

2. How comfortable did you feel parking 12 feet from the obstacle:

a. With a Headwind?

1	2	3	4	5
NOT COMFORTABLE		SOMEWHAT		OK- NO PROBLEM

b. With a tailwind?

1	2	3	4	5
NOT COMFORTABLE		SOMEWHAT		OK- NO PROBLEM

c. With a crosswind?

1	2	3	4	5
NOT COMFORTABLE		SOMEWHAT		OK- NO PROBLEM

3. When parking in close proximity to an object what do you consider the minimum safe rotor tip clearance: (in feet)

a. with a headwind?

b. with a tailwind?

c. with a crosswind?

TAXIING:

1. What is your preferable skid height for hover taxiing? (in feet)

2. A 20 foot rotor tip clearance from an obstacle for hover taxiing is:

a. OK-No Problem

b. Can do it with care

c. Can do it, but prefer not

d. Too close- won't do it

3. In your opinion what is the minimum safe rotor tip clearance from an obstacle while hover taxiing? (in feet)

4. Do you feel your taxiing performance decreased

a. from centerline to off centerline?

b. from markings, either centerline or side markings, to none?

5. How far laterally do you think your path deviated

a. when you had a centerline marking?

b. when you had only side markings?

c. when you had no markings?

COMMENTS:

ERRATA

Replaces original Appendix C in AD A214 1..

Report No. DOT/FAA/CT-TN88/30

HELIPORT SURFACE MANEUVERING TEST RESULTS

June 1989

Technical Note

Prepared by
U.S. Department of Transportation
Federal Aviation Administration
Technical Center
Atlantic City International Airport, N.J. 08405

New Appendix C attached.

Released November 19

APPENDIX C

PHOTOS AND DRAWINGS OF THE HELIPORTS VISITED

LIST OF ILLUSTRATIONS

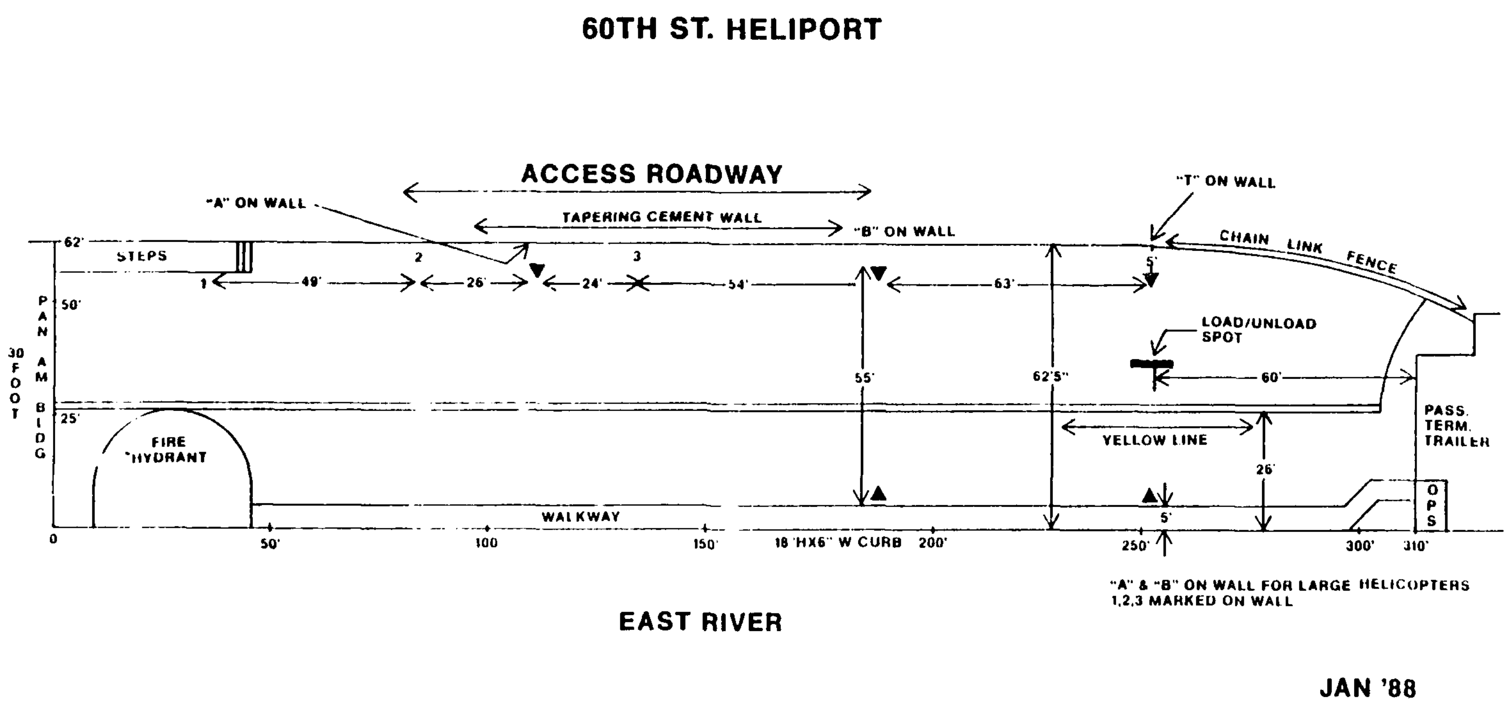


FIGURE C-1. LAYOUT OF 60TH STREET HELIPORT, NEW YORK CITY

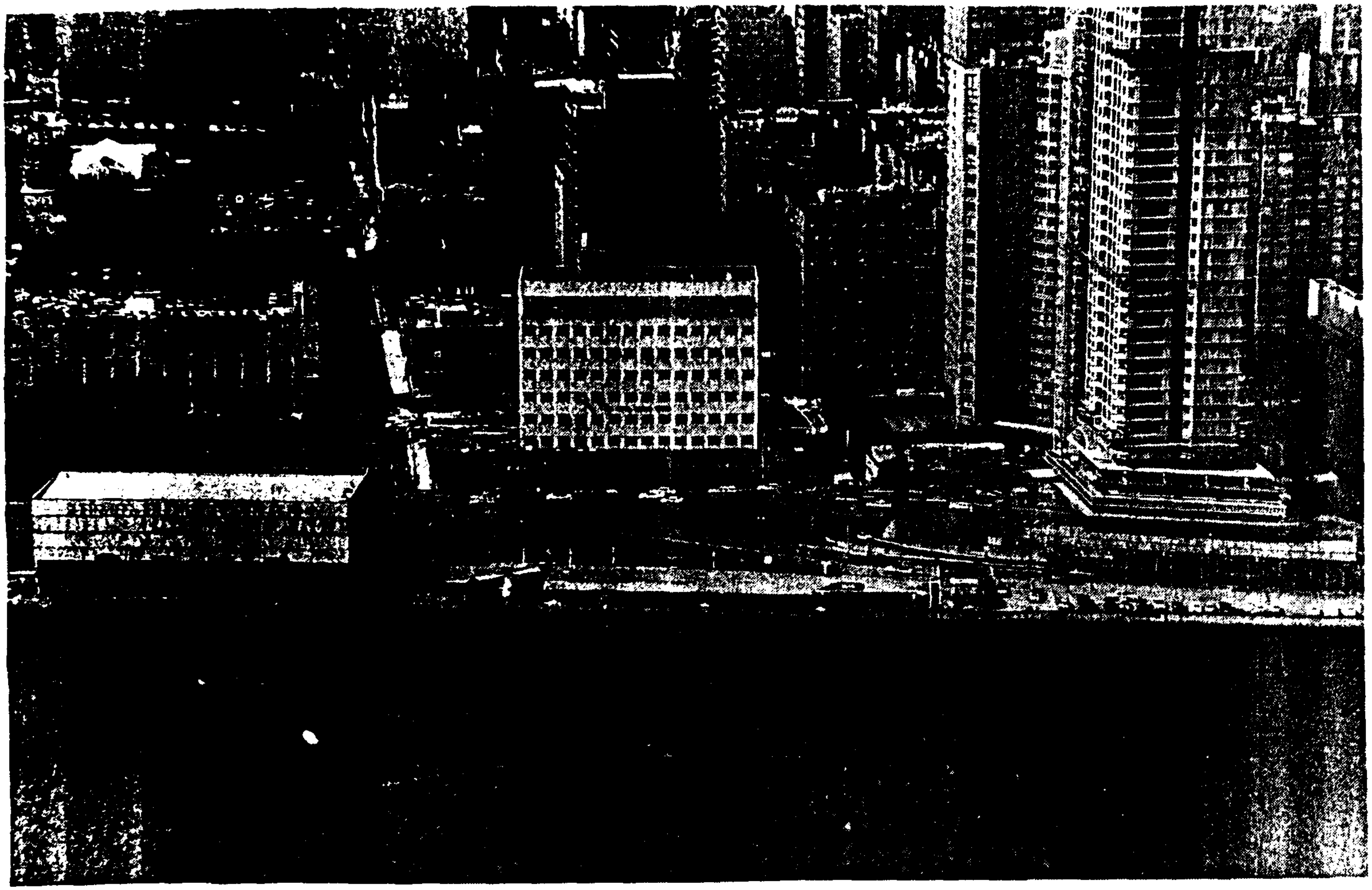


FIGURE C-2. AERIAL PHOTOGRAPH OF 60TH STREET HELIPORT, NEW YORK CITY

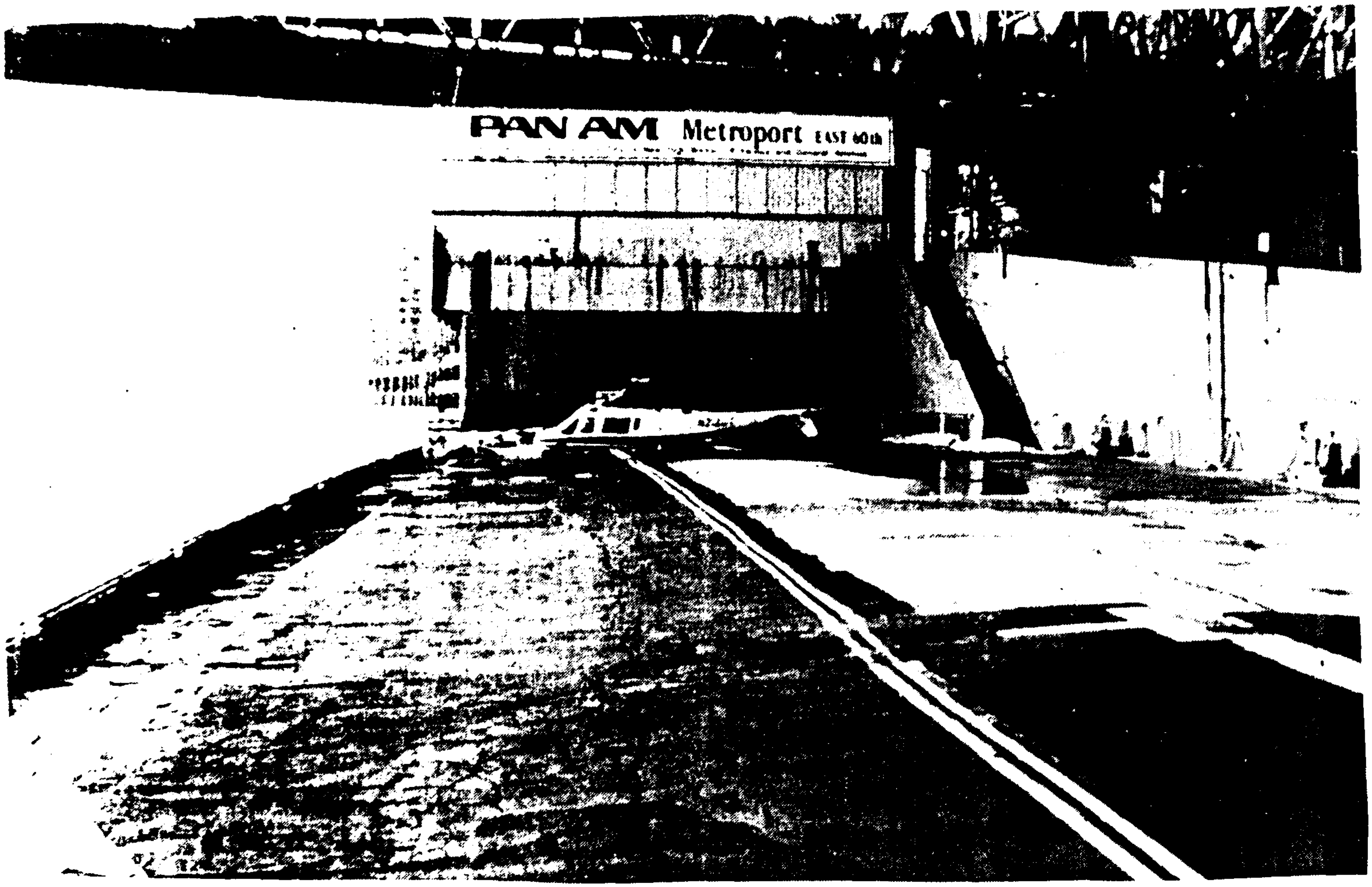


FIGURE C-3. PHOTOGRAPH OF 60TH STREET HELIPORT, NEW YORK CITY, LOOKING SOUTH

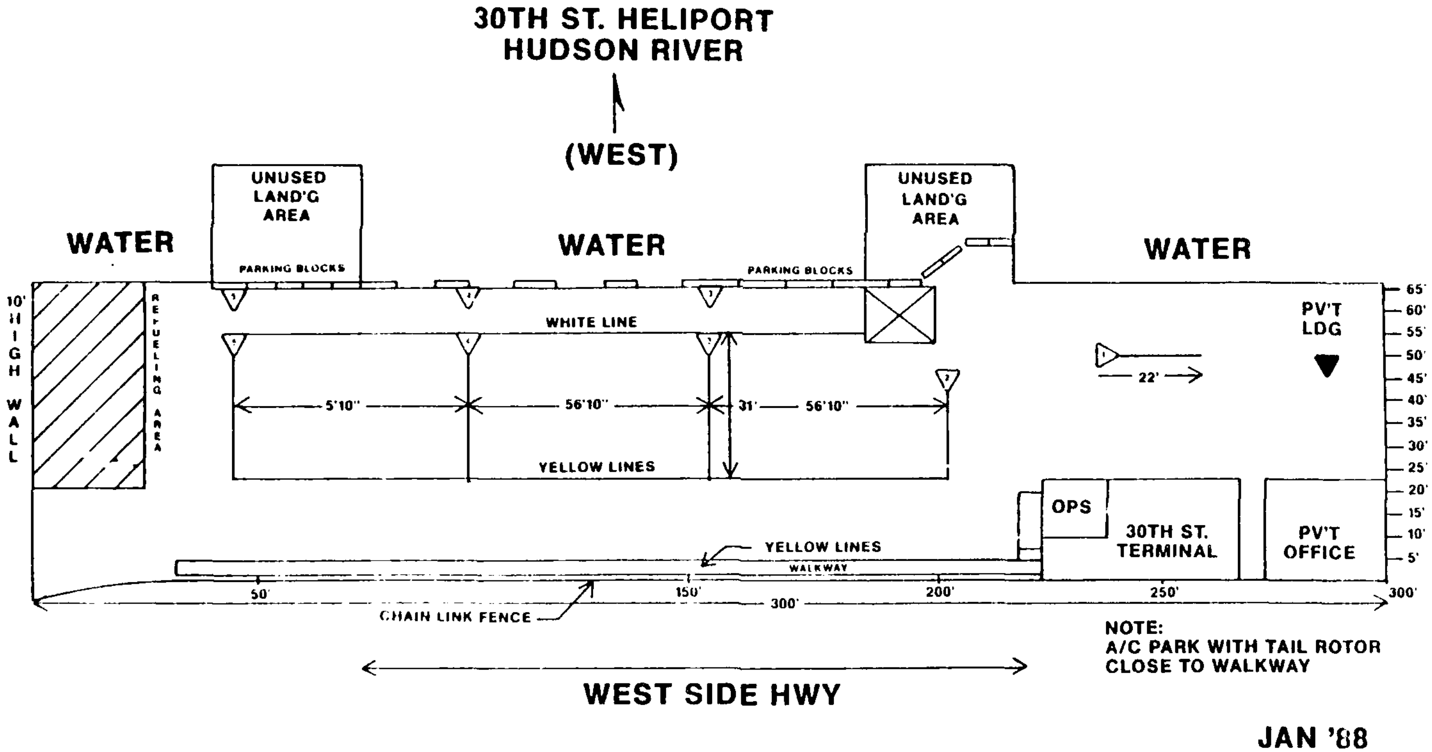


FIGURE C-4. LAYOUT OF 30TH STREET HELIPORT, NEW YORK CITY

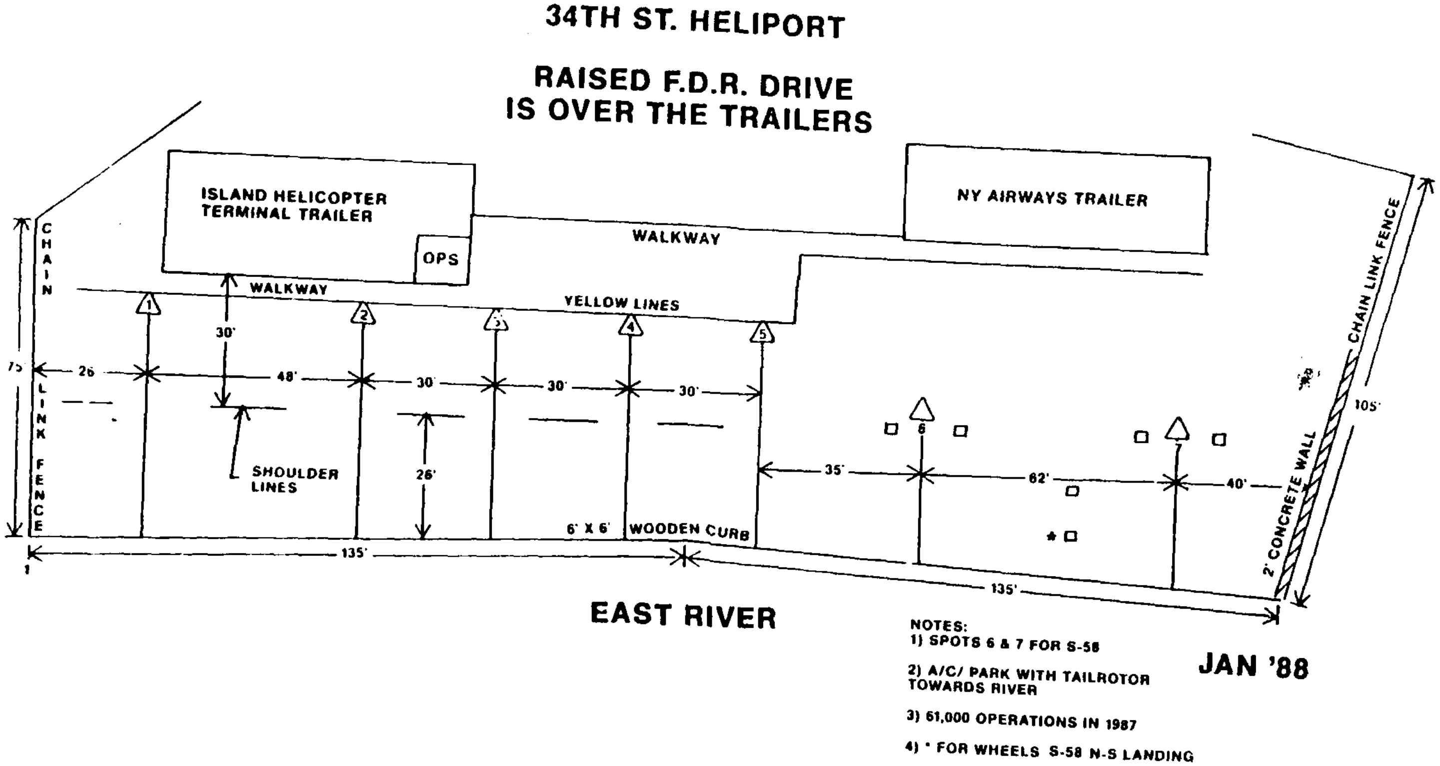


FIGURE C-5. LAYOUT OF 34TH STREET HELIPORT, NEW YORK CITY

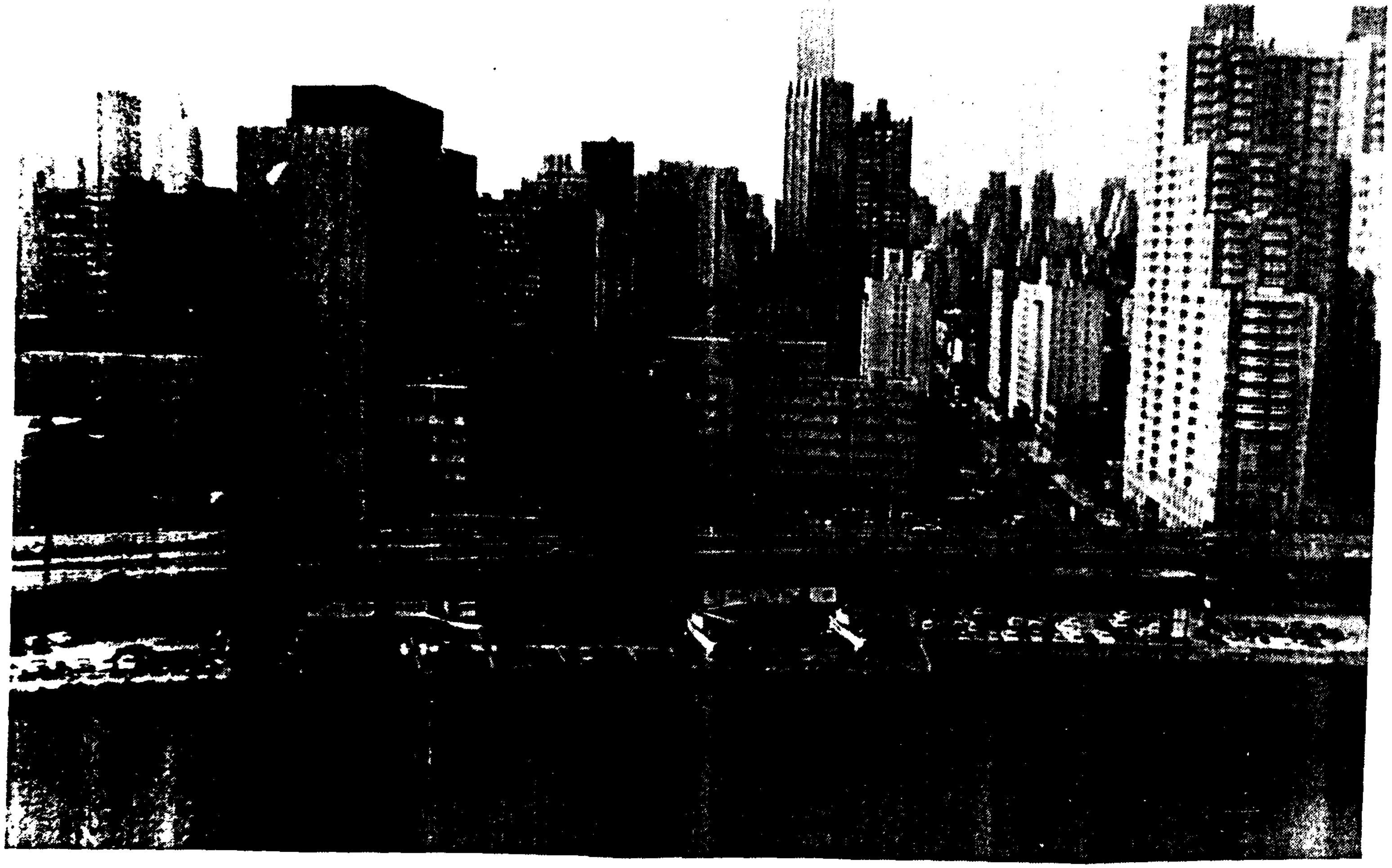


FIGURE C-6. AERIAL PHOTOGRAPH OF 34TH STREET HELIPORT, NEW YORK CITY

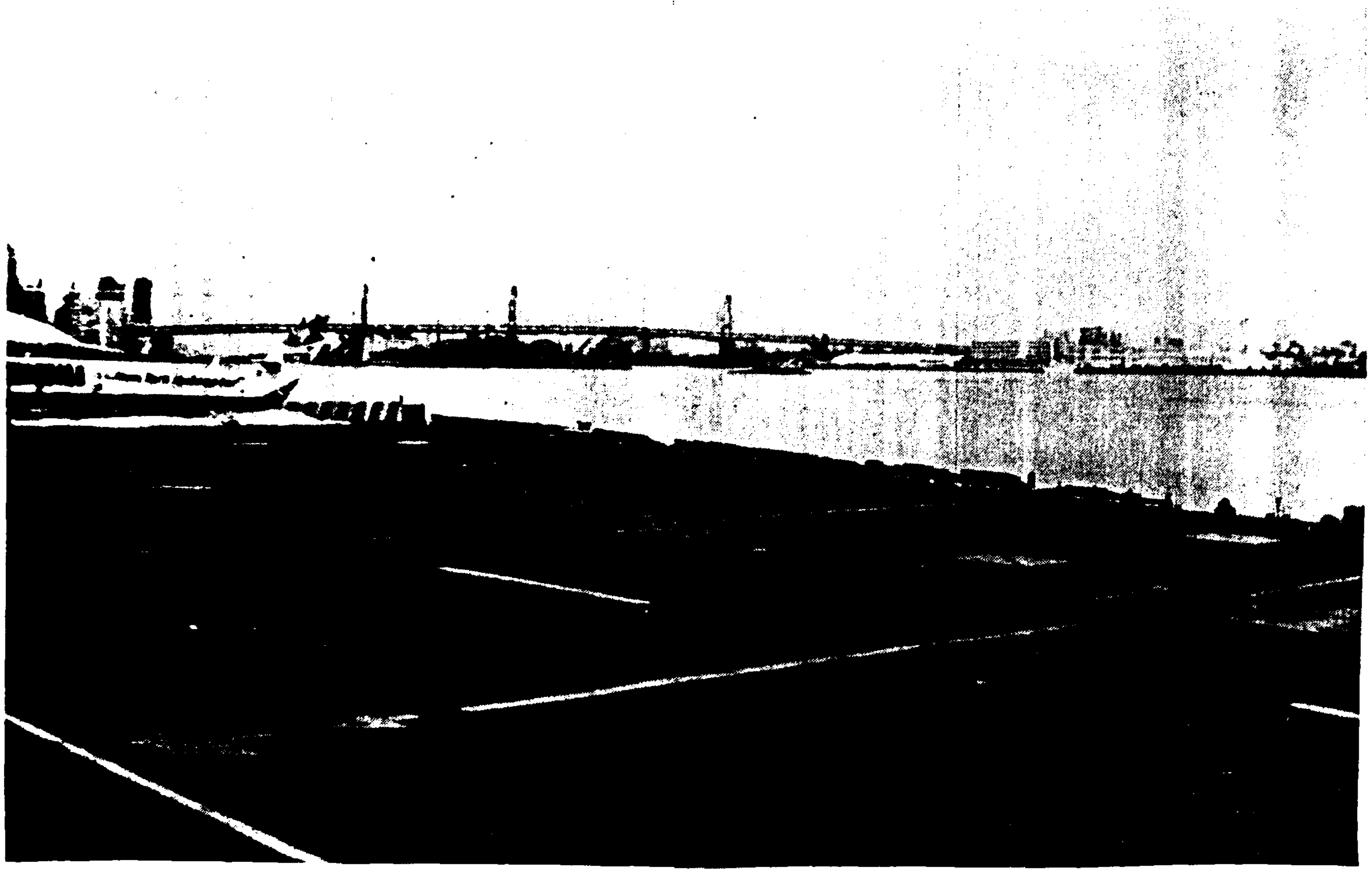


FIGURE C-7. PHOTOGRAPH OF 34TH STREET HELIPORT, NEW YORK CITY, LOOKING NORTH

FIGURE C-8. PHOTOGRAPH OF PHI HELIPORT, AMELIA, LA

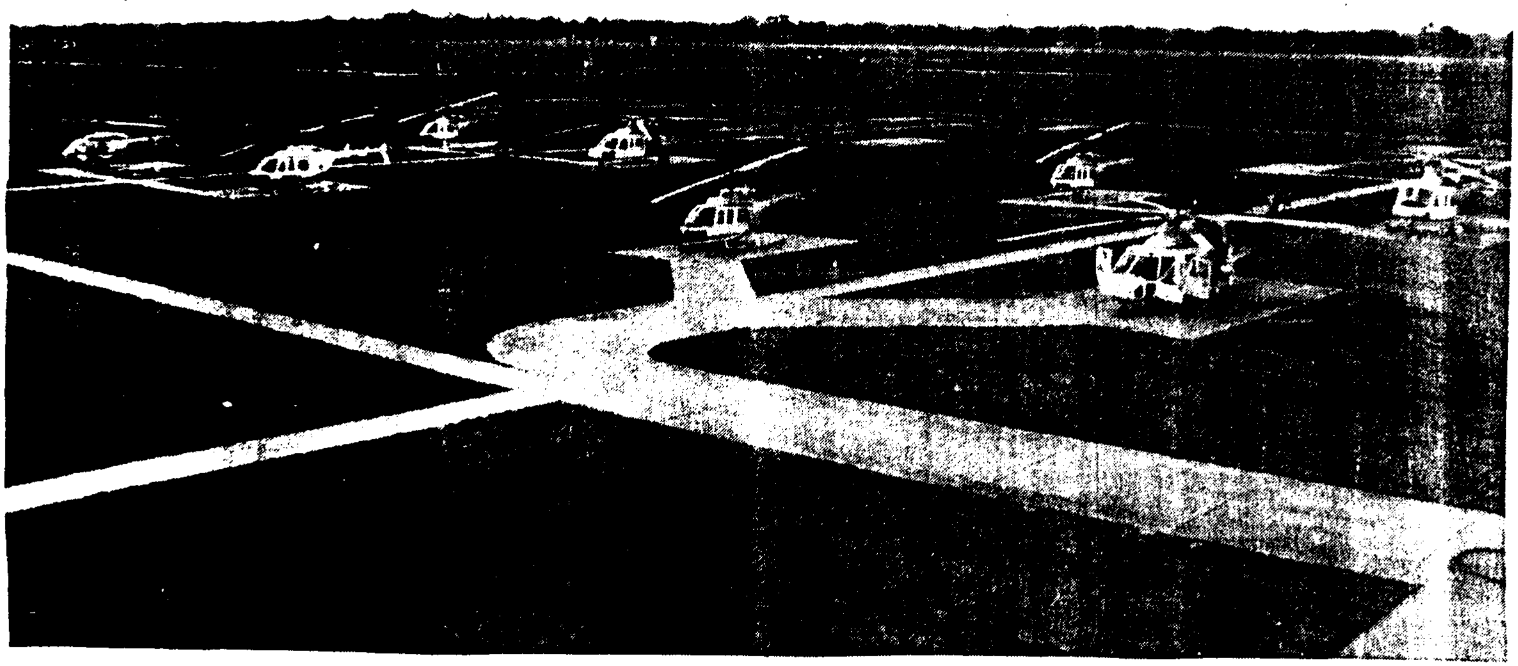


FIGURE C-9. PHOTOGRAPH OF AIR LOGISTICS HELIPORT, PATTERSON, LA

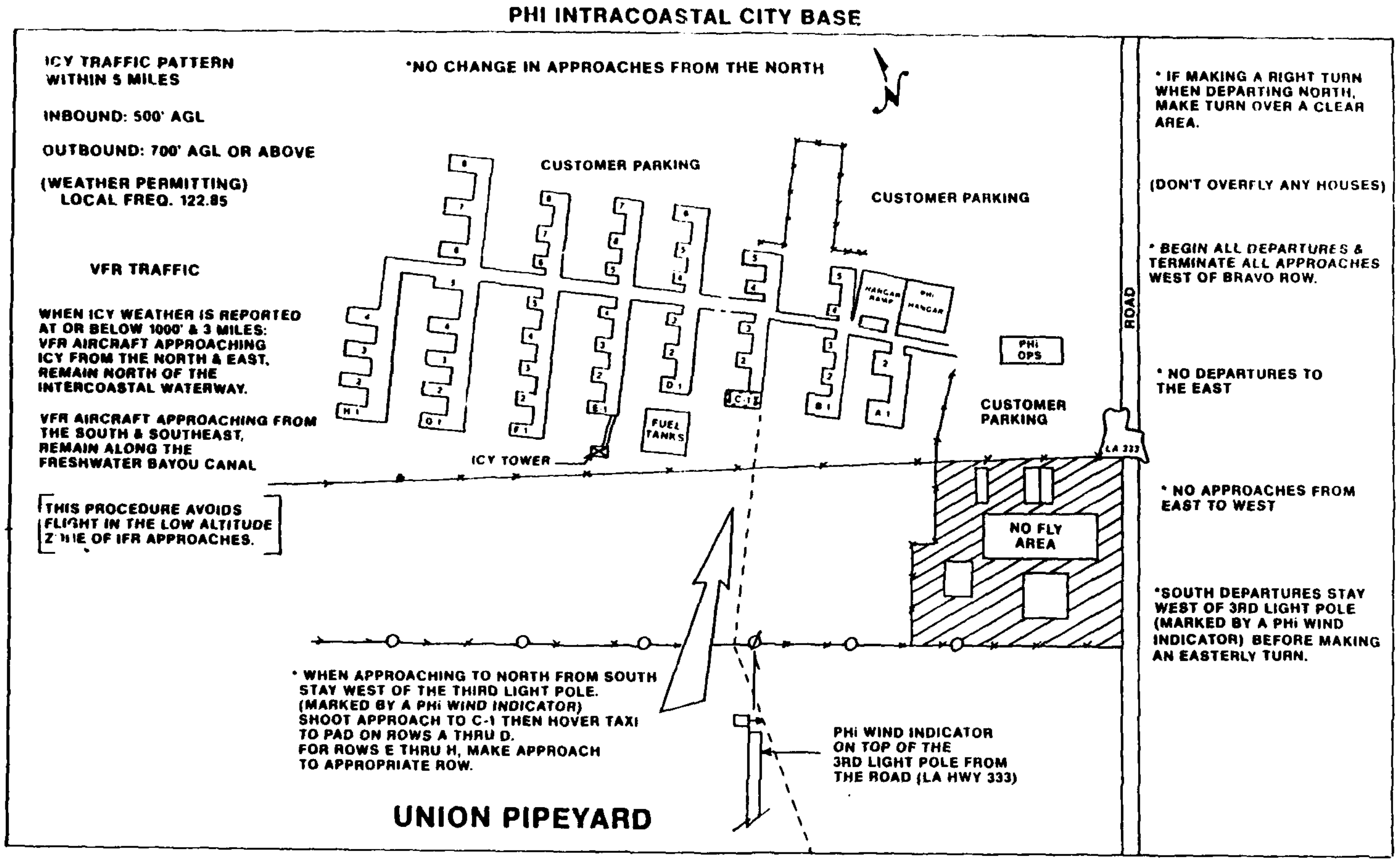


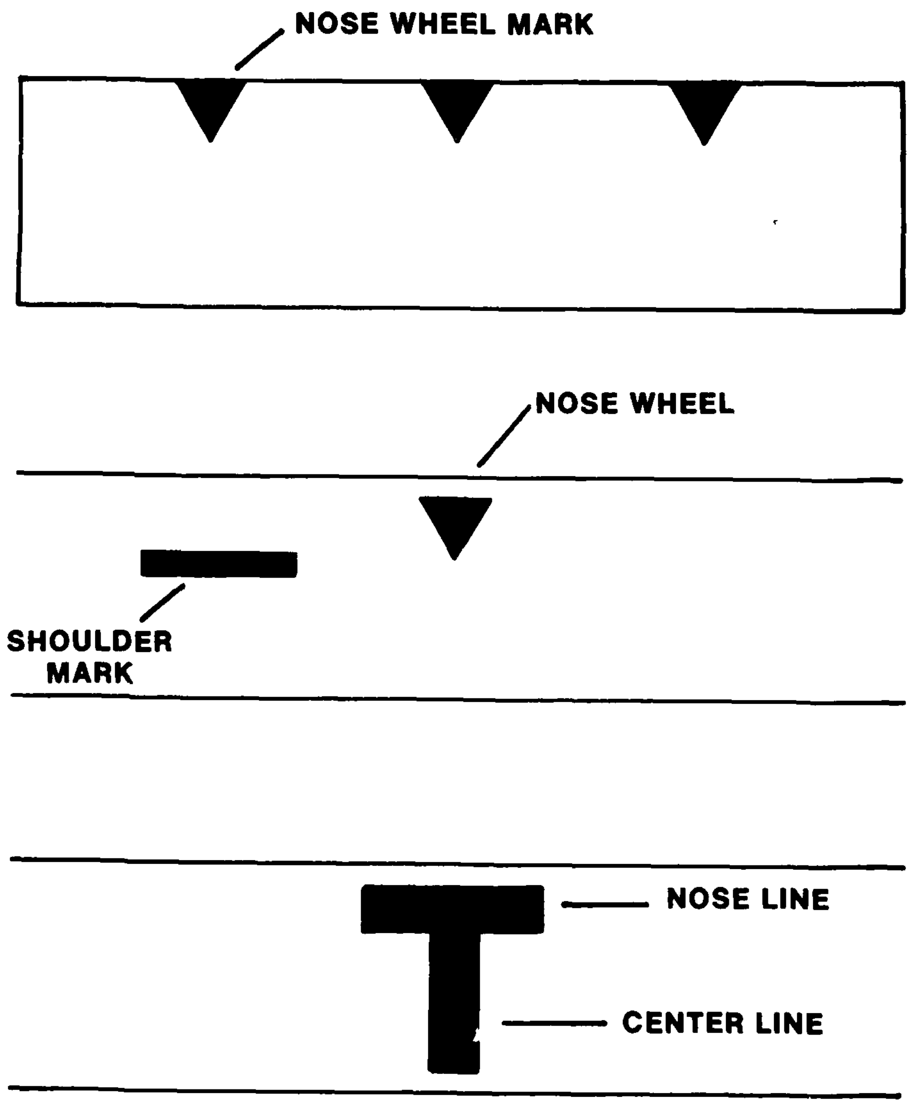
FIGURE C-10. LAYOUT OF PHI HELIPORT, INTRACOASTAL CITY, LA

FIGURE C-11. PHOTOGRAPH OF HOUSTON CITY HELIPORT, HOUSTON, TX

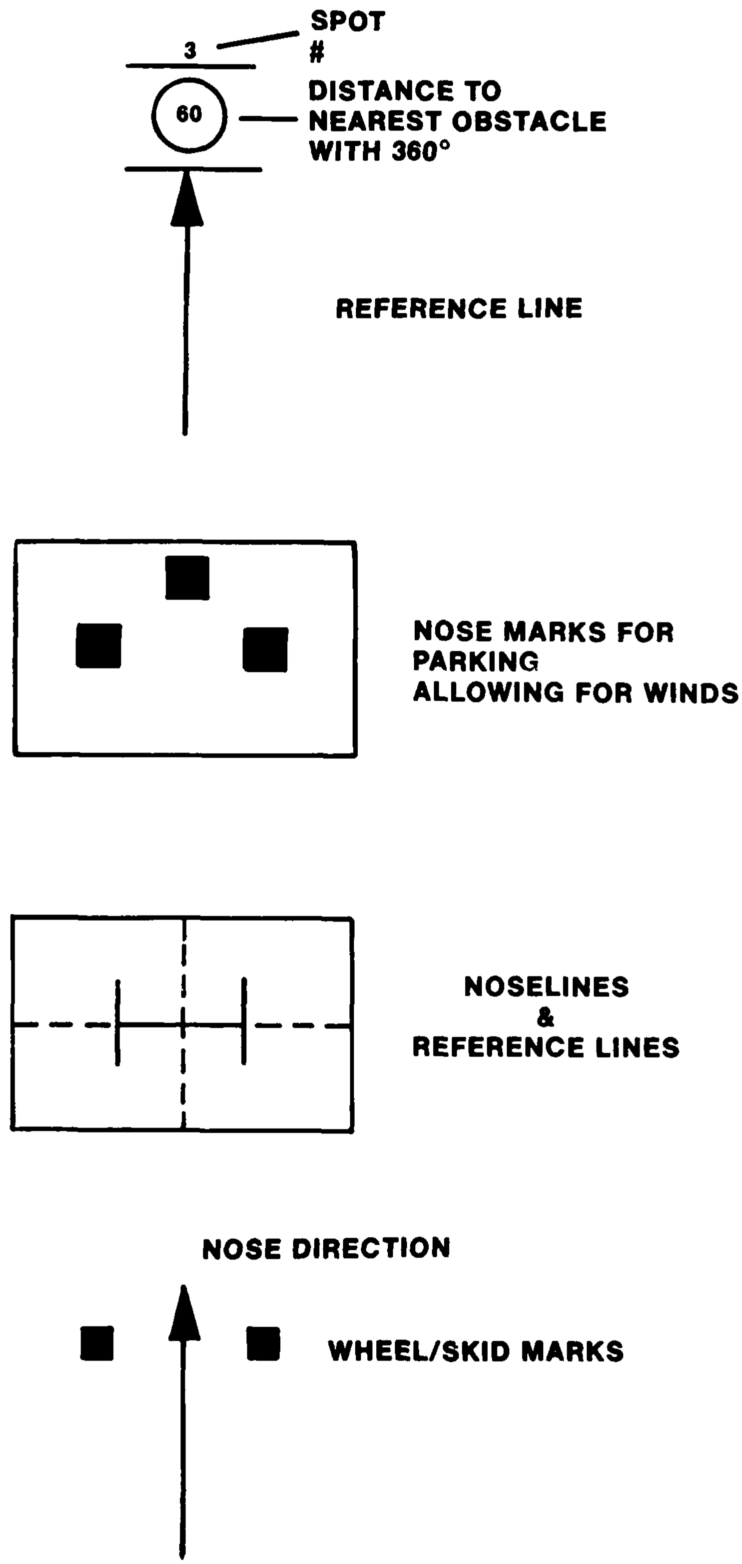
APPENDIX D

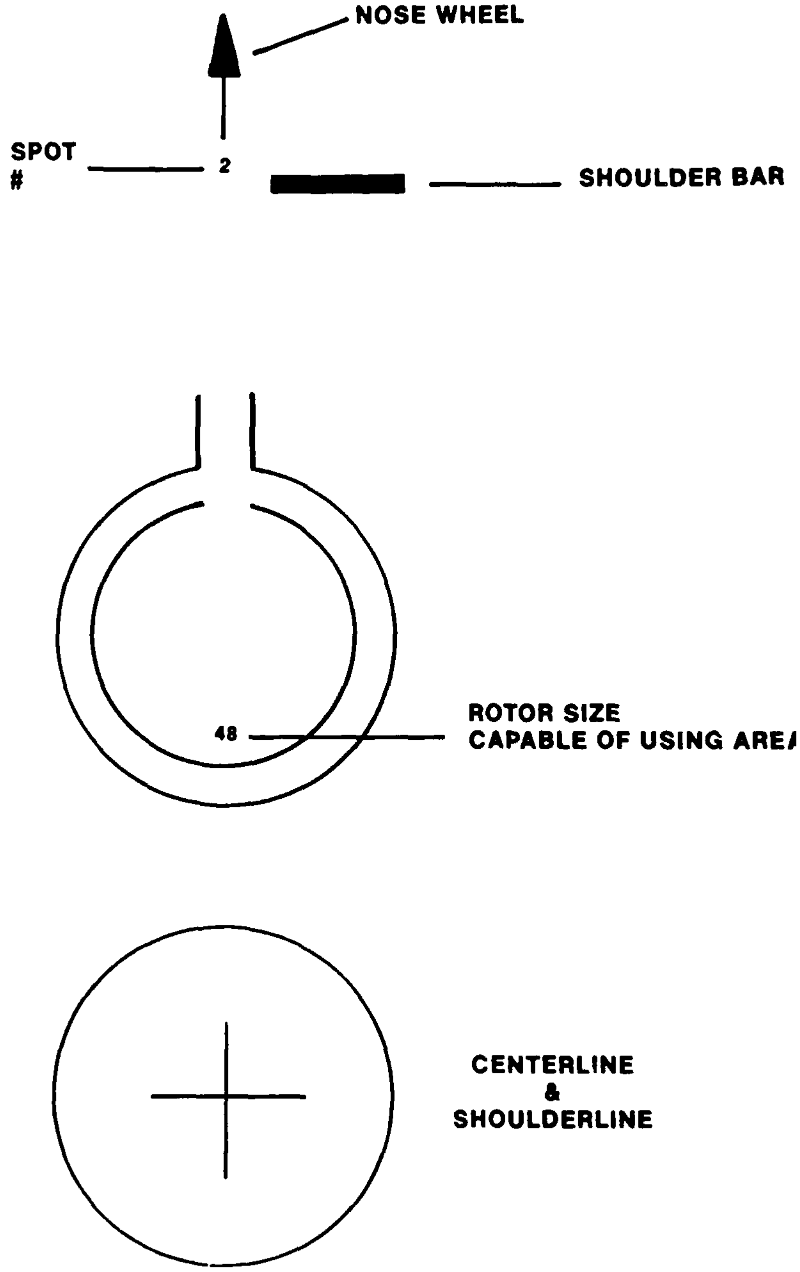
DRAWINGS OF PILOT SUGGESTIONS FOR PARKING AREA MARKINGS

PILOT SUGGESTED MARKINGS FOR PARKING OPERAT



NS


SPOT
#
3
60
DISTANCE TO
NEAREST OBSTACLE
WITH 360°
REFERENCE LINE
NOSE MARKS FOR
PARKING
ALLOWING FOR WINDS
NOSELINES
&
REFERENCE LINES
NOSE DIRECTION
WHEEL/SKID MARKS


NOSE WHEEL
SPOT
#
2
SHOULDER BAR
48
ROTOR SIZE
CAPABLE OF USING AREA
CENTERLINE
&
SHOULDERLINE