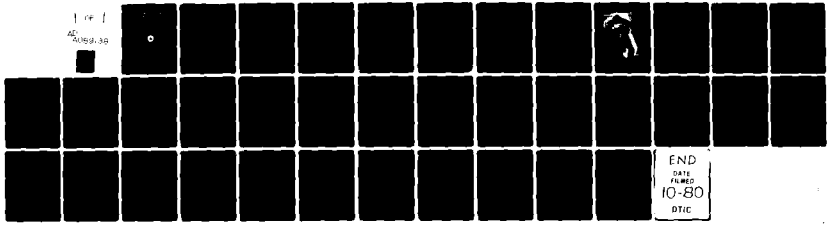
AD-A089 138 FEDERAL AVIATION ADMINISTRATION TECHNICAL CENTER ATL--ETC F/G 5/8
AUTOMATED FLIGHT PLAN FILING BY SIMULATED VOICE RECOGNITION.(U)
AUG 80 E SHOCHET, R LEMANSKI

UNCLASSIFIED FAA-CT-80-15 FAA-RD-80-56 NL



END
DATE FILMED
10-80
DTIC

Report No. FAA-RD-80-56
FAA-CT-80-15

LEVEL II

12

AUTOMATED FLIGHT PLAN FILING BY SIMULATED VOICE RECOGNITION

Ephraim Shochet
Richard Lemanski

FEDERAL AVIATION ADMINISTRATION TECHNICAL CENTER
Atlantic City, N. J. 08405

INTERIM

AUGUST 1980

Prepared for

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Systems Research & Development Service
Washington, D. C. 20590

NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for the contents or use thereof.

The United States Government does not endorse products or manufacturers. Trade or manufacturer's names appear herein solely because they are considered essential to the object of this report.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-80-56	AD-A089 138	

4. Title and Subtitle
AUTOMATED FLIGHT PLAN FILING BY SIMULATED VOICE RECOGNITION

5. Report Date
August 1980

6. Performing Organization Code

7. Author's
Ephraim Shochet and Richard Lemanski

8. Performing Organization Report No.
FAA-CT-80-15

9. Performing Organization Name and Address
Federal Aviation Administration
Technical Center
Atlantic City, New Jersey 08405

10. Work Unit No. (TRAIS)

11. Contract or Grant No.
131-401-835

12. Sponsoring Agency Name and Address
U.S. Department of Transportation
Federal Aviation Administration
Systems Research and Development Service
Washington, D.C. 20590

13. Type of Report and Period Covered
Interim rept.
August 1975—May 1978

14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

The Systems Research and Development Service (SRDS) asked the Federal Aviation Administration (FAA) Technical Center to develop and demonstrate the capability of automatic flight plan filing by computerized word recognition. To accomplish a prototype capability, it was necessary to begin gathering human factors data to help determine the correct technical approach and design concept. The tests reported herein centered on two questions: Would pilots use this method of flight plan entry? Which of the three protocols simulated do pilots prefer most? Because of the limitations inherent in this experiment, the answers to these questions are tentative at this time. Given the assumption that the actual utterance recognition device (URD) performs at a level comparable to the simulation used in this experiment, it is entirely reasonable to conclude that general aviation pilots would (1) elect to file flight plans by computerized word recognition using a real computer and (2) prefer "no prompt" or a "word echo-back prompt" over the "cue-tone prompt." The results show that the preferred protocol was the "no prompt" method.

17. Key Words		18. Distribution Statement
Flight Plan Filing	General Aviation	Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161
Automation	Word Recognition	
Utterance Recognition	Human Factors	
Flight Service Stations		

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	37	

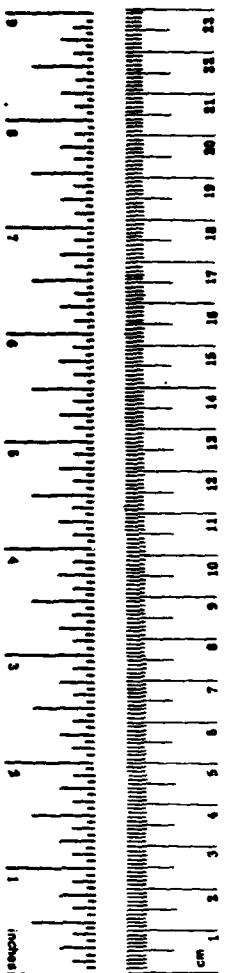
Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

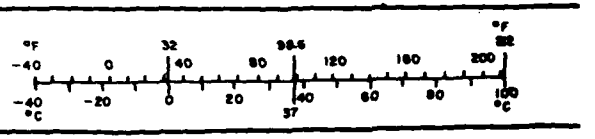
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures. Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



ACKNOWLEDGEMENT

The authors acknowledge Bruce Rosenberg, ACT-4B, for his assistance in the computation of the Z values shown in this report.

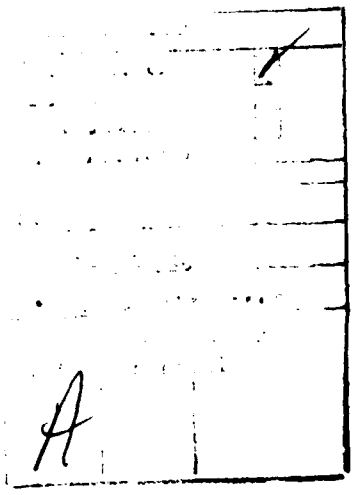


TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

INTRODUCTION

PURPOSE.

The purpose of the experiment documented in this report is to suggest tentative answers to the following questions:

1. Would pilots use a method of direct flight plan entry by computerized word recognition?

2. Which one of three protocols simulated do pilots prefer most?

Although the answers to these questions as obtained through this experiment are tentative and preliminary in nature, they may serve as a basis for more comprehensive testing and subsequent system design.

BACKGROUND.

The Mass Weather Dissemination System Exploratory Model located at the Federal Aviation Administration (FAA) Technical Center is a developmental effort sponsored by Systems Research and Development Service (SRDS). One of the recent objectives of this project is to develop a prototype model with the capability of direct flight plan filing by computerized word recognition. A major component of the system is an utterance recognition device (URD) used for the recognition of human speech over telephone lines. It is the only known commercially available word recognition machine designed for use on a switched telecommunications system. It is an eight-channel discrete utterance recognition machine designed to recognize words for which it has been programed. The URD is currently programed to recognize 25 words.

SRDS has asked the Technical Center to develop and demonstrate the capability of automatic flight plan filing by voice recognition. Improvements to the URD, which are now underway, include modifications to the software and hardware and expansion of the present vocabulary to include the international phonetic alphabet and additional command words.

MAJOR LIMITATIONS OF THE EXPERIMENT.

To enable the reader to judge the validity of the conclusions drawn from the data and the general worth of the experiment, it is important to point out the following major limitations. First, an actual voice recognition machine was not used. The machine recognition and voice was simulated by a person imitating the machine (see figure 1). This was unavoidable as the expanded vocabulary (phonetic alphabet and additional command words) was not yet available. Second, the pilots who participated in this experiment were professional Federal Aviation Administration (FAA) pilots and other Technical Center employees and, as a group, were not typical of the general aviation community. However, it was felt that their evaluation of the concept would be of distinct value in light of their substantial aviation knowledge and experience.

EXPERIMENTAL PROCEDURE

The subjects were volunteers from the pilot population at the Technical Center. They were all FAA employees with various levels of experience from a private pilot with 100 hours total flying time to an airline transport pilot with over 23,000 hours. The subjects were tested individually. Most were not familiar with the concept of direct flight plan filing by computerized word recognition. Three different flight plans were used on which five different tests were conducted. The flight plans were typical instrument flight rules (IFR), low altitude, high performance aircraft. The plans were nearly identical except for the route of flight which was changed slightly in each case to maintain interest and to provoke ideas

FIGURE 1. HUMAN VOICE AND CUE-TONE DEVICE (SIGNAL GENERATOR) SIMULATE A COMPUTER

and comments. The computer voice response was simulated by a test team member using a telephone in a different room. To maintain a high level of realism throughout the experiment, the tester or simulated "computer" responded to the pilot's input as an actual computer might. This included the insertion of typical errors for the pilot to correct. A second team member remained with the test subject, monitored the telephone dialog between pilot and "computer," and controlled the test.

The subject was presented with a sheet containing the three flight plans in order of testing. It was felt that having all the information on one work sheet would be an aid to the subject in making later comparisons.

Test instructions were explained while referring to the flight plan sample sheet. This also gave the subjects a chance to familiarize themselves with the material before testing. Since method of entry differed with each flight plan, the initial explanation was centered exclusively on flight plan A to minimize confusion. The method of testing and the overall objectives were briefly explained. Flight plan information was entered using the phonetic alphabet, and the "computer" verified the entries by a readback. It was explained that the computer was programed to recognize the phonetic alphabet, the numbers zero through nine, and certain command words (figure 2). Thus, all identifiers, names, etc., were required to be spelled out. For example, the aircraft identifier C310/U was entered as "Charlie Three One Zero Slant Uniform." The word slant was a command word the "computer" recognized and thus did not have to be spelled out. It separated the aircraft from the special equipment code. Omitting it would generate an error. Likewise, in the "route of flight" each route segment was separated by a slant and again was entered to avoid an error. The route of flight was entered as "Victor One Eight Four Slant Mike X-ray Echo Slant...."

All times were given using a 24-hour clock and were assumed to be Greenwich. Elapsed times were given on a 24-hour basis also. Thus, 4 hours 15 minutes fuel on board (or estimated time en route) was given as 0415 spoken "Zero Four One Five (leading zero is optional)." Cruising altitude 8,000 feet was entered as "Eight Zero Zero Zero." A visual flight rules (VFR) altitude of 6,500 feet was "Six Five Zero Zero."

All information was to be entered in the same manner. If a word that was not in the "computer's" vocabulary was inadvertantly entered, the "computer" read back a word it "thought" most closely resembled the word entered. For example, the phonetically correct INDIA might be mistakenly entered as ITEM. Since ITEM was not in the "computer's" vocabulary it might read back SEVEN or DELTA. The pilot must detect this error and enter the appropriate correction. It was explained to the subject that the methods of correction would vary among the flight plans tested, and one of our objectives was to select the best method. The pilots were told that all entries had to be clear and distinct or the "computer" would not be able to recognize a word even if it was correct. It was stressed that an actual operating system such as this would not be very tolerant of loud background noise or any extraneous noises or extra syllables that normal conversational speech might generate. An error could be caused by slurring the entry, clearing the throat, or mumbling. The person simulating the URD was especially watchful for these factors during the test and attempted to accurately duplicate what the actual computer's response might be to these extraneous inputs. He would either read back something different or say "PLEASE REPEAT," after which the subject would have to reenter the correct word.

VOCABULARY

PHONETIC ALPHABET		NUMBERS	COMMAND WORDS	
ALPHA	NOVEMBER	ONE	AFFIRMATIVE	FLIGHT LEVEL
BRAVO	OSCAR	TWO	YES	DIRECT
CHARLIE	PAPA	THREE	NEGATIVE	SID
DELTA	QUEBEC	FOUR	NO	STAR
ECHO	ROMEO	FIVE	EAST	INTERCEPT
FOXTROT	SIERRA	SIX	WEST	RADIAL
GOLF	TANGO	SEVEN	NORTH	JET
HOTEL	UNIFORM	EIGHT	SOUTH	MILES
INDIA	VICTOR	NINE	LOCAL	POINT
JULIETT	WHISKEY	NINER	AMEND	SLANT
KILO	X-RAY	ZERO	CLOSE	LAST
LIMA	YANKEE			
MIKE	ZULU			

FIGURE 2. SIMULATED TEST VOCABULARY

TEST ONE, CUE-TONE (FLIGHT PLAN A).

Flight plan A utilized in test one is shown in figure 3. After dialing up the "computer," communication was established after two rings, and a short introduction was given as follows: "HELLO, YOU ARE CONNECTED TO AUTOMATIC FLIGHT PLAN FILING VIA COMPUTER WORD RECOGNITION. PLEASE SPEAK EACH WORD CLEARLY AND DISTINCTLY AND WAIT FOR THE PROMPT BEFORE SPEAKING EACH WORD. A PAUSE OF 5 SECONDS WILL TERMINATE EACH LINE OF INFORMATION. ONLY VFR AND IFR FLIGHT PLANS MAY BE ENTERED. IS THIS A VFR FLIGHT PLAN?"

The pilot was instructed to respond "No," as an appropriate answer for this particular test. It was explained that YES, NO, AFFIRMATIVE, NEGATIVE were all recognized command words, and he could use whichever was most natural for him throughout the test. This introduction was repeated for every test.

The "computer" then initiated the first line of entry by directing him to ENTER AIRCRAFT IDENTIFICATION. This command was immediately followed by a beep tone which was the pilot's cue to enter the first character N or November. At this time it was stressed that this first test was the beep cue-tone method, and it was important to wait for the tone before making any entries. After about a 1- to 2-second pause, another tone is heard which was the cue to enter the next element. The test conductor demonstrated the correct method of entering the complete aircraft identification block, including the beep tones and proper cadence. A 5-second pause indicated to the "computer" that the entry was complete and the "computer" initiated a phonetic readback of the information to the pilot. This was also demonstrated. If an error was detected, the pilot was to wait until the "computer" was finished with the entire readback, and then say "no" or "negative." There was an immediate beep tone after which the pilot reentered the data as before, this time correcting the error. Once again, after the 5-second pause, the information was read back. If a new error was detected, the correction process was repeated. If the readback was acceptable, 3 seconds of silence initiated the next line of entry. In all cases a correction required the reentry of all the information in that line. If a pilot inadvertantly paused for 5 seconds before finishing a line, and the "computer" had initiated the next line of entry, he could say the command word LAST, and the "computer" would reinitiate the previous line for reentry. Changes were made in the same manner, as the pilot had the capability to back his way through the flight plan.

A partial demonstration of entry for "route of flight" was given. Since the remarks section of flight plan A was blank, a 5-second pause after the beep was all that was required for the computer to move to the next line.

After remarks, beginning with item 11, "fuel on board," all entries were tape recorded in the conventional manner and stored for future reference, such as for search and rescue use. The five remaining entries would not be entered by computerized word recognition. The user could enter the data in any manner he chose as it would not be processed by the "computer." While important for search and rescue or other needs, this information is not essential for computer processing of his flight plan into the National Airspace System (NAS).

The telephone transaction was completed by the closing statement by the "computer" as follows: "YOUR FLIGHT PLAN HAS BEEN ACCEPTED BY THE COMPUTER. THANK YOU. HAVE A GOOD FLIGHT."

The pilots were reminded to speak slowly and distinctly, to wait for the cue-tone before entering anything, and to begin the test.

1. AIRCRAFT IDENTIFICATION: N123B
2. AIRCRAFT TYPE & SPECIAL EQUIPMENT: C310/U
3. DESTINATION: PIT
4. ESTIMATED TIME EN ROUTE: 0215
5. AIRCRAFT TRUE AIRSPEED: 180
6. DEPARTURE POINT: ACY
7. DEPARTURE TIME: 1600
8. CRUISING ALTITUDE: 8,000
9. ROUTE OF FLIGHT: V184/MXE/V474/THS/V12S/JST
10. REMARKS:
11. FUEL ON BOARD: 0400
12. ALTERNATE AIRPORT: YNG
13. PILOT'S NAME, ADDRESS & TELEPHONE NO., AND AIRCRAFT HOME BASE:
14. NUMBER ABOARD: 2
15. COLOR OF AIRCRAFT: WHITE/RED

FIGURE 3. FLIGHT PLAN A

TEST TWO, WORD ECHO-BACK (FLIGHT PLAN B).

Flight plan B utilized in test two is shown in figure 4. All entries were still made phonetically. The main difference was the absence of the beep cue-tone, which was replaced by an echo-back of the word entered. The "computer" initiates the first line of the flight plan by saying ENTER AIRCRAFT IDENTIFICATION. There is no beep, and the pilot enters the first word, "November." The computer reads back NOVEMBER. This verifies the entry for the pilot and is a cue for him to proceed. After a 1-second pause he says "One," and if the computer again recognizes the word, it echoes back ONE, and so forth. With this method of prompting, no readback was given after the 5-second terminating pause. If the vocabulary word echoed back was incorrect (i.e., the word had been misrecognized), the command word "NO" or "NEGATIVE" was spoken, and after 1 second, the correct word was reentered and the correction echoed back. This method enabled the user to get immediate confirmation of the word being entered, and enabled him to make an immediate correction. It also eliminated the need for a complete readback of the line entered.

A demonstration of proper entry was performed using the aircraft identification block as "November...NOVEMBER... One...ONE...Two...TWO...Three...etc."

The technique for correcting was demonstrated as "November...NOVEMBER...One... NINE...No, One...ONE...etc."

The command word DIRECT was introduced. Since this word is in the "computer's" vocabulary, it is not entered phonetically. Its use in the route of flight was demonstrated as "Direct... DIRECT...Slant...SLANT...Victor... VICTOR...etc."

The command words NO, SID, and STAR were also introduced into the remarks section. As in the other entries, they are pronounced individually with an echo-back after each one.

All entries after the remarks section are tape recorded for local storage as in the first test. The computer initiates the line by saying ENTER FUEL ON BOARD and the pilot can enter the information as normally spoken. He will get no correction or readback. The computer only waits for the 5-second pause to terminate the line and proceed with the next.

TEST THREE, NO PROMPT (FLIGHT PLAN C).

Flight plan C utilized in test three is shown in figure 5. All entries are still made phonetically. The main difference is the entire line of information is entered without a cue-tone or echo-back. There is a 2- to 3-second pause between words. At the end of 5 seconds the "computer" verifies the information by reading back the entire line. If the readback contains an error, the subject first waits for the computer to finish, then says "No" or "Negative," and immediately reenters all the data with the correction. If satisfactory, the computer moves to the next line after 5 seconds. When making the entries, a pause of at least 2 to 3 seconds between words is required. Whereas in previous tests the computer provided this separation through the cue-tone or word echo-back, the subject now had this responsibility; and this point was emphasized. A demonstration was performed using the aircraft identification. The test conductor stressed the proper cadence to the subject. Most test subjects attained the desired cadence throughout the test.

A standard instrument departure (SID) and a standard terminal arrival route (STAR) were added to the route of flight in this test. The SID is a "denim one departure" with a "sea isle transition," and normally pronounced that way by the pilot when filing. Computer entry

1. AIRCRAFT IDENTIFICATION: N123B
2. AIRCRAFT TYPE & SPECIAL EQUIPMENT: C310/U
3. DESTINATION: ISP
4. ESTIMATED TIME EN ROUTE: 0215
5. AIRCRAFT TRUE AIRSPEED: 180
6. DEPARTURE POINT: PIT
7. DEPARTURE TIME: 2000
8. CRUISING ALTITUDE: 9,000
9. ROUTE OF FLIGHT: DIRECT/AGC/V12/JST/V35/PSB/V6/BWZ/V232/LGA
10. REMARKS: NO SID STAR
11. FUEL ON BOARD: 0400
12. ALTERNATE AIRPORT: ACY
13. PILOT'S NAME, ADDRESS & TELEPHONE NO., AND AIRCRAFT HOME BASE:
14. NUMBER ABOARD: 4
15. COLOR OF AIRCRAFT: WHITE/RED

FIGURE 4. FLIGHT PLAN B

1. AIRCRAFT IDENTIFICATION: N123B

2. AIRCRAFT TYPE & SPECIAL EQUIPMENT: C310/U

3. DESTINATION: ATL

4. ESTIMATED TIME EN ROUTE: 0340

5. AIRCRAFT TRUE AIRSPEED: 180

6. DEPARTURE POINT: ISP

7. DEPARTURE TIME: 2300

8. CRUISING ALTITUDE: 8,000

9. ROUTE OF FLIGHT: DENIM1.SIE/V308/HEDGE/V16/LYH/V16S/PSK/
PSK.MACEY1

10. REMARKS:

11. FUEL ON BOARD: 0445

12. ALTERNATE AIRPORT: JAX

13. PILOT'S NAME, ADDRESS & TELEPHONE NO., AND AIRCRAFT HOME BASE:

14. NUMBER ABOARD: 3

15. COLOR OF AIRCRAFT: WHITE/RED

FIGURE 5. FLIGHT PLAN C

appears as "DENIM1.SEAISLE" and is entered phonetically as "Delta Echo November India Mike One Point Sierra Echo Alpha India Sierra Lima Echo." The STAR is a "macey one arrival," "pulaski transition," and normally pronounced that way by the pilot when filing. Computer entry would appear as "PSK.MACEY1" and would be entered phonetically as "Papa Sierra Kilo Point Mike Alpha Charlie Echo Yankee One." POINT is a new command word.

A change in the method of entry for the route of flight was introduced. The subject entered the route data in its entirety, the same as the other entries. The "computer" gave the readback after 5 seconds. The "computer" paused at the slant and permitted a correction of the data up to that point instead of reading back the entire block before the pilot had an opportunity to say "No" for a correction. The "computer" did not read back the word SLANT but substituted it with a pause of about 2 seconds to allow the pilot to say "No" if an error had been detected. This method allows correction of data by route segments and precludes the need to reenter the entire route when there is only a single mistake. Only the small segment containing the error would have to be entered. A correction sequence would appear as "V16/LYH/...;" entered as "Victor One Six Slant Lima Yankee Hotel Slant...;" and readback with an error and corrected as "VICTOR ONE SIX...LIMA TANGO HOTEL...Negative, Lima Yankee Hotel...LIMA YANKEE HOTEL...." Again, beginning with "fuel on board," all entries were made as in the previous tests.

After completing flight plan C, the pilot was asked to select the preferred method up to that point.

TEST FOUR, PARTIAL INFORMATION REQUEST (OPTIONAL FLIGHT PLAN).

The optional flight plan utilized in test four and five is shown in figure 6. In the first three tests, the computer initiated the action by giving a full information request to the pilot each time data was to be entered. In test four a partial request was tried, and instead of the computer saying ENTER AIRCRAFT IDENTIFICATION, it said ENTER BLOCK ONE. After the first line, this was shortened even further by omitting the word ENTER and simply saying BLOCK TWO...BLOCK THREE...etc.

The test subject had the option of selecting any of the three flight plans to reenter for testing of this new feature. All other test procedures remained the same for the flight plan he selected. It was felt that selecting his own plan for this test would give him the opportunity to review any previous method before making a positive selection.

TEST FIVE, VISUAL FLIGHT RULES (VFR) FLIGHT PLAN ENTRY (OPTIONAL FLIGHT PLAN).

In the VFR flight plan test, only the first four lines of information are processed through word recognition. Lines 5 through 15 are recorded for future reference as needed. As in the other flight plan tests, this recorded information can be entered in any manner. The subject again had the choice of selecting any of three sample flight plans to enter and the choice of full information request or the block method of entry.

Upon completion of the fifth test, the subject filled out the questionnaire. Comments were encouraged not only in the special comments section, but also anywhere in the questionnaire where they felt inclined to make a note.

RESULTS

Responses to each of the questions are discussed in this section. Appendix A

COMPLETE REQUEST	PARTIAL REQUEST
ENTER AIRCRAFT IDENTIFICATION	BLOCK 1
ENTER AIRCRAFT TYPE & SPECIAL EQUIPMENT CODE	BLOCK 2
ENTER DESTINATION IDENTIFIER	BLOCK 3
ENTER ESTIMATED TIME EN ROUTE	BLOCK 4
ENTER AIRCRAFT TRUE AIRSPEED IN KNOTS	BLOCK 5
ENTER DEPARTURE IDENTIFIER	BLOCK 6
ENTER PROPOSED DEPARTURE TIME IN LOCAL OR GREENWICH	BLOCK 7
ENTER CRUISING ALTITUDE	BLOCK 8
ENTER ROUTE OF FLIGHT	BLOCK 9
ENTER REMARKS	BLOCK 10
ENTER FUEL ON BOARD	BLOCK 11
ENTER ALTERNATE AIRPORT IDENTIFIER	BLOCK 12
ENTER PILOT'S NAME, ADDRESS, AND TELEPHONE NUMBER, AND IDENTIFIER FOR AIRCRAFT HOME BASE	BLOCK 13
ENTER NUMBER OF PEOPLE ABOARD	BLOCK 14
ENTER COLOR OF AIRCRAFT	BLOCK 15

FIGURE 6. OPTIONAL FLIGHT PLAN

contains tables A-1 through A-8 which categorize the responses to each question according to the following subgroups:

1. Engine rating
2. License rating
3. Instrument rating
4. Annual flying time
5. Total flying time

RESPONSES TO QUESTION 1.

Question 1 asked, "Once familiar with the system and having a flight plan form in front of you, what are your feelings regarding the mode of information request?" The respondent was given two choices—the block method of request (partial) or the full information request (complete)—and was asked to explain the reason for his choice. Table 1 shows the distribution of responses to this question. Using a chi-square (χ^2) test, no statistically significant difference was found. A large sample binomial sign test, corrected for continuity, confirmed this result. All χ^2 tests were conducted at the 0.05 level of significance. In using the χ^2 test, it was assumed that if the pilots were completely indifferent, their responses would be tantamount to chance. The expected frequency on an indifference hypothesis would be 25 for the block method and 25 for the full information method. This result would be expected by chance.

The respondents who selected the block method of request indicated that this method was preferred because it was faster and saved time. No other reason was given for this preference. On the other hand, those who selected the full information request offered a variety of reasons for their choice. A summary of the reasons stated were:

1. Does not require the pilot to have a flight plan form.

2. There is less chance of error.

3. Communication is more natural.

4. Easier to understand.

5. Does not require the pilot to remember the flight plan format.

6. Easier to keep track of place and information to be provided.

7. Positively confirms which item is being presented.

TABLE 1. RESPONSES TO QUESTION 1

Once familiar with the system and having a flight plan form in front of you, what are your feelings regarding the mode of information request?

Block Method Request		Full Information Request		Total			
N	%	N	%	N	%	χ^2	Z
29	58.00	21	42.00	50	100.00	1.28	-0.99

RESPONSES TO QUESTION 2.

Question 2 asked, "Would you use this system more if you did not have to make all entries by word recognition but could use the method for recording some of the entries?" The subjects were given three choices: (1) complete entry by word recognition, (2) partial entry by word recognition and partial entry by recording, and (3) no preference.

Table 2 shows the distribution of responses to this question. The preponderant majority of pilots (44 out of 50) preferred partial entry by word recognition and partial entry by recording. The χ^2 and Z values shown in table 2 were computed after the no preference responses were evenly split between columns 1 and 2. These values are statistically significant. We may, therefore, reject the null hypothesis; that there was no difference between the entry methods.

The reasons given for selecting partial entry by word recognition and partial entry by recording were:

1. Requires less time to file.
2. There is less chance of error.

RESPONSES TO QUESTION 3.

Question 3 of the schedule asked, "With repeated use do you feel you could adapt to filing a flight plan in an automated manner?" The respondent was given two choices—yes or no. Table 3 shows the distribution of responses to this question. With the exception of one pilot, all of the subjects answered in the affirmative.

TABLE 2. RESPONSES TO QUESTION 2

Would you use this system more if you did not have to make all entries by word recognition but could use the method for recording some of the entries?

Complete Entry		Partial Entry		No Preference		Total			
N	%	N	%	N	%	N	%	χ^2	Z
3	6.00	44	88.00	3	6.00	50	100.00	32.96	5.60

TABLE 3. RESPONSES TO QUESTION 3

With repeated use do you feel you could adapt to filing a flight plan in an automated manner?

Yes		No		Total			
N	%	N	%	N	%	χ^2	Z
49	98.00	1	2.00	50	100.00	46.08	-6.65

RESPONSES TO QUESTION 4.

Item 4 of the questionnaire stated, "We realize there is a trade-off in using any means of filing a flight plan; namely, a longer filing time in using the word recognition system for flight plan filing versus possible long delays in reaching the flight service station (FSS) (specialist or fast file) to file by phone. Delay time in reaching the FSS by phone will vary depending on current weather in the FSS service area and geographic location of the FSS (very long phone waits in the New York City area during periods of marginal weather). Considering all the above factors, which would be your preferred method of filing future flight plans?"

The respondent was given two choices, the longer time using the word recognition system or a phone call directly to the specialist. As shown in table 4, 29 pilots selected the longer time using word recognition, 20 selected a phone call directly to the specialist, and 1 did not select either of the fixed choices. The χ^2 is equal to 1.65 which is not statistically significant at the 0.05 level. A large sample binomial sign test confirmed this result—Z = -1.14. A number of the pilots who indicated a preference for filing flight plans by computerized word recognition qualified their responses by adding, "If specialist not readily available...If the phone is busy to the specialist...If it allows me to get through quicker...," etc.

Many pilots felt that question 4 required more thought than the others because of the requirement to choose between the URD and the FSS specialist for filing. The difficulty arose because under the present system, weather and other aeronautical data are normally procured at the same time the flight plan is filed. It was explained to the pilots that this test was only concerned with the flight plan filing function and not with weather or Notice to Airmen data. However, they had trouble divorcing these functions. They questioned what would be gained timewise by filing through the URD when a second

TABLE 4. RESPONSES TO QUESTION 4

We realize there is a trade-off in using any means of filing flight plans; namely, a longer filing time in using the word recognition system for flight plan filing versus possible long delays in reaching the FSS (specialist or fast file) to file by phone. Delay time in reaching the FSS by phone will vary depending on current weather in the FSS service area and geographic location of the FSS (very long phone waits in the NYC area during periods of marginal weather). Considering all the above factors, which would be your preferred method of filing future flight plans?

Word Recognition System		Phone Call		Total			
N	%	N	%	N	%	χ^2	Z
29	59.18	20	40.82	49*	100.00	1.65	-1.14

*One respondent did not select either of the fixed choices. Instead he stated, "answer depends on which way is longer." He indicated that the word recognition system was "preferred if overall time saving is significant," and a phone call direct to specialist was preferred if time difference is tolerable or not significant.

call would still have to be made to the specialist which could require a further wait. The pilots who expressed this concern suggested that some type of selected weather data be included as an URD option. Offering limited weather information as an URD option could significantly reduce the time spent with the specialist and also reduce the number of amended flight plans, since the pilot could make better initial decisions on altitude or other elements.

RESPONSES TO QUESTION 5.

Question 5 asked the pilot, "On the manner of prompt, do you prefer the cue-tone prompt, the word echo-back prompt, or no prompt?" Of the fifty subjects, not one selected the cue-tone prompt. The majority of respondents selected the no prompt choice. Table 5 shows the distribution of responses. Since the X^2 and Z values were statistically significant, the null-hypothesis, that there was no difference between methods of prompting, may be rejected.

The beep tone used in flight plan A (figure 3) was evidently quite irritating to the users. When all three tests were completed, they were asked to tentatively select the preferred method while all were fresh in their minds. The cue-tone prompt (method A) was immediately rejected without hesitation by most subjects. The sound of the tone was undesirable.

The outstanding feature of the word echo-back prompt (method B) was the ability to hear immediate confirmation of the word entered and the ability to immediately enter a correction. No prompt (method C, preferred) had the desirable effect of allowing a more natural conversational style of entry which had a very strong appeal with most subjects.

The use of the command word LAST to correct previous lines was considered useful and was used quite often during testing. Many pilots used it; however, several admitted employing it unnecessarily just to see how it would work.

TABLE 5. RESPONSES TO QUESTION 5

On the manner of prompt, do you prefer the cue-tone prompt, the word echo-back prompt, or no prompt?

Cue-Tone Prompt		Word Echo-Back Prompt		No Prompt		Total			
N	%	N	%	N	%	N	%	X^2	Z
0	0	16	32.00	34	68.00	50	100.00	6.48	2.40

RESPONSES TO QUESTION 6.

Item 6 of the questionnaire asked, "Is the available vocabulary sufficient or would more command words better enable flight plan entry?" The respondents were given three choices as follows:

1. Present vocabulary sufficient.

2. Need changes in present vocabulary as noted.

3. Present vocabulary insufficient, should add.

The χ^2 and Z values shown in table 6 indicate a test of the significance of the difference between the number of responses in column 1 (Vocabulary Sufficient) and the total number of responses in column 2 (Need Changes) and column 3 (Vocabulary Insufficient). No statistically significant difference was found.

The following changes and additions to the vocabulary were suggested:

1. Use slash instead of slant.

2. Add the command word "thousand" for altitudes and "hundred" for time and fuel instead of successive zeros.

3. Add common aircraft manufacturers names, such as Cessna, Piper, etc.

4. Add the words "knots," "zulu," "hours," "minutes," "single engine," and "over water."

5. Fuel on board expressed as "four four five" is not as meaningful as 4 hours and 45 minutes.

6. Add multiple variations of the phonetic alphabet.

7. Use the command word "none" or "blank" to signify no entry.

Table 6 shows the distribution of responses to question 6.

A significant problem encountered during testing involved nonstandard words in the phonetic alphabet. Many of the older, more experienced pilots were using the old phonetic alphabet, which generated a lot of mistakes. In fact, before testing began many pilots confessed to being a "little rusty," or some similar statement, regarding use of the phonetic alphabet. This opinion was expressed by pilots in all categories of experience, but the older group predominated. Several pilots suggested programing several of the "old" phonetic words along with the correct ones. This might consist of half a dozen or so of the words most likely to present a problem because of their widespread, though incorrect, use. To avoid confusion, these nonstandard words would not be advertised as existing in the system, but would nevertheless be programed and available anytime a pilot lapsed into old ways. A significant proportion of errors might be avoided this way. A comparison of the phonetically correct word with examples of what many pilots tended to use is shown below. Each example was used at least once, and the asterisk indicates frequent usage.

PHONETIC ALPHABET COMPARISON

Correct	Often Used
Alpha	Able
* Bravo	Baker
Delta	Dog
* Echo	Easy
Golf	George
* India	Item
Juliett	Jig
Kilo	King
November	Nan
* Sierra	Sugar
Uniform	Uncle
Yankee	Yoke
Zulu	Zebra, Zed

In a few cases, there were problems with dialects, accents, or personnal idiosyncracies. For example, one individual used Limo for Lima, and Sierro for Sierra.

TABLE 6. RESPONSES TO QUESTION 6

Is the available vocabulary sufficient or would more command words better enable flight plan entry?

Vocabulary Sufficient		Need Changes		Vocabulary Insufficient		Total			
N	%	N	%	N	%	N	%	X^2	Z
30	58.82	6	11.76	15	29.41	51*	100.00	1.59	-1.12

*One respondent selected two of the three alternatives—"Need Changes" and "Vocabulary Insufficient."

RESPONSES TO QUESTION 7.

Question 7 asked the pilot, "Do you feel that you could successfully file a flight plan using this word recognition system?" The subjects were given a choice of a "yes" or "no" in responding to this question. As shown in table 7, the overwhelming majority of pilots (49 out of 50) answered "yes" to this question. However, 2 of the 49 pilots qualified their answer as follows:

1. "With more practice."

2. "It can be done, I would not like this type of filing a flight plan."

RESPONSES TO QUESTION 8.

Item 8 of the questionnaire asked the pilot, "Would you use a filing system similar to this?" The answer to this question was limited to a "yes" or "no" response. Table 8 shows that the overwhelming majority (46 out of 50 pilots) answered "yes" to question 8. It should be noted, however, that 7 out of the 46 pilots qualified their answer with the following statements:

1. "Yes, if this was all that was available."

2. "Only if no other choice."

3. "Yes, if the alternative meant excessive delay."

4. "Yes, if specialist not available."

5. "Yes—probably."

6. "Depending upon location."

7. "Yes, if I had trouble getting a FSS person."

There were no qualifying answers from any of the 4 pilots who answered "no" to question 8.

TABLE 7. RESPONSES TO QUESTION 7

Do you feel that you could successfully file a flight plan using this word recognition system?

Yes		No		Total			
N	%	N	%	N	%	χ^2	Z
49	98.00	1	2.00	50	100.00	46.08	6.65

TABLE 8. RESPONSES TO QUESTION 8

Would you use a filing system similar to this?

Yes		No		Total			
N	%	N	%	N	%	χ^2	Z
46	92.00	4	8.00	50	100.00	35.28	-5.80

RESPONSES TO ITEM 9.

Item 9 of the questionnaire invited the respondents to write in any comments they wished to make. The comments received provide important insights into th attitudes of the subject pilots toward automatic flight plan filing. For this reason they are provided in this report as actually stated rather than summarized. Except for some comments that were eliminated because they were not considered to be pertinent or informative, the following is a list of the write-in comments received.

1. "Reference item 4, the longer times using word recognition. Typically, there are delays in obtaining the specialist to the extent that word recognition would imply a longer period on the phone but less problems completing the phone call. Also, on occasions where weather information has been obtained; otherwise, there is no need to call the specialist."

2. "I felt better with the echo prompt than with the others—although I felt the no prompt would be faster."

3. "I preferred no prompter system because the repeated information was longer (continuity) as opposed to short segments of repeated information. More concentration and time appeared to be required for flight plans 1 and 2 (especially No. 1)."

4. "A specialist would advise one on new (weather) data. A computer would not. I feel the computer has a future in flight planning. However, it could not replace the TRUST I receive from a specialist. I like to see weather observation tied in with computerized flight planning."

5. "If no form available, prefer full info request."

6. "Recent flight experience with USDA screwworm eradication in Mexico. The area we flew in has no NAVAIDS to speak of and our only radio contact was with FSS and we were totally dependent on FSS for flight following. Replacement of the FSS specialist would affect safety of this particular program."

7. "Once the flight plan is in proper format in front of you the automation of reading into phone should be no problem. In fact, I prefer this method."

8. "Silence as a terminator makes a demand not easily met at some phone stations (noisy offices, outside phone booths, etc.)."

9. "We need to guard against adding user burdens in an attempt to ease the burdens of the service elements."

10. "Presently FSS phones at FSS's are limited and line ups exist at high density airports, time delay in getting through to computer—if as bad as getting through to SPECIALIST would be prohibitive."

11. "I can foresee tempers flaring, if executive pilots have to put up with these aggravated delays at flight plan filing telephones."

12. "Sometimes excessive repeating to voice computer of its mistakes could be most disturbing mentally. Could even cause pilots in disgust to cancel IFR flight plans and jeopardize flight safety."

13. "Time is important, any means to reduce time without compromising accuracy should be tried."

14. "Regarding No. 4: I feel I would prefer to file a flight plan directly with a specialist at FSS. It just seems more personalized talking with another person. Perhaps a combination could be worked out whereby the computer filing would be used during periods of high workloads on the specialists and directly with people when they are available."

15. "Liked flight plan three the best. I could get used to it and take very little longer than method now used."

16. "The read back of departure time, fuel aboard, and routing, plus alternate airport would save time on flight plan."

17. "Background noise could be a problem for filing in some locations."

18. "Somewhere downstream why can't we, just for example, just give departure and destination airports and just request appropriate routes."

19. "Biggest problem was corrections for me, and where to jump in for correction—I would always like to hear play back corrections."

20. "Has the thought of using CRT display of typed entry been explored?"

21. "When computer asks to please repeat or correction is made, have computer read back whole segment."

22. "I think the computer would need to be proven reliable."

23. "Much info could be 'canned' for each aircraft, thereby shortening flight plan."

Important items:

Destination
Aircraft type
Departure point

24. "I am an Army Guard pilot. We fill out a 175-1 weather briefing before the 175 (flight plan). This would mean that a computer giving weather info would have to be separate from one accepting flight plans."

25. "Computer had some difficulty understanding me on flight plan No. 2. Proper enunciation is important and pilots (foreign accent) would have to be briefed. Flight plan No. 2—On two entries, altitude 9,000 feet and /BWZ/, I was not sure whether the computer properly accepted 9,000 feet and W."

26. "If you can speed up filing flight plans in areas like DCA and BAL, I am all for it."

27. "I use the system (FSS) almost daily and have experienced little or no delays in getting my flight plan filed."

28. "I want the luxury of discussing the WX with the flight service specialists."

29. "Would like to see the Pireps for my route of flight included at the end of flight plan."

30. "The system at present to me is fine—it keeps a personal touch and it feels better. Also, if there is a mistake, you can talk to a person."

31. "Reference No. 4—For special missions such as our flight testing at NAFEC, this automated system is not usable. For example, we may have to fly unusual patterns both vertically and horizontally at varying speeds, etc."

32. "Need specialist for pilot reports and specific weather en route briefing, rather than getting a weather report for large section of country."

CONCLUSIONS

Given the assumption that the actual utterance recognition device performs at a level comparable to that of the simulation used in this experiment, it is reasonable to conclude that:

1. General aviation pilots could, and would, elect to file flight plans by computerized word recognition using a real computer.

2. General aviation pilots would prefer partial entry by word recognition and partial entry by recording over complete entry of information via word recognition when speaking to a real computer.

3. General aviation pilots would prefer the no prompt method or word echo-back prompt over the cue-tone prompt when speaking to a real-word recognition computer.

4. General aviation pilots would be able to file flight plans by computerized word recognition using the experimental vocabulary when speaking to a real computer. We cannot offer any compelling evidence at this time regarding the optimum size and content of the word recognition vocabulary. Further testing is necessary to ascertain this information.

Our results show a small absolute difference between the preference for the block method of request and the full information request; with the larger

number of subjects preferring the block method. The difference is not statistically reliable. Therefore, we cannot offer any compelling evidence at this time that there is any profound difference in the preference for either method.

Our results show a small difference between the preference for using the word recognition system over calling the specialist directly (given the possible long delays in reaching the Flight Service Station (FSS). The difference, however, is not statistically reliable. Therefore, we cannot offer any compelling evidence at this time that there is any profound difference in pilot preference.

RECOMMENDATIONS

1. It is recommended that additional experiments be conducted using a real utterance recognition device (URD) to determine:

   a. The performance degradation due to an expanded vocabulary.

   b. The effects of regional differences in pronunciations.

   c. The optimum size and content of the vocabulary.

   d. The best protocol for entering the data.

   e. The attitude of the general aviation public toward this system.

2. Once the limitations of the utterance recognition device are fully known, an adaptation strategy should be developed to overcome these limitations.

3. In future evaluation experiments, make provision for a limited amount of weather or Notice to Airmen (NOTAM) data to be available to the pilot as an URD option. (See commentary on question 4.)

APPENDIX A

RESPONSES TO QUESTIONS ACCORDING TO SUBGROUP

TABLE A-1. RESPONSES TO QUESTION 1 ACCORDING TO SUBGROUP

	Block Method Request		Full Information Request		Total		
	N	%	N	%	N	%	Z
Engine Rating							
Single Engine	10	62.50	6	37.50	16	100.00	-0.75
Multi Engine	19	55.88	15	44.12	34	100.00	-0.51
Total	29	58.00	21	42.00	50	100.00	-0.99
License Rating							
Private	3	42.86	4	57.14	7	100.00	0
Commercial	14	60.87	9	39.13	23	100.00	-0.83
ATP	12	60.00	8	40.00	20	100.00	-0.67
Total	29	58.00	21	42.00	50	100.00	-0.99
Instrument Rating							
IFR	22	57.89	16	42.11	38	100.00	-0.81
VFR	7	58.33	5	41.67	12	100.00	-0.29
Total	29	58.00	21	42.00	50	100.00	-0.99
Annual Flying Time							
0-100 hours	14	50.00	14	50.00	28	100.00	0
> 100 hours	15	68.18	7	31.82	22	100.00	-1.49
Total	29	58.00	21	42.00	50	100.00	-0.99
Total Flying Time							
1-999	7	50.00	7	50.00	14	100.00	0
1,000-3,999	9	64.29	5	35.71	14	100.00	-0.80
4,000-10,000	7	70.00	3	30.00	10	100.00	-0.95
> 10,000	6	50.00	6	50.00	12	100.00	0
Total	29	58.00	21	42.00	50	100.00	-0.99

TABLE A-2. RESPONSES TO QUESTION 2 ACCORDING TO SUBGROUP

	Complete Entry		Partial Entry		No Preference		Total		
	N	%	N	%	N	%	N	%	Z*
Engine Rating									
Single Engine	1	5.88	15	88.24	1	5.88	17	100.00	3.06
Multi Engine	2	6.06	29	87.88	2	6.06	33	100.00	4.53
Total	3	6.00	44	88.00	3	6.00	50	100.00	5.60
License Rating									
Private	0	0	7	100.00	0	0	7	100.00	2.27
Commercial	1	4.35	20	86.96	2	8.70	23	100.00	3.75
ATP	2	10.00	17	85.00	1	5.00	20	100.00	2.92
Total	3	6.00	44	88.00	3	6.00	50	100.00	5.60
Instrument Rating									
IFR	2	5.26	34	89.47	2	5.26	38	100.00	5.03
VFR	1	8.33	10	83.33	1	8.33	12	100.00	2.41
Total	3	6.00	44	88.00	3	6.00	50	100.00	5.60
Annual Flying Time									
0-100	1	3.57	25	89.29	2	7.14	28	100.00	4.35
> 100	2	9.09	19	86.36	1	4.55	22	100.00	3.20
Total	3	6.00	44	88.00	3	6.00	50	100.00	5.60
Total Flying Time									
0-999	1	7.14	13	92.86	0	0	14	100.00	2.94
1,000-3,999	0	0	12	85.71	2	14.29	14	100.00	2.94
4,000-10,000	1	10.00	9	90.00	0	0	10	100.00	2.21
> 10,000	1	8.33	10	83.33	1	8.33	12	100.00	2.41
Total	3	6.00	44	88.00	3	6.00	50	100.00	5.60

*All Z values significant at the 0.05 level.

TABLE A-3. RESPONSES TO QUESTION 3 ACCORDING TO SUBGROUP

	Yes		No		Total		
	N	%	N	%	N	%	Z*
Engine Rating							
Single Engine	16	100.00	0	0	16	100.00	-3.75
Multi Engine	33	97.06	1	2.94	34	100.00	-5.32
Total	49	98.00	1	2.00	50	100.00	-6.65
License Rating							
Private	7	100.00	0	0	7	100.00	-2.27
Commercial	23	100.00	0	0	23	100.00	-4.59
ATP	19	95.00	1	5.00	20	100.00	-3.80
Total	49	98.00	1	2.00	50	100.00	-6.65
Instrument Rating							
IFR	37	97.37	1	2.63	38	100.00	-5.68
VFR	12	100.00	0	0	12	100.00	-3.18
Total	49	98.00	1	2.00	50	100.00	-6.65
Annual Flying Time							
0-100 hours	28	100.00	0	0	28	100.00	-5.10
> 100 hours	21	95.45	1	4.55	22	100.00	-4.05
Total	49	98.00	1	2.00	50	100.00	-6.65
Total Flying Time							
0-999	14	100.00	0	0	14	100.00	-3.47
1,000-3,999	14	100.00	0	0	14	100.00	-3.47
4,000-10,000	10	100.00	0	0	10	100.00	-2.85
> 10,000	11	91.67	1	8.33	12	100.00	-2.60
Total	49	98.00	1	2.00	50	100.00	-6.65

*All Z values are significant at the 0.05 level.

TABLE A-4. RESPONSES TO QUESTION 4 ACCORDING TO SUBGROUP

	Word Recognition		Phone Call		Total		
	N	%	N	%	N	%	Z
Engine Rating							
Single Engine	11	68.75	5	31.25	16	100.00	-1.25
Multi Engine	18	54.55	15	45.45	33	100.00	-0.35
Total	29	59.18	20	40.82	49	100.00	-1.14
License Rating							
Private	4	57.14	3	42.86	7	100.00	0
Commercial	17	73.91	6	26.09	23	100.00	-2.09*
ATP	8	42.11	11	57.89	19	100.00	0.46
Total	29	59.18	20	40.82	49	100.00	-1.14
Instrument Rating							
IFR	22	59.46	15	40.54	37	100.00	-0.99
VFR	7	58.33	5	41.67	12	100.00	-0.29
Total	29	59.18	20	40.82	49	100.00	-1.14
Annual Flying Time							
0-100 hours	21	75.00	7	25.00	28	100.00	-2.46*
> 100 hours	8	38.10	13	61.90	21	100.00	0.87
Total	29	59.18	20	40.82	49	100.00	-1.14
Total Flying Time							
0-999	9	64.29	5	35.71	14	100.00	-0.80
1,000-3,999	11	84.62	2	15.38	13	100.00	-2.22*
4,000-10,000	5	45.45	6	54.55	11	100.00	0
> 10,000	4	36.36	7	63.64	11	100.00	0.60
Total	29	59.18	20	40.82	49	100.00	-1.14

*Significant at the 0.05 level.

TABLE A-5. RESPONSES TO QUESTION 5 ACCORDING TO SUBGROUP

	Cue-Tone Prompt		Word Echo-Back Prompt		No Prompt		Total		
	N	%	N	%	N	%	N	%	Z
Engine Rating									
Single Engine	0	0	5	31.25	11	68.75	16	100.00	1.25
Multi Engine	0	0	11	32.35	23	67.65	34	100.00	1.89
Total	0	0	16	32.00	34	68.00	50	100.00	2.40*
License Rating									
Private	0	0	3	42.86	4	57.14	7	100.00	0
Commercial	0	0	7	30.43	16	69.57	23	100.00	1.67
ATP	0	0	6	30.00	14	70.00	20	100.00	1.57
Total	0	0	16	32.00	34	68.00	50	100.00	2.40*
Instrument Rating									
IFR	0	0	12	31.58	26	68.42	38	100.00	2.11*
VFR	0	0	4	33.33	8	66.67	12	100.00	0.87
Total	0	0	16	32.00	34	68.00	50	100.00	2.40*
Annual Flying Time									
0-100	0	0	11	39.29	17	60.71	28	100.00	0.94
> 100	0	0	5	22.73	17	77.27	22	100.00	2.35*
Total	0	0	16	32.00	34	68.00	50	100.00	2.40*
Total Flying Time									
0-999	0	0	6	42.86	8	57.14	14	100.00	0.27
1,000-3,999	0	0	4	28.57	10	71.43	14	100.00	1.34
4,000-10,000	0	0	2	20.00	8	80.00	10	100.00	1.58
> 10,000	0	0	4	33.33	8	66.67	12	100.00	0.87
Total	0	0	16	32.00	34	68.00	50	100.00	2.40*

*Significant at the 0.05 level.

TABLE A-6. RESPONSES TO QUESTION 6 ACCORDING TO SUBGROUP

	Vocabulary Sufficient		Need Changes		Vocabulary Insufficient		Total		
	N	%	N	%	N	%	N	%	Z*
Engine Rating									
Single Engine	11	68.75	1	6.25	4	25.00	16	100.00	-1.25
Multi Engine	19	54.29	5	14.29	11	31.43	35	100.00	-0.34
Total	30	58.82	6	11.76	15	29.41	51	100.00	-1.12
License Rating									
Private	4	57.14	1	14.29	2	28.57	7	100.00	0
Commercial	15	60.00	2	8.00	8	32.00	25	100.00	-0.80
ATP	11	57.89	3	15.79	5	26.32	19	100.00	-0.46
Total	30	58.82	6	11.76	15	29.41	51	100.00	-1.12
Instrument Rating									
IFR	22	57.89	4	10.53	12	31.58	38	100.00	-0.81
VFR	8	61.54	2	15.38	3	23.08	13	100.00	-0.55
Total	30	58.82	6	11.76	15	29.41	51	100.00	-1.12
Annual Flying Time									
0-100	18	62.07	2	6.90	9	31.03	29	100.00	-1.11
> 100	12	54.55	4	18.18	6	27.27	22	100.00	-0.21
Total	30	58.82	6	11.76	15	29.41	51	100.00	-1.12
Total Flying Time									
0-999	7	50.00	1	7.14	6	42.86	14	100.00	0
1,000-3,999	9	69.23	1	7.69	3	23.08	13	100.00	-1.11
4,000-10,000	8	66.67	3	25.00	1	8.33	12	100.00	-0.87
> 10,000	6	50.00	1	8.33	5	41.67	12	100.00	0
Total	30	58.82	6	11.76	15	29.41	51	100.00	-1.12

*Z scores indicate a test of the significance of the difference between the number of responses in column 1 (Vocabulary Sufficient) and the total number of responses in columns 2 and 3 (Need Changes) and (Vocabulary Insufficient).

TABLE A-7. RESPONSES TO QUESTION 7 ACCORDING TO SUBGROUP

	Yes		No		Total		
	N	%	N	%	N	%	Z*
Engine Rating							
Single Engine	16	100.00	0	0	16	100.00	-3.75
Multi Engine	33	97.06	1	2.94	34	100.00	-5.32
Total	49	98.00	1	2.00	50	100.00	-6.65
License Rating							
Private	7	100.00	0	0	7	100.00	-2.27
Commercial	23	100.00	0	0	23	100.00	-4.59
ATP	19	95.00	1	5.00	20	100.00	-3.80
Total	49	98.00	1	2.00	50	100.00	-6.65
Instrument Rating							
IFR	37	97.37	1	2.63	38	100.00	-5.68
VFR	12	100.00	0	0	12	100.00	-3.18
Total	49	98.00	1	2.00	50	100.00	-6.65
Annual Flying Time							
0-100	28	100.00	0	0	28	100.00	-5.10
> 100	21	95.45	1	4.55	22	100.00	-4.05
Total	49	98.00	1	2.00	50	100.00	-6.65
Total Flying Time							
0-999	14	100.00	0	0	14	100.00	-3.47
1,000-3,999	13	92.86	1	7.14	14	100.00	-2.94
4,000-10,000	10	100.00	0	0	10	100.00	-2.85
> 10,000	12	100.00	0	0	12	100.00	-3.18
Total	49	98.00	1	2.00	50	100.00	-6.65

*All Z values significant at the 0.05 level.

TABLE A-8. RESPONSES TO QUESTION 8 ACCORDING TO SUBGROUP

	Yes		No		Total		
	N	%	N	%	N	%	Z*
Engine Rating							
Single Engine	16	100.00	0	0	16	100.00	-3.75
Multi Engine	30	88.24	4	11.76	34	100.00	-4.29
Total	46	92.00	4	8.00	50	100.00	-5.80
License Rating							
Private	7	100.00	0	0	7	100.00	-2.27
Commercial	23	100.00	0	0	23	100.00	-4.59
ATP	16	80.00	4	20.00	20	100.00	-2.46
Total	46	92.00	4	8.00	50	100.00	-5.80
Instrument Rating							
IFR	34	89.47	4	10.53	38	100.00	-4.70
VFR	12	100.00	0	0	12	100.00	-3.18
Total	46	92.00	4	8.00	50	100.00	-5.80
Annual Flying Time							
0-100	28	100.00	0	0	28	100.00	-5.10
> 100	18	81.82	4	18.18	22	100.00	-2.77
Total	46	92.00	4	8.00	50	100.00	-5.80
Total Flying Time							
0-999	14	100.00	0	0	14	100.00	-3.47
1,000-3,999	13	92.86	1	7.14	14	100.00	-2.94
4,000-10,000	9	90.00	1	10.00	10	100.00	-2.21
> 10,000	10	83.33	2	16.67	12	100.00	-2.02
Total	46	92.00	4	8.00	50	100.00	-5.80

*All Z values significant at the 0.05 level.