(14)

Evaluation of the FAA/MITRE Weather Data Device

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Development Service
Washington, D.C. 20590

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January 1982

Final Report

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Abstract

Evaluation of cockpit weather display unit. Results of pilot experiences using National Weather Service (NWS) ground weather radar data uplinked to the cockpit via land lines to a Very High Frequency Omnidirectional Radio Range (VOR) and via the VOR voice channel to the aircraft VOR receiver then decoded and displayed on a printed paper format. NWS weather radar information is available on demand using this system.

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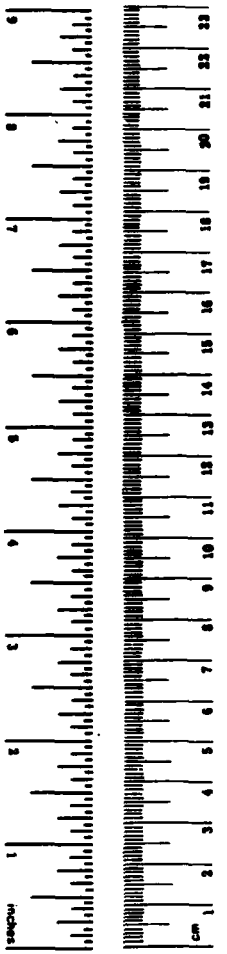
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

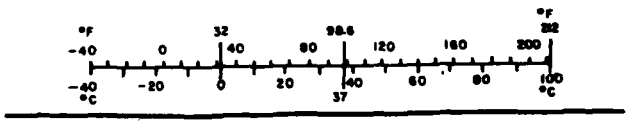
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	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

*) 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



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I. SUMMARY AND CONCLUSIONS

A. Summary. The Avionics Engineering Center of Ohio University, under contract to the Federal Aviation Administration (FAA), evaluated a Cockpit Weather Display unit developed for the FAA by the MITRE Corporation.* Twenty subject pilots were flown using prerecorded weather information, and, when possible, real-time weather information from the Columbus weather radar uplinked to the aircraft on the Zanesville VOR. The airborne system consisted of a VOR receiver, a processor unit, a control module, and a hardcopy printer that provided the pilot with ground weather radar information in the cockpit upon demand.

B. Conclusions. Throughout the evaluation, pilot acceptance of the unit was universal and enthusiastic. Each pilot felt that this was a long-needed aid for weather avoidance by all types of aircraft. The immediate and thorough understanding of the system operation by pilots of all experience levels illustrates that operational utilization of this unit should be successful. A clear conclusion is that providing the pilot with a low-cost, real time radar weather information source, will be a distinct factor in reducing unnecessary radio transmissions, controller workload, and will aid the pilot in his decision-making process.

This can be further reinforced with the realization that such a unit installed in the cockpit would eliminate errors due to verbal communication of the weather picture, provide useful information, and most significantly, directly attack the major problem of aviation thunderstorm avoidance. Importantly, the widespread use of this unit would directly address the flying safety problem of pilots flying into adverse weather conditions for which they are not equipped to handle.

* was evaluated.

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II. INTRODUCTION

The Ohio University Avionics Engineering Center was selected by the Federal Aviation Administration to evaluate the Cockpit Weather Display (CWD) unit which was developed by the MITRE Corporation under contract to the FAA. This report deals with the formal evaluation of that unit by 20 selected subject pilots and an informal evaluation by 10 other pilots. Throughout the evaluation, every effort was made to determine pilot acceptance of the CWD and the ease or difficulty with which the pilot became familiar with and used it.

This report summarizes the responses of the subject pilots, and attempts to present their desires and proposed changes that they feel would make the unit more acceptable to the general aviation user. The subject pilots ranged in experience from student pilot to Airline Transport Pilot (ATP), and each pilot was presented the same prerecorded weather situation. They were flown in the same aircraft, and the flights averaged one hour in length. This reduced the variables which must be taken into account in the final evaluation of their responses.

Pilot responses to an opinionnaire were analyzed by using the Ohio University IBM 370 computer, and that analysis is used to present the final evaluation of the CWD unit.

III. COCKPIT WEATHER DISPLAY UNIT EVALUATION

A. System Description. The CWD provides the pilot a printed display of real time National Weather Service weather radar data which has been converted to digital information and broadcast on a ground navaid RF carrier. For this experimental program, the data was uplinked via the voice channel of the Zanesville, Ohio VOR (ZZV). In the aircraft, the audio output of a VOR receiver feeds a set of tone filters and a microcomputer-based processor which interprets the digital data and drives the output printer. A keyboard and display panel allows selection of output display format (Figure 1).

For ease of use, the system contains its own operating instructions, (Figure 2), which the pilot may request on the output printer. The weather displays permit several formats, including the standard 256-mile by 256-mile charts (Figure 3, Scale 1), the hazardous weather output, PIREP's, NOTAMs, hourly weather sequences (SA's), and terminal forecasts (FT's). See Figures 3 and 4 for example printouts. Note the use of variable print density for describing weather intensity levels. The weather information presented to the subject pilots contained level 1 through 4 weather displays. Although prerecorded data was used, the Columbus, Ohio National Weather Service weather radar a WSR-74C unit was connected via landline enabling the use of actual weather radar pictures when they were available.

As used for this evaluation project, both keyboard and printer units were movable in the cockpit, to permit evaluation in various locations by the subject pilots.

B. Opinionnaire Development. Early in the development of this task, an opinionnaire was prepared and forwarded to the FAA for evaluation and final approval. A copy of the final opinionnaire is in Appendix A. The opinionnaire is intended to measure pilot reaction to the CWD, and it also provides the experience level of the subject pilots. It, therefore, becomes possible to analyze pilot responses based upon ratings and experience level. The pilot was also able to indicate his desires as to location, type of display, and his opinion as to ease or difficulty of the operation of the CWD. A 39-question opinionnaire was designed, and the answers were placed on computerized answer sheets so the information could be placed in the Ohio University computer. Using the Statistical Pogram for the Social Sciences (SPSS) package, each opinionnaire was sorted by category of instrument rating or non-instrument rating, instructor and instrument instructor. The ability to sort on total time, cross-country time, and pilot certificate remains within the system, but has not been used in this report. The computer analysis is attached (Appendix B).

C. Equipment Installation and Route Selection. FAA and MITRE personnel installed the necessary equipment on the Zanesville, Ohio, VOR, and linked it with the Columbus weather radar. This was accomplished early in September and was done while evaluators were waiting for adequate actual weather information to be recorded that could be used for a standard against which the subject pilots would fly. Sufficient weather was

KEYBOARD INSTRUCTIONS

WX RADAR: PRINTS THE WEATHER RADAR DATA WITH THE LAST SELECTED MAP CENTER AND SCALE. PRECIPITATION LEVELS ARE ENCODED AS FOLLOWS:

LIGHT	<.2 IN/HR
MODERATE	.2 - 1 IN/HR
HEAVY	1 - 4 IN/HR
SEVERE	> 4 IN/HR

HAZ WX: PRINTS THE HAZARDOUS WEATHER DATA WITH THE LAST SELECTED MAP CENTER AND SCALE

PIREP NOTAM: PRINTS PIREPS + NOTAMS

SAS: PRINTS SURFACE OBSERVATIONS

RADAR: CENTERS THE MAP ON THE RADAR SITE; SCALE = 1 (256 NMI SQUARE)

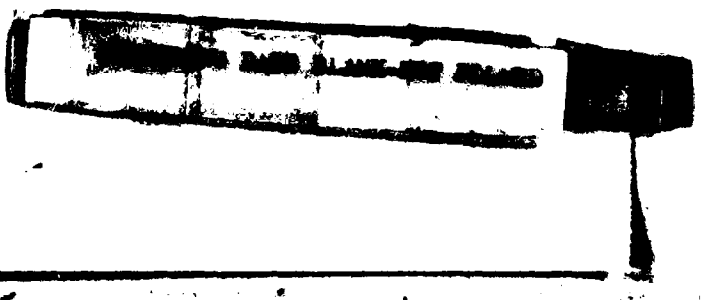
NW.NE.SW.SE: CENTERS THE MAP IN THE QUADRANT; SCALE = 2 (128 NMI SQ)

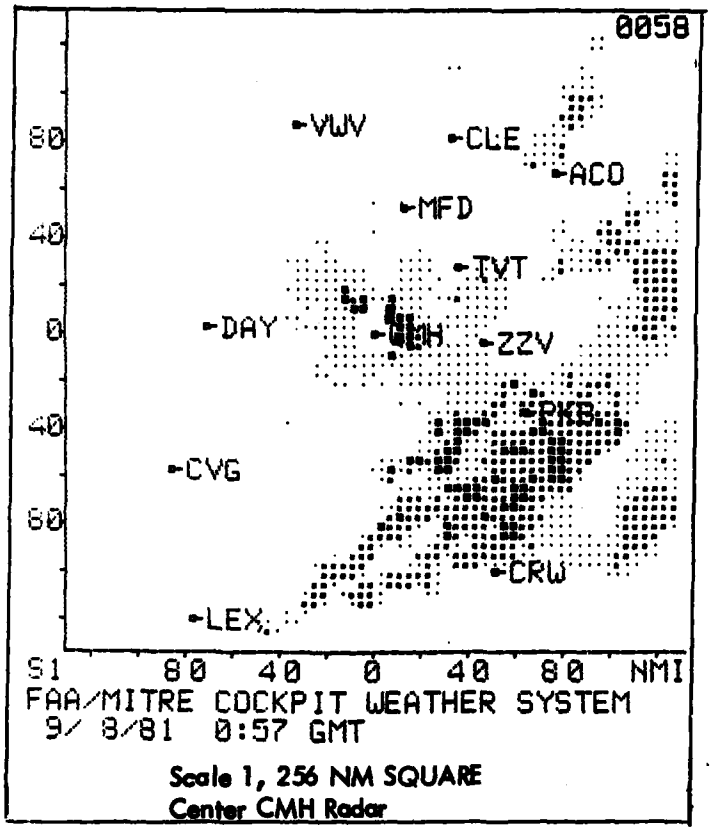
MAP ID: FOLLOWED BY 3 LETTERS CENTERS THE MAP ON THE MAP LOCATION; SCALE = 3 (85 NMI SQ)

SCALE: FOLLOWED BY A DIGIT N SETS THE MAP SIZE TO 256/N NMI SQUARE

DISPLAY ALTIM SET: PLUS 3 LETTERS DISPLAYS SITE ALTIMETER SETTING

Figure 2. Instruction Sheet.




0058
VWV
CLE
ACO
MFD
TVT
DAY
CMH
ZZV
PKB
CVG
CRW
LEX
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40
0
40
80
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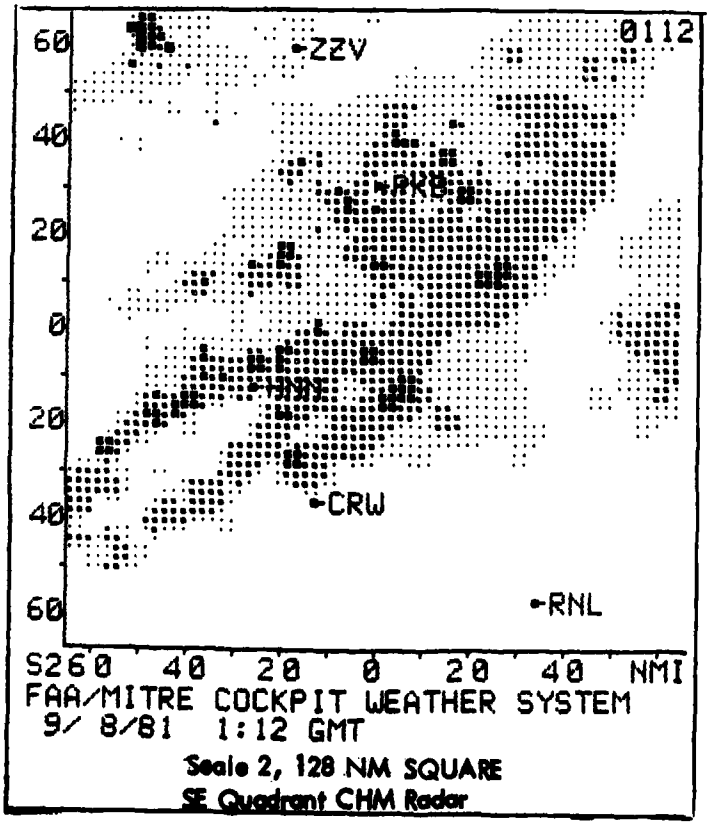
FAA/MITRE COCKPIT WEATHER SYSTEM
9/ 8/81 0:57 GMT
Scale 1, 256 NM SQUARE
Center CMH Radar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ZZV
PKB
CRW
RNL
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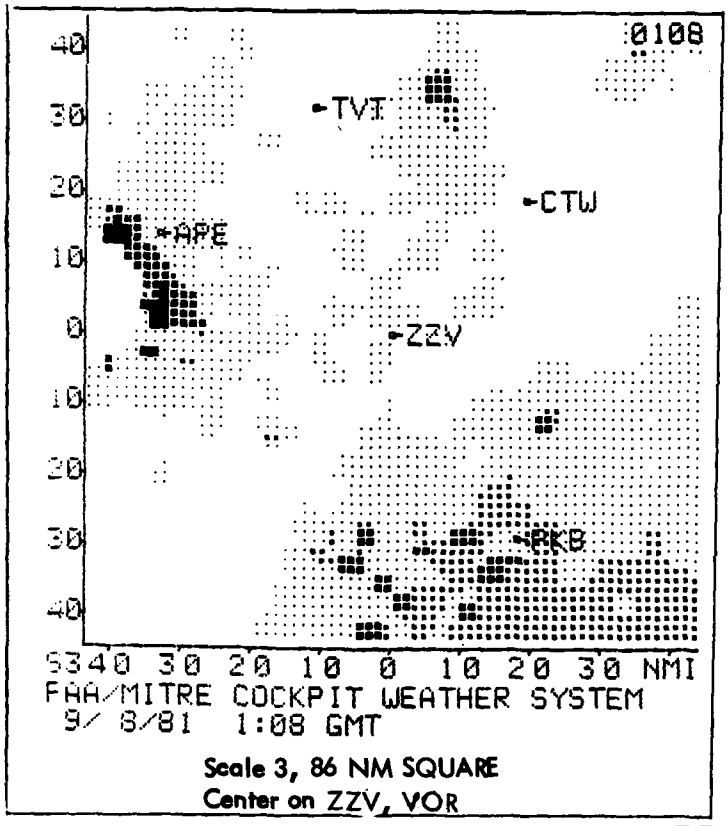
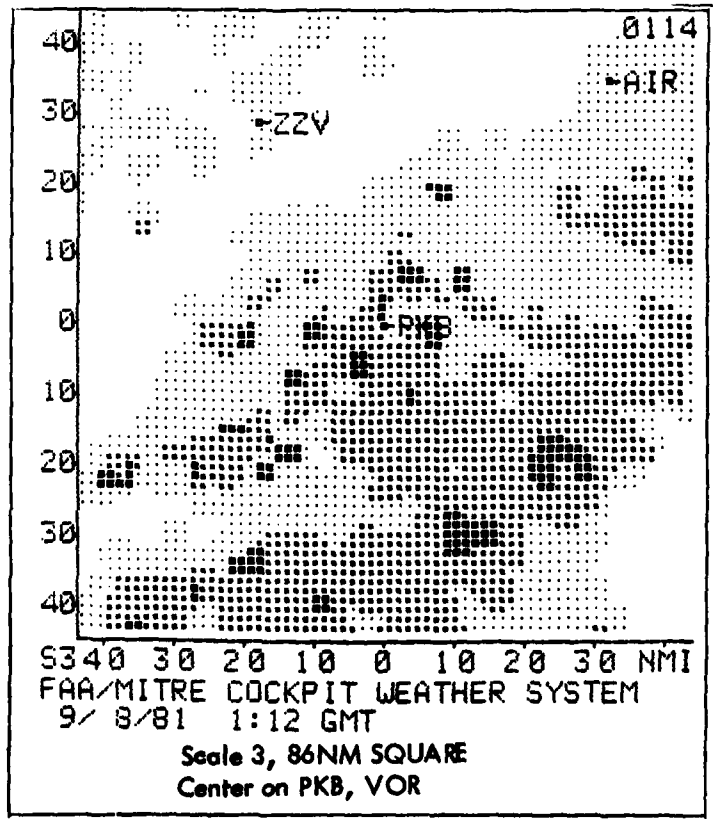
40
20
0
20
40
60
S2 60 40 20 0 20 40 NMI
FAA/MITRE COCKPIT WEATHER SYSTEM
9/ 8/81 1:12 GMT
Scale 2, 128 NM SQUARE
SE Quadrant CMH Radar

Figure 3.



Scale 3, 86 NM SQUARE
Center on ZZV, VOR



Scale 3, 86NM SQUARE
Center on PKB, VOR

Figure 4.

recorded by late September 1981, and flying began immediately. An initial route in Ohio from Athens to Cambridge, Tiverton, Newark, and return to Athens was selected (Figure 5), but after the first flight it became evident that this route did not present a definitive weather decision opportunity for the pilot. A conference was held with the FAA project manager and a new route Athens, Newark, Parkersburg, Athens (Figure 6) was selected.

This route was flown on all subject pilot evaluations, and a portion of the recorded weather situation presented is illustrated in Appendix C. Four printouts are displayed which show the overall picture centered on Columbus radar, the southeast quadrant, and expanded views of Zanesville and Parkersburg VORs. Each pilot was asked to fly this route and make his decision on what, if anything, he would do to alter his flight plan based upon observation of the printouts. All flights were flown in VFR conditions, and it was noted throughout the evaluations that the pilots had no trouble making a decision despite flying in simulated weather conditions. It was readily apparent that they became engrossed in the flight and based their decisions on the thought that the weather was actually there. This is supported by their responses to question number 13 on the opinionnaire.

D. Pilot Evaluation. A Beechcraft 35, N3169V (Figure 7) was modified to accept the CWD unit and was the aircraft used throughout the evaluation period. The box containing the processor was placed in the rear seat, and the printer was placed on the floorboard of the front seat. The pilot control keyboard was placed in various positions in the cockpit. This was based on individual pilot's desires. The specific location was addressed in the opinionnaire, and as expected the pilots each preferred a slightly different location. See Figure 8 for one such location.

As stated earlier, twenty (20) pilots were selected to fly with and evaluate the CWD unit. Each pilot was given an individual briefing emphasizing that the purpose of the mission was not to evaluate his flying abilities, nor to evaluate his decisions regarding weather, but instead to use the CWD and to provide his evaluation of how he felt the CWD would affect his flying. Some questions to be answered were: would the system be useful in VFR/IFR; would the information be useful in making weather related decisions; and would he have any trouble learning and operating the system as presented? Each of the questions were addressed in the opinionnaire and will be discussed later.

The table below shows the distribution of pilot certificates and ratings of the individuals flown. Two of the pilots were female and eleven (11) of the twenty (20) were aircraft owners, either individually or in partnerships.

Student Pilot	1
Private Pilot	10
Commercial Pilot	3
ATP	6

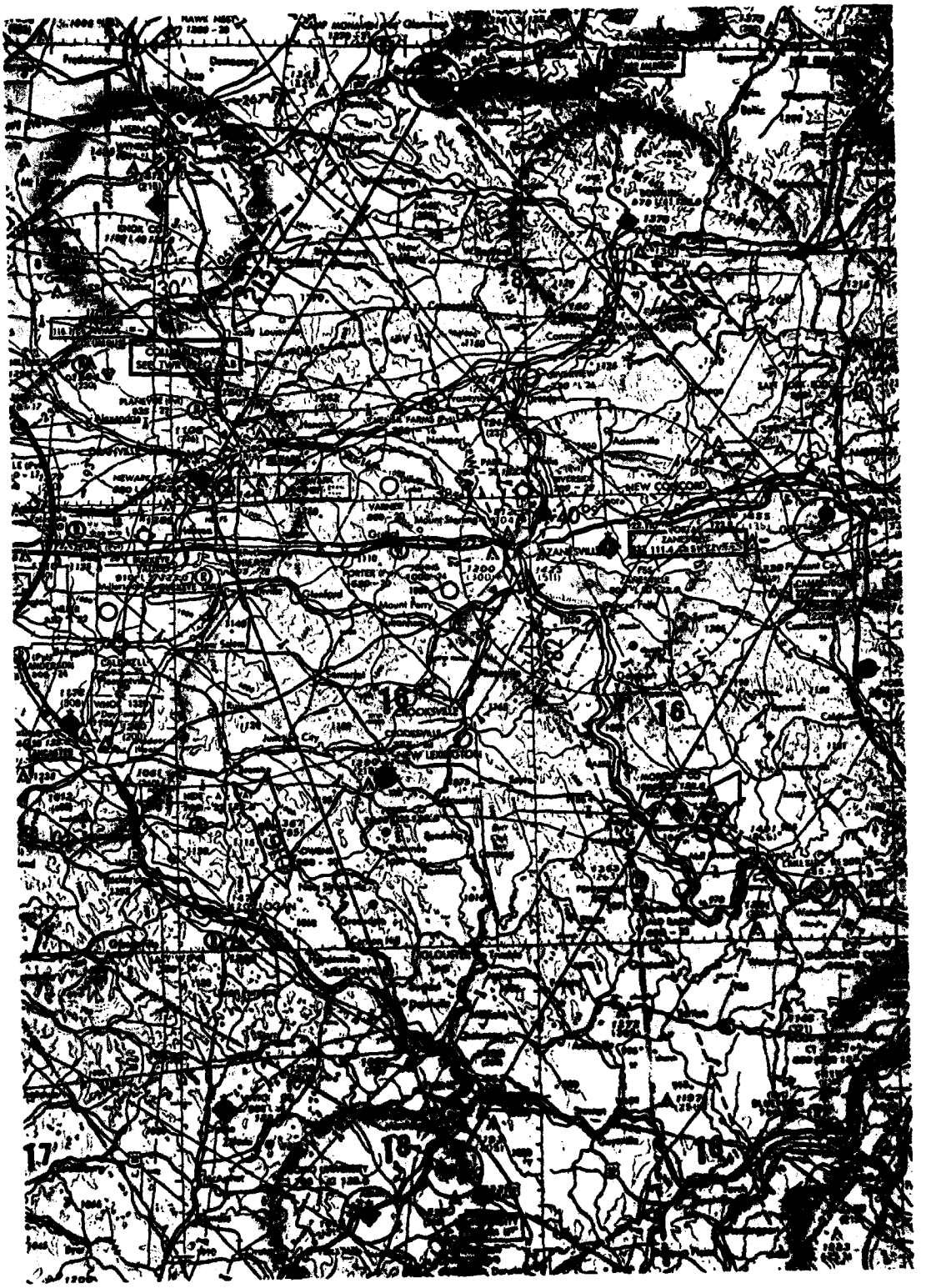
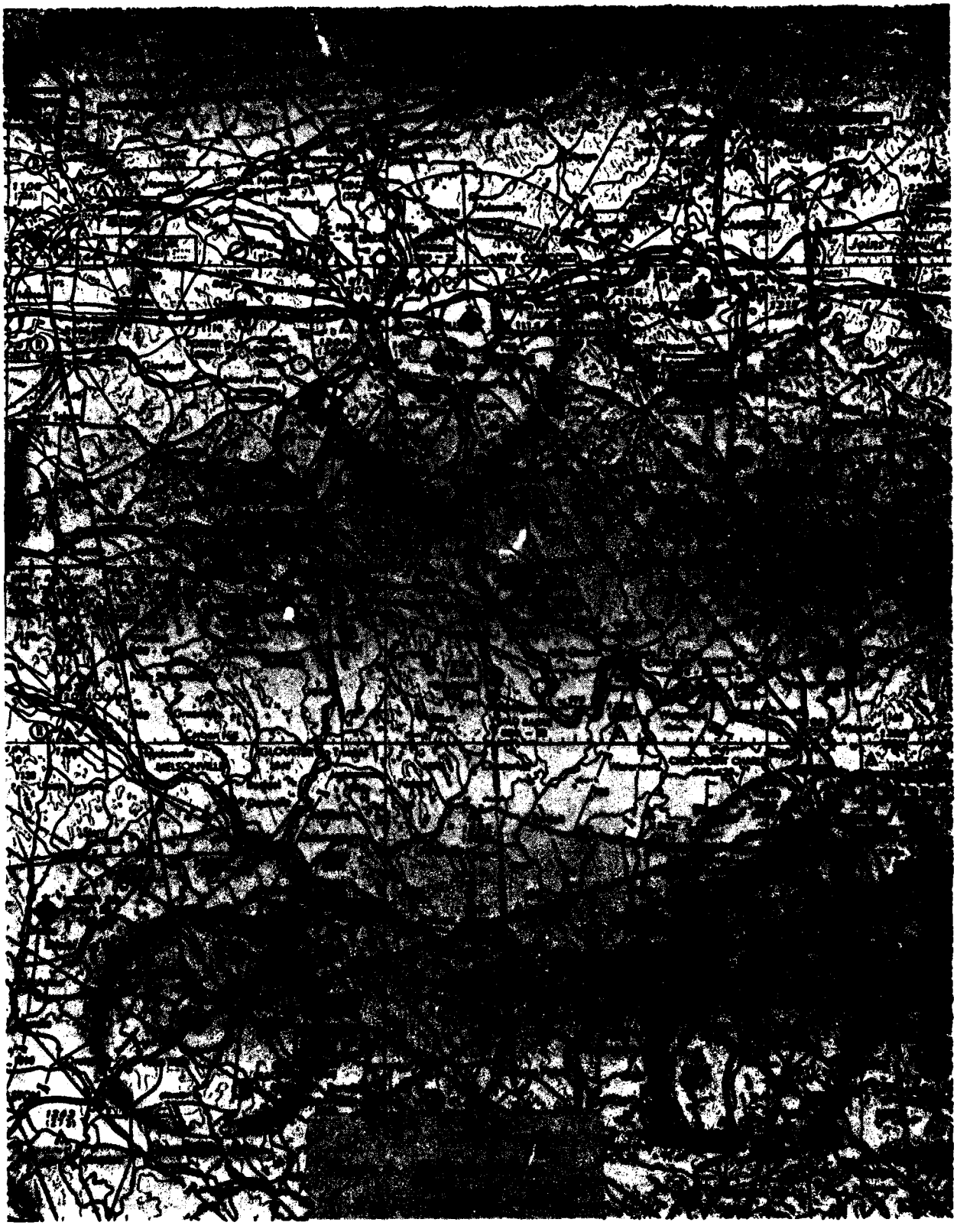


Figure 5. Initial Route in Ohio.



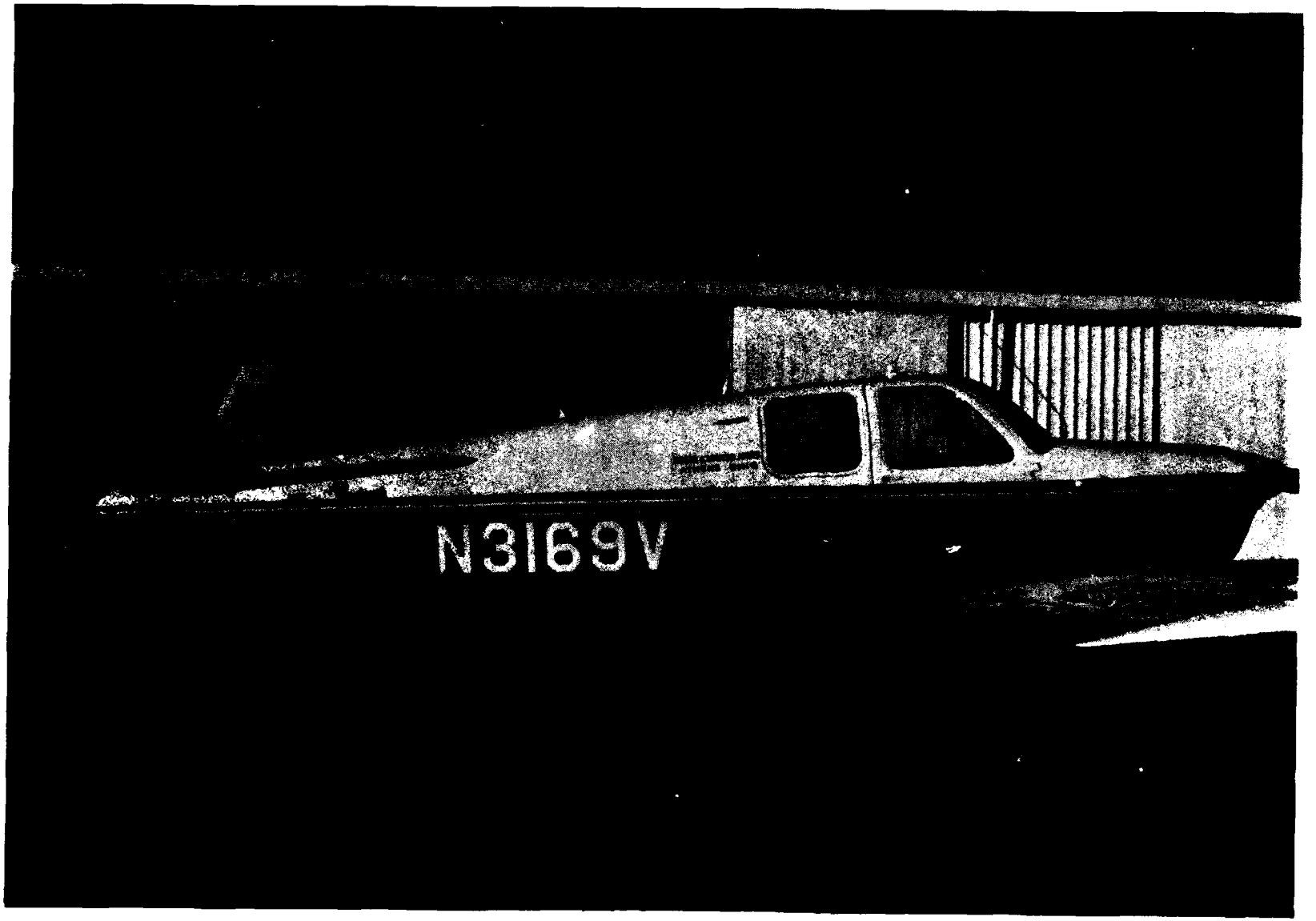


Figure 7. Beechcraft 35, N3169V.

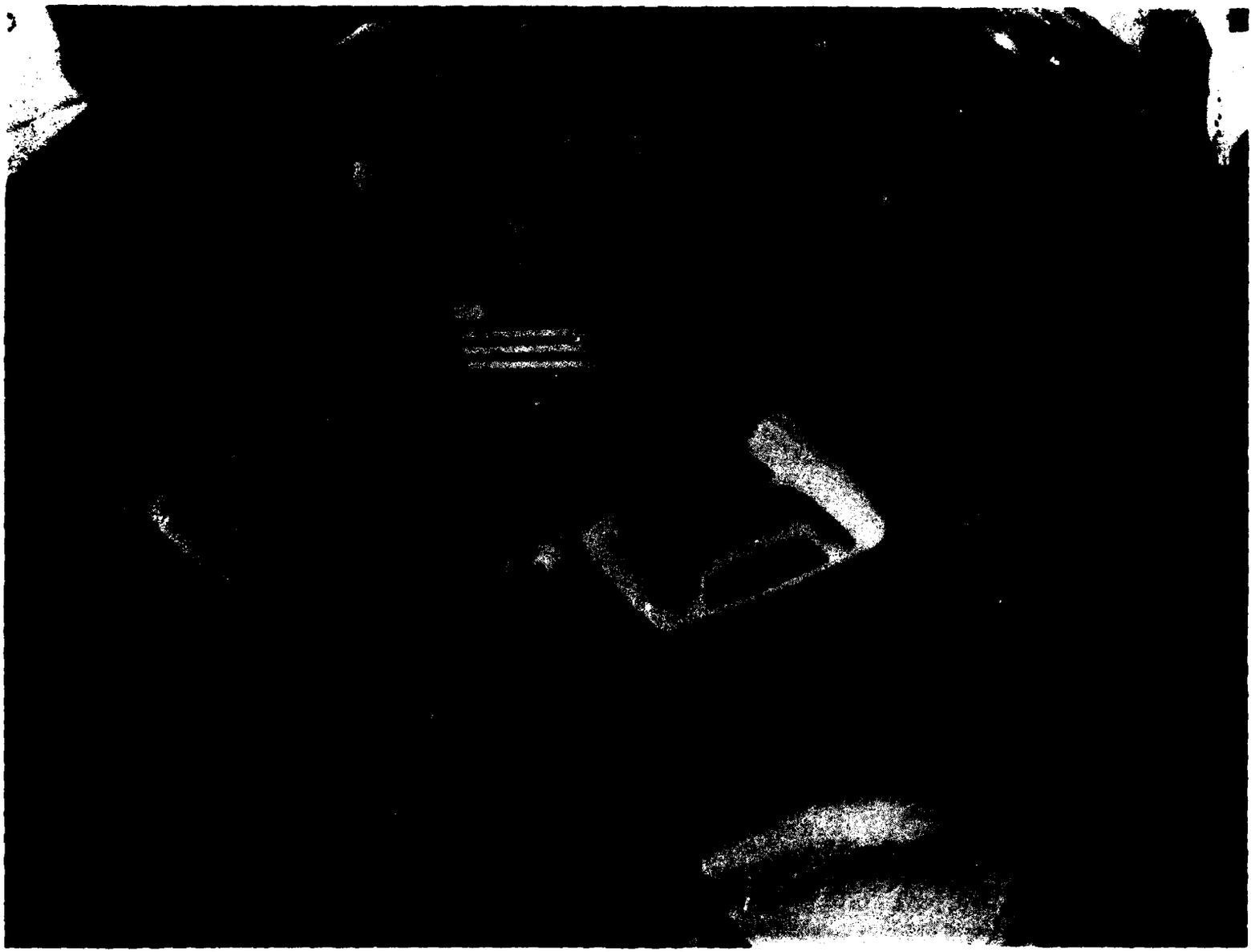


Figure 8. Sample Collimated Beam Location.

Non-Instrument rated	7
Instrument rated	7
Instructor	1
Instrument Instructor	5

Each pilot was asked to simulate a flight with waypoints at Athens, Newark, Zanesville in Ohio, and continuing on to Parkersburg and Charleston in West Virginia. He was to be making this flight in weather conditions that matched his instrument rating and experience. Each pilot then flew the route, accompanied by an instrument instructor pilot/observer. Based on the weather displayed on the CWD printer, the pilot made a decision on the route he would fly to reach his projected destination of Charleston. Based on their flight experience and ratings, some pilots would have landed short of their destination, others would have continued, and others altered their route to proceed to their final destination. Each flight during the test was eventually terminated at or near the Parkersburg VOR. The flights were flown in VFR conditions so the pilots would not have to worry about actual weather while evaluating the system. In addition, restrictions placed on general aviation IFR operations due to the August air traffic controllers strike would have prevented timely completion of this project.

A total of 33.6 hours was flown in the Beechcraft 35 using the CWD. The system operated as predicted by MITRE, although the range was at times limited. It was usually possible to receive the data at 6,500 feet MSL (Mean Sea Level) and 34 nm (nautical miles) from the VOR. Valid data were dropped from the system 30 nm from the VOR at 4,500 feet MSL. There were occasions when the CWD maintained lock until 2,700 feet MSL and 42 nm from the VOR. The stability of the lock appeared to be directly related to the atmospheric conditions and the positioning of the aircraft antenna in relation to the VOR. The range and altitude restrictions, if they were such, had no effect on the results of the evaluation.

E. Evaluation Results. Each pilot received the same preflight briefing, and based on his or her personal preference, was placed in either the left or right seat of the aircraft for the flight. It can be stated at the outset, that pilot response was enthusiastic and that none of the pilots encountered any difficulty operating or interpreting the information presented to them by the preflight briefer or the CWD. Two areas of concern were identified. First, was the problem of the LEDs (Light Emitting Diodes) on the keyboard/display unit fading out in direct sunlight. Secondly, because of the prototype nature of the system, the display/keyboard was loose in the cockpit and the printer was on the floor. These two factors contributed directly to some of the aircraft control difficulties experienced while operating or requesting information from the CWD.

One of the factors determined was the pilot's experience with weather radar,observed ground weather radar in operation, and one had operated it. This was not the case in airborne radar, as 50% of the pilots had observed its operation, and 50% of those had operated airborne radar. With this base, then, it was established that those pilots flown had at least some

experience with weather radar, and would, therefore, not be in a completely foreign environment regardless of their flight experience or ratings. Having established the experience level with radar and flying, the pilot was then asked to evaluate the CWD unit. Understanding the operation of the system in order to get the information was rated as fairly easy to easy, the two highest ratings possible. No pilot was witnessed having difficulty knowing what to ask for and the observer was impressed with the ease with which the pilots began to understand and request CWD information. Those instrument instructors that were flown rated the system fairly easy to operate. This is one step below the highest or easiest rating. This evaluation was accompanied by an equally high rating as to ease of understanding of the weather situation depicted on the printouts. All pilots rated their understanding level as good or excellent. The third question, related to the same situation, addressed the pilot's ability to interpret the data presented to him. Although these flights used prerecorded weather situations, all pilots felt they had no problem interpreting the information and acting upon it.

Once the ability of the pilot to determine the kind of weather and his reaction to it was found, the pilot was asked to evaluate the CWD printout and display, thus providing opinion guidance as to what changes should or should not be made in future developments. 85% of the pilots felt it was easy to become oriented on the printout and that to place the weather in relation to the aircraft position was not difficult. The non-instrument rated pilots rated this as easy as did those with instrument ratings. In addition to finding it easy to orient themselves in relation to the weather, 90% of the pilots flown felt that the size of the printout was adequate, and that no change in the relative size of the printout was necessary. As to weather data available on the printout, again a majority felt that the information presented was adequate (65%). Pilot comments and suggestions will be addressed later in this report.

Only one of the twenty pilots flown reported that it was difficult to select a route through the weather depicted. Most (95%) of the pilots felt that their decisions were easy and there was no question in their minds that in actual weather conditions they would have made the same or similar decisions. Non-instrument rated pilots were particularly excited about the possibility of having on-board, current, weather radar information. They indicated it would be most helpful in maintaining VFR (Visual Flight Rules), and would prevent them from having to use already busy ATC (Air Traffic Control) services. This opinion was further substantiated when analyzing the response to the questions asking the pilot to rate other sources of weather information. The instrument-rated pilots rated ATC radar information much higher than the VFR pilot. Both types of pilots rated Flight Service Station (FSS) weather information well below or less reliable than the CWD information displayed. The conclusion reached by the observer is that the instrument-rated pilot using the ATC radar for weather avoidance is comfortable with that system and would consider that information more reliable then the CWD information. Most of those flown felt that given more experience on the system it would be a very reliable supplement to ATC radar.

Pilots were also asked to evaluate the CWD unit as to access, size, and ease of operation. One area of concern was the operation of the unit in turbulence, and this was addressed in the opinionnaire. A majority of pilots expressed concern over ability to operate the system in turbulence. In the prototype system, turbulence is a factor. 79% of the pilots responded that it would be difficult to operate the system in turbulence. This was attributed to the size of the keys, and to the location of the control board. It is also noted that 65% of the pilots reported that making inputs to the control board somewhat affected aircraft control.

The aircraft used in the evaluation did have an autopilot on board, and it was used in many cases. Each pilot that used it remarked that the availability of the autopilot made the operation both easier and safer. It affected the use of the CWD in two ways; one during the pilot input phase, and, secondly, during the time the pilot analyzes the printouts. The autopilot provided the extra time needed to evaluate properly and make weather-related decisions.

It should be noted that 83% of those who had instructor ratings felt that aircraft control suffered while making entries. By the same token, the pilots indicated that the display board keys were the right size, although some commented that they felt there were too many keys on the control board. The final line on the pilot evaluation shows that over 70% of the pilots responded that the system as presented was acceptable and this was further confirmed by the fact that 80% of those flown reported that they would have no reservations using the CWD in a single-pilot IFR (Instrument Flight Rules) situation. An attempt to find an ideal cockpit location for the unit did not result with any definitive location. A location on the instrument panel met with the most favorable response. It was determined in the environment in which the prototype was flown that a location on the center of the control yoke in the B35 was the most accessible and preferred location (Figure 8). The price range which was most acceptable to those flown was between 1,000 and 2,000 dollars for a unit that offered CWD capability. Finally, a color CRT display would be acceptable if the additional cost was not restrictive. It should be noted at this point that those with instructor ratings favored a CRT type display over the printed display.

At the conclusion of each flight the pilot was asked to list his preference or rating of weather information sources. All pilots having flown the CWD rated it superior or at least equal to all choices listed. Those listed were airborne radar, stormscope, ATC weather, FSS information, CWD unit, TV and AM weather. As expected, TV and AM weather were rated lowest. The CWD was rated high or highest by all personnel, and using it as a choice to supplement the ATC weather information supplied by controllers was the idea proposed by most pilots. Those who were VFR pilots saw the CWD system as a necessary aid in the planning of their flights, and in avoiding adverse weather enroute.

Pilots were asked to provide their opinions as to additional information to be placed on the printout. The current use of and number of

VOR's was deemed satisfactory. The subjects were split on the need for some sort of route structure on the printout. They also felt that addition of a compass rose would not be necessary. A majority of the pilots felt that the addition of some NDB's would be advantageous. It should be noted here that the only navigation aid available in the local area is the NDB for Ohio University airport. Of the pilots, 80% felt that the addition of their position to the printout would be necessary. They felt that with their position indicated on the printout less diversion from aircraft control would be necessary in interpreting the weather presented on the CWD printout.

Attached to this report in the appendices are the pilots' comments supplied on the back of the answer sheets (Appendix D). The thoughts and ideas of the subject pilots are incorporated within this report and are also an inherent part of the conclusions and recommendation portion of this report.

Throughout the evaluation period, attempts were made to fly the CWD unit in actual weather conditions. Due to the time of year covered by the contract period of performance, suitable weather was seldom available to evaluate the system properly. In all, four flights were conducted, one using the Avionics Engineering Center DC-3 aircraft, N7AP (Appendix E), and the others using A-36 (N25688), and the B-35. On one occasion, aircraft N25688 was on a return flight from Washington, D.C., with the CWD unit on-board. Acquisition was made on radar information at 52 nm, and level one activity was portrayed from east of the Parkersburg VOR to the Ohio University Airport. Based on the information of only level-one activity, the flight proceeded inbound, and experienced only the level of weather that had been shown on the CWD. Results in actual weather conditions were very encouraging, and the promise the CWD unit has for providing the necessary information for weather avoidance can most assuredly be met. The flight using the DC-3 aircraft was in conjunction with a data-collection flight for Loran-C. On that flight, after take-off using the CWD, it was discovered that the definitive line of thunderstorms and associated heavy weather had moved south of the route of flight selected. It was with the aid of the CWD that the heavy weather was located, and the Loran-C weather flight was completed. The flights conducted with the B-35 in real-time weather conditions were during a period of level-one weather activity. The CWD outputs were analyzed in flight, and the aircraft was placed in the area of the heaviest activity. In each case, light rain or virga was found to exist in the area of the heaviest radar returns.

IV. RECOMMENDATIONS

Based upon the experience thus far, it is highly recommended that the unit be tested more extensively in real-time weather conditions. Further, planning should be started immediately in determining the cost and effort involved in modifying VOR's and NWS radar to implement the system. All efforts should be made to assure that the avionics industry is aware of the development thus far.

V. ACKNOWLEDGEMENTS

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VI. APPENDICES

Appendix A. Opinionnaire.

USE A PENCIL AND MAKE YOUR ANSWER COMPLETE AND AS DARK AS POSSIBLE. PLEASE ANSWER THE FOLLOWING QUESTIONS AS COMPLETELY AS YOU CAN. THE INPUTS SUPPLIED WILL BE A FACTOR IN THE FUTURE APPLICATION OF THIS SYSTEM. USE THE BACK OF THE QUESTIONNAIRE FOR CONTINUATION AND ADDITIONAL COMMENTS.

1. Are you an aircraft owner? a. Yes b. No

2. What percentage of your flying is business oriented? a. 0-20% b. 21-40% c. 41-60% d. 61-80% e. 81-100%

3. What is your experience with ground-based weather radar? a. None b. Observed operating c. Operated

4. What is your experience with airborne weather radar? a. None b. Observed operating c. Operated

5. Understanding how to operate the unit was: a. Difficult b. Mildly difficult c. Fairly easy d. Easy

6. My understanding of the weather information presented was: a. Confused b. Fair c. Good d. Excellent

7. Interpreting the weather information was: a. Difficult b. Mildly difficult c. Fairly easy d. Easy

8. Orienting my position to the location of the weather was: a. Difficult b. Mildly difficult c. Fairly easy d. Easy

9. To use the printout, it needs to be: a. Larger b. No change c. Smaller d. Darker e. Lighter

10. I would like on the printout: a. More data b. Less data c. Amount of data sufficient

11. Selecting a route of flight through the weather was: a. Impossible b. Difficult c. Easy

12. The weather information should be displayed: a. Heading-up b. North-up c. Other (explain on back of answer sheet)

13. The same information in real weather would have resulted in my actions being: a. The same b. 180 degree turn c. Using other facilities

14. In comparison, radar weather information relayed from an ATC Center would be: a. Less useful b. The same c. More useful

15. In comparison, radar weather information relayed from an FSS would be: a. Less useful b. The same c. More useful

16. Using this system in turbulence would be: a. Impossible b. Difficult c. Easy

17. Making entries to request information affected aircraft control: a. Not at all b. Somewhat c. Major diversion d. Dangerous

18. The display on the control board is: a. Difficult to read b. Easy to read

19. The control board display needs to be: a. The same b. Larger c. Smaller

20. The size of the keys on the control board is: a. Too small b. Too large c. Just right

21. After requesting information, the chart being printed affects aircraft control:
a. Not at all b. Somewhat c. Major diversion d. Dangerous

22. I would use this system in a single pilot IFR flight: a. Not at all b. With reservation
c. With no reservation

23. This unit would be best located: a. Instrument panel b. Between seats c. On floor
d. Side panel e. Control wheel

24. If marketed, what price range would you consider reasonable? a. Under $500
b. $500-1000 c. $1000-2000 d. $2000-5000 e. Over 5000

25. Use of this system in VFR conditions would be: a. Of no use b. Some help
c. A necessary aid

26. Use of this system in IFR conditions would be: a. Of no use b. Some help
c. A necessary aid

27. If a CRT/Color display version was available at $500 additional cost, which system would you purchase? a. CRT b. Printer

List the following sources of weather information giving your preference for each.

	Highest a	b	c	Lowest d	No experience e
28. Airborne Radar					
29. Stormscope					
30. ATC Weather					
31. FSS Information					
32. Experimental Printer unit					
33. TV Weather					
34. AM Weather					

Information I would like added or deleted on the printout: a. Add b. Delete c. No change

35. VOR's
36. NDB's
37. Route Structure
38. Compass Rose
39. My position

Appendix B. Computer Analysis of Opinionnaire.

C1 CERTIFICATE

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
STUDENT PILOT	0.	1	5.0	5.0	5.0
PRIVATE PILOT	1.	10	50.0	50.0	55.0
COMMERCIAL PILOT	2.	3	15.0	15.0	70.0
ATP	3.	6	30.0	30.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

C2 RATING

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
NONE	0.	7	35.0	35.0	35.0
INSTRUMENT	1.	7	35.0	35.0	70.0
INSTRUCTOR	2.	1	5.0	5.0	75.0
INSTRUMENT INSTRUCTO	3.	5	25.0	25.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

C3 XC TIME X10

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
	1.	2	10.0	10.0	10.0
	2.	2	10.0	10.0	20.0
	3.	1	5.0	5.0	25.0
	4.	3	15.0	15.0	40.0
	5.	1	5.0	5.0	45.0
	8.	2	10.0	10.0	55.0
	10.	4	20.0	20.0	75.0
	11.	1	5.0	5.0	80.0
	15.	1	5.0	5.0	85.0
	23.	1	5.0	5.0	90.0
	30.	1	5.0	5.0	95.0
	40.	1	5.0	5.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

C4 TOTAL TIME X10

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
	4.	1	5.0	5.0	5.0
	6.	1	5.0	5.0	10.0
	10.	1	5.0	5.0	15.0
	13.	1	5.0	5.0	20.0
	15.	1	5.0	5.0	25.0
	18.	1	5.0	5.0	30.0
	21.	1	5.0	5.0	35.0
	55.	2	10.0	10.0	45.0
	60.	1	5.0	5.0	50.0
	75.	1	5.0	5.0	55.0
	230.	1	5.0	5.0	60.0
	350.	1	5.0	5.0	65.0
	600.	1	5.0	5.0	70.0
	700.	1	5.0	5.0	75.0
	800.	1	5.0	5.0	80.0
	850.	1	5.0	5.0	85.0
	960.	1	5.0	5.0	90.0
	999.	2	10.0	10.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N1 AIRCRAFT OWNER

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
YES	0.	11	55.0	55.0	55.0
NO	1.	9	45.0	45.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N2 PERCENT BUSINESS FLYING

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
0-20	0.	7	35.0	35.0	35.0
21-40	1.	2	10.0	10.0	45.0
61-80	3.	2	10.0	10.0	55.0
81-100	4.	9	45.0	45.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N3 EXP GROUND RADAR

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
NONE	0.	3	15.0	15.0	15.0
OBSERVED	1.	17	85.0	85.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N4 EXP AIR RADAR

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
NONE	0.	10	50.0	50.0	50.0
OBSERVED	1.	5	25.0	25.0	75.0
OPERATED	2.	5	25.0	25.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N5 OPERATING UNIT WAS

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
FAIRLY EASY	2.	5	25.0	25.0	25.0
EASY	3.	14	70.0	70.0	95.0
	4.	1	5.0	5.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N6 WX INFO UNDERSTANDING

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
GOOD	2.	10	50.0	50.0	50.0
EXCELLENT	3.	8	40.0	40.0	90.0
	4.	2	10.0	10.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N7 WX INFO INTERPRETING

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
FAIRLY EASY	2.	8	40.0	40.0	40.0
EASY	3.	11	55.0	55.0	95.0
	4.	1	5.0	5.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N8 EASE OF ORIENTING POSN

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
MILDLY DIFFICULT	1.	3	15.0	15.0	15.0
FAIRLY EASY	2.	8	40.0	40.0	55.0
EASY	3.	9	45.0	45.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N9 PRINTOUT SHOULD BE

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
NO CHANGE	1.	19	95.0	95.0	95.0
DARKER	3.	1	5.0	5.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N10 AMOUNT OF DATA WANTED

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
MORE DATA	0.	7	35.0	35.0	35.0
AMONT OF DATA SUFFIC	2.	13	65.0	65.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N11 ROUTE SELECTION WAS

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
DIFFICULT	1.	1	5.0	5.0	5.0
EASY	2.	19	95.0	95.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N12 DISPLAY ORIENTAION SHOULD BE

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
HEADING UP	0.	3	15.0	15.0	15.0
NORTH UP	1.	15	75.0	75.0	90.0
OTHER	2.	2	10.0	10.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N13 REAL WEATHER REACTIONS WOULD BE

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
THE SAME	0.	18	90.0	90.0	90.0
USE OTHER FACILITIES	2.	2	10.0	10.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N14 ATC WX WOULD BE

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
LESS USEFUL	0.	14	70.0	70.0	70.0
THE SAME	1.	1	5.0	5.0	75.0
MORE USEFUL	2.	5	25.0	25.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N15 FSS WX WOULD BE

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
LESS USEFUL	0.	14	70.0	70.0	70.0
THE SAME	1.	3	15.0	15.0	85.0
MORE USEFUL	2.	3	15.0	15.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N16 CWD IN TURB WOULD BE

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
DIFFICULT	1.	14	70.0	70.0	70.0
EASY	2.	5	25.0	25.0	95.0
	3.	1	5.0	5.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N17 CWD ENTRIES EFFECT ON CONTROL

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
NOT AT ALL	0.	6	30.0	30.0	30.0
SOMEWHAT	1.	13	65.0	65.0	95.0
MAJOR DIVERSION	2.	1	5.0	5.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N18 CWD CONTROL BOARD

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
DIFFICULT TO READ	0.	7	35.0	35.0	35.0
EASY TO READ	1.	13	65.0	65.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N19 CWD CONT BD DISPLAY SHOULD BE

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
THE SAME	0.	15	75.0	75.0	75.0
LARGER	1.	3	15.0	15.0	90.0
SMALLER	2.	2	10.0	10.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N20 CWD CONT BD KEYS ARE

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
TOO SMALL	0.	3	15.0	15.0	15.0
JUST RIGHT	2.	17	85.0	85.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N21 CWD OUTPUT EFFECT ON CONTROL

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
NOT AT ALL	0.	15	75.0	75.0	75.0
SOMEWHAT	1.	5	25.0	25.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N22 CWD USE SINGLE PILOT IFR

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
WITH RESERVATIONS	1.	2	10.0	10.0	10.0
WITH NO RESERVATIONS	2.	18	90.0	90.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N23 CWD SHOULD BE LOCATED

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
INSTRUMENT PANEL	0.	7	35.0	35.0	35.0
BETWEEN SEATS	1.	4	20.0	20.0	55.0
ON FLOOR	2.	1	5.0	5.0	60.0
SIDE PANEL	3.	1	5.0	5.0	65.0
CONTROL WHEEL	4.	7	35.0	35.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N24 CWD PRICE RANGE

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
UNDER $500	0.	1	5.0	5.0	5.0
$500 TO $1000	1.	3	15.0	15.0	20.0
$1000 TO $2000	2.	13	65.0	65.0	85.0
$2000 TO $5000	3.	3	15.0	15.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N25 CMD USE IN VFR

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
SOME HELP	1.	10	50.0	50.0	50.0
A NECESSARY AID	2.	10	50.0	50.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N26 CMD USE IN IFR

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
SOME HELP	1.	6	30.0	30.0	30.0
A NECESSARY AID	2.	14	70.0	70.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N27 IF CRT COLOR AT $500, WHICH

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
CRT	0.	10	50.0	50.0	50.0
PRINTER	1.	10	50.0	50.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N28 AIRBORNE RADAR RATING

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
HIGHEST	0.	4	20.0	20.0	20.0
HIGH	1.	6	30.0	30.0	50.0
LOWEST	3.	1	5.0	5.0	55.0
NO EXPERIENCE	4.	9	45.0	45.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N29 STORMSCOPE RATING

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
HIGHEST	0.	1	5.0	5.0	5.0
HIGH	1.	6	30.0	30.0	35.0
LOWEST	3.	1	5.0	5.0	40.0
NO EXPERIENCE	4.	12	60.0	60.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N30 ATC WEATHER RATING

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
HIGHEST	0.	6	30.0	30.0	30.0
HIGH	1.	7	35.0	35.0	65.0
LOW	2.	6	30.0	30.0	95.0
LOWEST	3.	1	5.0	5.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N31 FSS WEATHER RATING

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
HIGHEST	0.	3	15.0	15.0	15.0
HIGH	1.	7	35.0	35.0	50.0
LOW	2.	6	30.0	30.0	80.0
LOWEST	3.	3	15.0	15.0	95.0
NO EXPERIENCE	4.	1	5.0	5.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N32 CWD RATING

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
HIGHEST	0.	11	55.0	55.0	55.0
HIGH	1.	8	40.0	40.0	95.0
LOW	2.	1	5.0	5.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N33 TV WEATHER RATING

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
HIGH	1.	2	10.0	10.0	10.0
LOW	2.	6	30.0	30.0	40.0
LOWEST	3.	12	60.0	60.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N34 AM WEATHER RATING

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
HIGHEST	0.	1	5.0	5.0	5.0
HIGH	1.	4	20.0	20.0	25.0
LOW	2.	9	45.0	45.0	70.0
LOWEST	3.	4	20.0	20.0	90.0
NO EXPERIENCE	4.	2	10.0	10.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N35 VOR ON CWD OUTPUT

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
ADD	0.	1	5.0	5.0	5.0
NO CHANGE	2.	19	95.0	95.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N36 NDB ON CWD OUTPUT

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
ADD	0.	14	70.0	70.0	70.0
DELETE	1.	1	5.0	5.0	75.0
NO CHANGE	2.	5	25.0	25.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N37 ROUTE ON CWD OUTPUT

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
ADD	0.	7	35.0	35.0	35.0
DELETE	1.	2	10.0	10.0	45.0
NO CHANGE	2.	11	55.0	55.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N38 COMPASS ROSE ON CWD OUTPUT

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
ADD	0.	2	10.0	10.0	10.0
DELETE	1.	1	5.0	5.0	15.0
NO CHANGE	2.	17	85.0	85.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

N39 MY POSITION ON CWD OUTPUT

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
ADD	0.	16	80.0	80.0	80.0
NO CHANGE	2.	4	20.0	20.0	100.0
	TOTAL	20	100.0	100.0	

VALID CASES 20 MISSING CASES 0

**** CROSSTABULATION OF **********
C2 RATING BY N1 AIRCRAFT OWNER

C2	N1	YES 0.	NO 1.	ROW TOTAL
NONE	0.	2	5	7
	ROW PCT	28.6	71.4	35.0
	COL PCT	18.2	55.6	
	TOT PCT	10.0	25.0	
INSTRUMENT	1.	6	1	7
	ROW PCT	85.7	14.3	35.0
	COL PCT	54.5	11.1	
	TOT PCT	30.0	5.0	
INSTRUCTOR	2.	1	0	1
	ROW PCT	100.0	0.0	5.0
	COL PCT	9.1	0.0	
	TOT PCT	5.0	0.0	
INSTRUMENT INSTR	3.	2	3	5
	ROW PCT	40.0	60.0	25.0
	COL PCT	18.2	33.3	
	TOT PCT	10.0	15.0	
	COLUMN TOTAL	11 55.0	9 45.0	20 100.0

**** CROSSTABULATION OF ****

C2 RATING BY N2 PERCENT BUSINESS FLYING

C2	COUNT / ROW PCT / COL PCT / TOT PCT	N2 10-20 (0.)	21-40 (1.)	61-80 (3.)	81-100 (4.)	ROW TOTAL
0. NONE		6	1	0	0	7
		85.7	14.3	0.0	0.0	35.0
		85.7	50.0	0.0	0.0	
		30.0	5.0	0.0	0.0	
1. INSTRUMENT		1	1	2	3	7
		14.3	14.3	28.6	42.9	35.0
		14.3	50.0	100.0	33.3	
		5.0	5.0	10.0	15.0	
2. INSTRUCTOR		0	0	0	1	1
		0.0	0.0	0.0	100.0	5.0
		0.0	0.0	0.0	11.1	
		0.0	0.0	0.0	5.0	
3. INSTRUMENT INSTR		0	0	0	5	5
		0.0	0.0	0.0	100.0	25.0
		0.0	0.0	0.0	55.6	
		0.0	0.0	0.0	25.0	
COLUMN TOTAL		7	2	2	9	20
		35.0	10.0	10.0	45.0	100.0

**** CROSSTABULATION OF ****

C2 RATING BY N3 EXP GROUND RADAR

C2	COUNT / ROW PCT / COL PCT / TOT PCT	N3 NONE (0.)	OBSERVED (1.)	ROW TOTAL
0. NONE		1	6	7
		14.3	85.7	35.0
		33.3	35.3	
		5.0	30.0	
1. INSTRUMENT		1	6	7
		14.3	85.7	35.0
		33.3	35.3	
		5.0	30.0	
2. INSTRUCTOR		1	0	1
		100.0	0.0	5.0
		33.3	0.0	
		5.0	0.0	
3. INSTRUMENT INSTR		0	5	5
		0.0	100.0	25.0
		0.0	29.4	
		0.0	25.0	
COLUMN TOTAL		3	17	20
		15.0	85.0	100.0

**** CROSSTABULATION OF ****************
C2 RATING BY N4 EXP AIR RADAR

C2	N4 OBSERVED OPERATED 0.	1.	2.	ROW TOTAL
0. NONE	3	3	1	7
	42.9	42.9	14.3	35.0
	30.0	60.0	20.0	
	15.0	15.0	5.0	
1. INSTRUMENT	4	2	1	7
	57.1	28.6	14.3	35.0
	40.0	40.0	20.0	
	20.0	10.0	5.0	
2. INSTRUCTOR	1	0	0	1
	100.0	0.0	0.0	5.0
	10.0	0.0	0.0	
	5.0	0.0	0.0	
3. INSTRUMENT INSTR	2	0	3	5
	40.0	0.0	60.0	25.0
	20.0	0.0	60.0	
	10.0	0.0	15.0	
COLUMN TOTAL	10	5	5	20
	50.0	25.0	25.0	100.0

**** CROSSTABULATION OF ****************
C2 RATING BY N5 OPERATING UNIT WAS

C2	N5 FAIRLY EASY 2.	3.	EASY 4.	ROW TOTAL
0. NONE	0	7	0	7
	0.0	100.0	0.0	35.0
	0.0	50.0	0.0	
	0.0	35.0	0.0	
1. INSTRUMENT	1	5	1	7
	14.3	71.4	14.3	35.0
	20.0	35.7	100.0	
	5.0	25.0	5.0	
2. INSTRUCTOR	0	1	0	1
	0.0	100.0	0.0	5.0
	0.0	7.1	0.0	
	0.0	5.0	0.0	
3. INSTRUMENT INSTR	4	1	0	5
	80.0	20.0	0.0	25.0
	80.0	7.1	0.0	
	20.0	5.0	0.0	
COLUMN TOTAL	5	14	1	20
	25.0	70.0	5.0	100.0

*** * * * CROSSTABULATION OF * * * * * * * * * * * * * * ***
C2 RATING BY N6 WX INFO UNDERSTANDING

C2	COUNT / ROW PCT / COL PCT / TOT PCT	N6 GOOD 2.	EXCELLENT 3.	4.	ROW TOTAL
0. NONE		4	2	1	7
		57.1	28.6	14.3	35.0
		40.0	25.0	50.0	
		20.0	10.0	5.0	
1. INSTRUMENT		4	2	1	7
		57.1	28.6	14.3	35.0
		40.0	25.0	50.0	
		20.0	10.0	5.0	
2. INSTRUCTOR		1	0	0	1
		100.0	0.0	0.0	5.0
		10.0	0.0	0.0	
		5.0	0.0	0.0	
3. INSTRUMENT INSTR		1	4	0	5
		20.0	80.0	0.0	25.0
		10.0	50.0	0.0	
		5.0	20.0	0.0	
COLUMN TOTAL		10	8	2	20
		50.0	40.0	10.0	100.0

*** * * * CROSSTABULATION OF * * * * * * * * * * * * * * ***
C2 RATING BY N7 WX INFO INTERPRETING

C2	COUNT / ROW PCT / COL PCT / TOT PCT	N7 FAIRLY EASY 2.	E EASY 3.	4.	ROW TOTAL
0. NONE		4	3	0	7
		57.1	42.9	0.0	35.0
		50.0	27.3	0.0	
		20.0	15.0	0.0	
1. INSTRUMENT		2	4	1	7
		28.6	57.1	14.3	35.0
		25.0	36.4	100.0	
		10.0	20.0	5.0	
2. INSTRUCTOR		1	0	0	1
		100.0	0.0	0.0	5.0
		12.5	0.0	0.0	
		5.0	0.0	0.0	
3. INSTRUMENT INSTR		1	4	0	5
		20.0	80.0	0.0	25.0
		12.5	36.4	0.0	
		5.0	20.0	0.0	
COLUMN TOTAL		8	11	1	20
		40.0	55.0	5.0	100.0

****** CROSSTABULATION OF ******************
C2 RATING BY N8 EASE OF ORIENTING POSN

C2	N8 MILDLY DIFFICULT	FAIRLY EASY	EASY	ROW TOTAL
	1.	2.	3.	
0. NONE	1	3	3	7
	14.3	42.9	42.9	35.0
	33.3	37.5	33.3	
	5.0	15.0	15.0	
1. INSTRUMENT	1	2	4	7
	14.3	28.6	57.1	35.0
	33.3	25.0	44.4	
	5.0	10.0	20.0	
2. INSTRUCTOR	0	1	0	1
	0.0	100.0	0.0	5.0
	0.0	12.5	0.0	
	0.0	5.0	0.0	
3. INSTRUMENT INSTR	1	2	2	5
	20.0	40.0	40.0	25.0
	33.3	25.0	22.2	
	5.0	10.0	10.0	
COLUMN TOTAL	3	8	9	20
	15.0	40.0	45.0	100.0

****** CROSSTABULATION OF *******************
C2 RATING BY N9 PRINTOUT SHOULD BE

C2	N9 NO CHANGE	DARKER	ROW TOTAL
	1.	3.	
0. NONE	6	1	7
	85.7	14.3	35.0
	31.6	100.0	
	30.0	5.0	
1. INSTRUMENT	7	0	7
	100.0	0.0	35.0
	36.8	0.0	
	35.0	0.0	
2. INSTRUCTOR	1	0	1
	100.0	0.0	5.0
	5.3	0.0	
	5.0	0.0	
3. INSTRUMENT INSTR	5	0	5
	100.0	0.0	25.0
	26.3	0.0	
	25.0	0.0	
COLUMN TOTAL	19	1	20
	95.0	5.0	100.0

**** CROSSTABULATION OF **********
C2 RATING BY N10 AMOUNT OF DATA WANTED

C2	N10 MORE DATA	N10 AMOUNT OF DATA SU	ROW TOTAL
	0.	2.	
0. NONE	3	4	7
	42.9	57.1	35.0
	42.9	30.8	
	15.0	20.0	
1. INSTRUMENT	1	6	7
	14.3	85.7	35.0
	14.3	46.2	
	5.0	30.0	
2. INSTRUCTOR	0	1	1
	0.0	100.0	5.0
	0.0	7.7	
	0.0	5.0	
3. INSTRUMENT INSTR	3	2	5
	60.0	40.0	25.0
	42.9	15.4	
	15.0	10.0	
COLUMN TOTAL	7	13	20
	35.0	65.0	100.0

**** CROSSTABULATION OF **********
C2 RATING BY N11 ROUTE SELECTION WAS

C2	N11 DIFFICULT	N11 EASY	ROW TOTAL
	1.	2.	
0. NONE	1	6	7
	14.3	85.7	35.0
	100.0	31.6	
	5.0	30.0	
1. INSTRUMENT	0	7	7
	0.0	100.0	35.0
	0.0	36.8	
	0.0	35.0	
2. INSTRUCTOR	0	1	1
	0.0	100.0	5.0
	0.0	5.3	
	0.0	5.0	
3. INSTRUMENT INSTR	0	5	5
	0.0	100.0	25.0
	0.0	26.3	
	0.0	25.0	
COLUMN TOTAL	1	19	20
	5.0	95.0	100.0

**** CROSSTABULATION OF **********
C2 RATING BY N12 DISPLAY ORIENTAION SHOULD BE

C2	N12 COUNT / ROW PCT / COL PCT / TOT PCT	0. HEADING UP	1. NORTH UP	2. OTHER	ROW TOTAL
0. NONE		1	5	1	7
		14.3	71.4	14.3	35.0
		33.3	33.3	50.0	
		5.0	25.0	5.0	
1. INSTRUMENT		1	6	0	7
		14.3	85.7	0.0	35.0
		33.3	40.0	0.0	
		5.0	30.0	0.0	
2. INSTRUCTOR		0	1	0	1
		0.0	100.0	0.0	5.0
		0.0	6.7	0.0	
		0.0	5.0	0.0	
3. INSTRUMENT INSTR		1	3	1	5
		20.0	60.0	20.0	25.0
		33.3	20.0	50.0	
		5.0	15.0	5.0	
COLUMN TOTAL		3	15	2	20
		15.0	75.0	10.0	100.0

**** CROSSTABULATION OF **********
C2 RATING BY N13 REAL WEATHER REACTIONS WOULD BE

C2	N13 COUNT / ROW PCT / COL PCT / TOT PCT	0. THE SAME	2. USE OTHER FACILI	ROW TOTAL
0. NONE		6	1	7
		85.7	14.3	35.0
		33.3	50.0	
		30.0	5.0	
1. INSTRUMENT		6	1	7
		85.7	14.3	35.0
		33.3	50.0	
		30.0	5.0	
2. INSTRUCTOR		1	0	1
		100.0	0.0	5.0
		5.6	0.0	
		5.0	0.0	
3. INSTRUMENT INSTR		5	0	5
		100.0	0.0	5.0
		27.8	0.0	
		25.0	0.0	
COLUMN TOTAL		18	2	20
		90.0	10.0	100.0

*** * * * CROSSTABULATION OF * * * * * * * * * * * * * * ***
C2 RATING BY N14 ATC WX WOULD BE

C2	N14	LESS USE THE SAME FUL (0.)	(1.)	MORE USE FUL (2.)	ROW TOTAL
0. NONE	COUNT	7	0	0	7
	ROW PCT	100.0	0.0	0.0	35.0
	COL PCT	50.0	0.0	0.0	
	TOT PCT	35.0	0.0	0.0	
1. INSTRUMENT	COUNT	3	0	4	7
	ROW PCT	42.9	0.0	57.1	35.0
	COL PCT	21.4	0.0	80.0	
	TOT PCT	15.0	0.0	20.0	
2. INSTRUCTOR	COUNT	1	0	0	1
	ROW PCT	100.0	0.0	0.0	5.0
	COL PCT	7.1	0.0	0.0	
	TOT PCT	5.0	0.0	0.0	
3. INSTRUMENT INSTR	COUNT	3	1	1	5
	ROW PCT	60.0	20.0	20.0	25.0
	COL PCT	21.4	100.0	20.0	
	TOT PCT	15.0	5.0	5.0	
COLUMN TOTAL		14	1	5	20
		70.0	5.0	25.0	100.0

*** * * * CROSSTABULATION OF * * * * * * * * * * * * * * ***
C2 RATING BY N15 FSS WX WOULD BE

C2	N15	LESS USE THE SAME FUL (0.)	(1.)	MORE USE FUL (2.)	ROW TOTAL
0. NONE	COUNT	6	1	0	7
	ROW PCT	85.7	14.3	0.0	35.0
	COL PCT	42.9	33.3	0.0	
	TOT PCT	30.0	5.0	0.0	
1. INSTRUMENT	COUNT	4	1	2	7
	ROW PCT	57.1	14.3	28.6	35.0
	COL PCT	28.6	33.3	66.7	
	TOT PCT	20.0	5.0	10.0	
2. INSTRUCTOR	COUNT	1	0	0	1
	ROW PCT	100.0	0.0	0.0	5.0
	COL PCT	7.1	0.0	0.0	
	TOT PCT	5.0	0.0	0.0	
3. INSTRUMENT INSTR	COUNT	3	1	1	5
	ROW PCT	60.0	20.0	20.0	25.0
	COL PCT	21.4	33.3	33.3	
	TOT PCT	15.0	5.0	5.0	
COLUMN TOTAL		14	3	3	20
		70.0	15.0	15.0	100.0

**** CROSSTABULATION OF **********
C2 RATING BY N16 CWD IN TURB WOULD BE

C2	N16 DIFFICULT	EASY		ROW TOTAL
	1.	2.	3.	
0. NONE	5	1	1	7
	71.4	14.3	14.3	35.0
	35.7	20.0	100.0	
	25.0	5.0	5.0	
1. INSTRUMENT	4	3	0	7
	57.1	42.9	0.0	35.0
	28.6	60.0	0.0	
	20.0	15.0	0.0	
2. INSTRUCTOR	1	0	0	1
	100.0	0.0	0.0	5.0
	7.1	0.0	0.0	
	5.0	0.0	0.0	
3. INSTRUMENT INSTR	4	1	0	5
	80.0	20.0	0.0	25.0
	28.6	20.0	0.0	
	20.0	5.0	0.0	
COLUMN TOTAL	14	5	1	20
	70.0	25.0	5.0	100.0

**** CROSSTABULATION OF **********
C2 RATING BY N17 CWD ENTRIES EFFECT ON CONTROL

C2	N17 NOT AT ALL	SOMEWHAT	MAJOR DIVERSION	ROW TOTAL
	0.	1.	2.	
0. NONE	2	4	1	7
	28.6	57.1	14.3	35.0
	33.3	30.8	100.0	
	10.0	20.0	5.0	
1. INSTRUMENT	3	4	0	7
	42.9	57.1	0.0	35.0
	50.0	30.8	0.0	
	15.0	20.0	0.0	
2. INSTRUCTOR	0	1	0	1
	0.0	100.0	0.0	5.0
	0.0	7.7	0.0	
	0.0	5.0	0.0	
3. INSTRUMENT INSTR	1	4	0	5
	20.0	80.0	0.0	25.0
	16.7	30.8	0.0	
	5.0	20.0	0.0	
COLUMN TOTAL	6	13	1	20
	30.0	65.0	5.0	100.0

**** CROSSTABULATION OF ****************
C2 RATING BY N18 CMD CONTROL BOARD

C2 RATING	N18 DIFFICUL T TO REA 0.	EASY TO READ 1.	ROW TOTAL
0. NONE	2	5	7
	28.6	71.4	35.0
	28.6	38.5	
	10.0	25.0	
1. INSTRUMENT	3	4	7
	42.9	57.1	35.0
	42.9	30.8	
	15.0	20.0	
2. INSTRUCTOR	0	1	1
	0.0	100.0	5.0
	0.0	7.7	
	0.0	5.0	
3. INSTRUMENT INSTR	2	3	5
	40.0	60.0	25.0
	28.6	23.1	
	10.0	15.0	
COLUMN TOTAL	7	13	20
	35.0	65.0	100.0

**** CROSSTABULATION OF **************
C2 RATING BY N19 CMD CONT BD DISPLAY SHOULD BE

C2 RATING	N19 THE SAME 0.	LARGER 1.	SMALLER 2.	ROW TOTAL
0. NONE	5	2	0	7
	71.4	28.6	0.0	35.0
	33.3	66.7	0.0	
	25.0	10.0	0.0	
1. INSTRUMENT	6	0	1	7
	85.7	0.0	14.3	35.0
	40.0	0.0	50.0	
	30.0	0.0	5.0	
2. INSTRUCTOR	1	0	0	1
	100.0	0.0	0.0	5.0
	6.7	0.0	0.0	
	5.0	0.0	0.0	
3. INSTRUMENT INSTR	3	1	1	5
	60.0	20.0	20.0	25.0
	20.0	33.3	50.0	
	15.0	5.0	5.0	
COLUMN TOTAL	15	3	2	20
	75.0	15.0	10.0	100.0

**** CROSSTABULATION OF **********
C2 RATING BY N20 CMD CONT BD KEYS ARE

C2	N20	TOO SMAL L 0.	JUST RIG HT 2.	ROW TOTAL
NONE	0.	1	6	7
		14.3	85.7	35.0
		33.3	35.3	
		5.0	30.0	
INSTRUMENT	1.	0	7	7
		0.0	100.0	35.0
		0.0	41.2	
		0.0	35.0	
INSTRUCTOR	2.	0	1	1
		0.0	100.0	5.0
		0.0	5.9	
		0.0	5.0	
INSTRUMENT INSTR	3.	2	3	5
		40.0	60.0	25.0
		66.7	17.6	
		10.0	15.0	
COLUMN TOTAL		3 15.0	17 85.0	20 100.0

**** CROSSTABULATION OF **********
C2 RATING BY N21 CMD OUTPUT EFFECT ON CONTROL

C2	N21	NOT AT A LL 0.	SOMEWHAT 1.	ROW TOTAL
NONE	0.	5	2	7
		71.4	28.6	35.0
		33.3	40.0	
		25.0	10.0	
INSTRUMENT	1.	5	2	7
		71.4	28.6	35.0
		33.3	40.0	
		25.0	10.0	
INSTRUCTOR	2.	1	0	1
		100.0	0.0	5.0
		6.7	0.0	
		5.0	0.0	
INSTRUMENT INSTR	3.	4	1	5
		80.0	20.0	25.0
		26.7	20.0	
		20.0	5.0	
COLUMN TOTAL		15 75.0	5 25.0	20 100.0

****** CROSSTABULATION OF ******************
C2 RATING BY N22 CMD USE SINGLE PILOT IFR

C2 RATING	N22 WITH RESERVATION 1.	N22 WITH NO RESERVAT 2.	ROW TOTAL
0. NONE	1	6	7
	14.3	85.7	35.0
	50.0	33.3	
	5.0	30.0	
1. INSTRUMENT	0	7	7
	0.0	100.0	35.0
	0.0	38.9	
	0.0	35.0	
2. INSTRUCTOR	0	1	1
	0.0	100.0	5.0
	0.0	5.6	
	0.0	5.0	
3. INSTRUMENT INSTR	1	4	5
	20.0	80.0	25.0
	50.0	22.2	
	5.0	20.0	
COLUMN TOTAL	2	18	20
	10.0	90.0	100.0

****** CROSSTABULATION OF ******************
C2 RATING BY N23 CMD SHOULD BE LOCATED

C2 RATING	N23 INSTRUMENT PANEL 0.	N23 BETWEEN SEATS 1.	N23 ON FLOOR 2.	N23 SIDE PANEL 3.	N23 CONTROL WHEEL 4.	ROW TOTAL
0. NONE	2	1	0	0	4	7
	28.6	14.3	0.0	0.0	57.1	35.0
	28.6	25.0	0.0	0.0	57.1	
	10.0	5.0	0.0	0.0	20.0	
1. INSTRUMENT	3	1	1	0	2	7
	42.9	14.3	14.3	0.0	28.6	35.0
	42.9	25.0	100.0	0.0	28.6	
	15.0	5.0	5.0	0.0	10.0	
2. INSTRUCTOR	1	0	0	0	0	1
	100.0	0.0	0.0	0.0	0.0	5.0
	14.3	0.0	0.0	0.0	0.0	
	5.0	0.0	0.0	0.0	0.0	
3. INSTRUMENT INSTR	1	2	0	1	1	5
	20.0	40.0	0.0	20.0	20.0	25.0
	14.3	50.0	0.0	100.0	14.3	
	5.0	10.0	0.0	5.0	5.0	
COLUMN TOTAL	7	4	1	1	7	20
	35.0	20.0	5.0	5.0	35.0	100.0

*** * * * CROSSTABULATION OF * * * * * * * * * * * * * * ***
C2 RATING BY N24 CMD PRICE RANGE

C2	N24	UNDER $5 100 (0.)	$500 TO $1000 (1.)	$1000 TO $2000 (2.)	$2000 TO $5000 (3.)	ROW TOTAL
0. NONE	COUNT	0	1	5	1	7
	ROW PCT	0.0	14.3	71.4	14.3	35.0
	COL PCT	0.0	33.3	38.5	33.3	
	TOT PCT	0.0	5.0	25.0	5.0	
1. INSTRUMENT	COUNT	1	2	4	0	7
	ROW PCT	14.3	28.6	57.1	0.0	35.0
	COL PCT	100.0	66.7	30.8	0.0	
	TOT PCT	5.0	10.0	20.0	0.0	
2. INSTRUCTOR	COUNT	0	0	1	0	1
	ROW PCT	0.0	0.0	100.0	0.0	5.0
	COL PCT	0.0	0.0	7.7	0.0	
	TOT PCT	0.0	0.0	5.0	0.0	
3. INSTRUMENT INSTR	COUNT	0	0	3	2	5
	ROW PCT	0.0	0.0	60.0	40.0	25.0
	COL PCT	0.0	0.0	23.1	66.7	
	TOT PCT	0.0	0.0	15.0	10.0	
COLUMN TOTAL		1 5.0	3 15.0	13 65.0	3 15.0	20 100.0

*** * * * CROSSTABULATION OF * * * * * * * * * * * * * * ***
C2 RATING BY N25 CMD USE IN VFR

C2	N25	SOME HELP (1.)	A NECESSARY AID (2.)	ROW TOTAL
0. NONE	COUNT	2	5	7
	ROW PCT	28.6	71.4	35.0
	COL PCT	20.0	50.0	
	TOT PCT	10.0	25.0	
1. INSTRUMENT	COUNT	5	2	7
	ROW PCT	71.4	28.6	35.0
	COL PCT	50.0	20.0	
	TOT PCT	25.0	10.0	
2. INSTRUCTOR	COUNT	1	0	1
	ROW PCT	100.0	0.0	5.0
	COL PCT	10.0	0.0	
	TOT PCT	5.0	0.0	
3. INSTRUMENT INSTR	COUNT	2	3	5
	ROW PCT	40.0	60.0	25.0
	COL PCT	20.0	30.0	
	TOT PCT	10.0	15.0	
COLUMN TOTAL		10 50.0	10 50.0	20 100.0

****** CROSSTABULATION OF *****************
C2 RATING BY N26 CMD USE IN IFR

C2 RATING	N26 1. SOME HELP	N26 2. NECESSARY AID	ROW TOTAL
0. NONE	2	5	7
	28.6	71.4	35.0
	33.3	35.7	
	10.0	25.0	
1. INSTRUMENT	3	4	7
	42.9	57.1	35.0
	50.0	28.6	
	15.0	20.0	
2. INSTRUCTOR	1	0	1
	100.0	0.0	5.0
	16.7	0.0	
	5.0	0.0	
3. INSTRUMENT INSTR	0	5	5
	0.0	100.0	25.0
	0.0	35.7	
	0.0	25.0	
COLUMN TOTAL	6	14	20
	30.0	70.0	100.0

****** CROSSTABULATION OF ******************
C2 RATING BY N27 IF CRT COLOR AT $500, WHICH

C2 RATING	N27 0. CRT	N27 1. PRINTER	ROW TOTAL
0. NONE	3	4	7
	42.9	57.1	35.0
	30.0	40.0	
	15.0	20.0	
1. INSTRUMENT	2	5	7
	28.6	71.4	35.0
	20.0	50.0	
	10.0	25.0	
2. INSTRUCTOR	1	0	1
	100.0	0.0	5.0
	10.0	0.0	
	5.0	0.0	
3. INSTRUMENT INSTR	4	1	5
	80.0	20.0	25.0
	40.0	10.0	
	20.0	5.0	
COLUMN TOTAL	10	10	20
	50.0	50.0	100.0

**** CROSSTABULATION OF **********
C2 RATING BY N28 AIRBORNE RADAR RATING

C2	N28	HIGHEST 0.	HIGH 1.	LOWEST 3.	NO EXPERIENCE 4.	ROW TOTAL
0. NONE	COUNT	1	2	0	4	7
	ROW PCT	14.3	28.6	0.0	57.1	35.0
	COL PCT	25.0	33.3	0.0	44.4	
	TOT PCT	5.0	10.0	0.0	20.0	
1. INSTRUMENT	COUNT	0	3	1	3	7
	ROW PCT	0.0	42.9	14.3	42.9	35.0
	COL PCT	0.0	50.0	100.0	33.3	
	TOT PCT	0.0	15.0	5.0	15.0	
2. INSTRUCTOR	COUNT	0	0	0	1	1
	ROW PCT	0.0	0.0	0.0	100.0	5.0
	COL PCT	0.0	0.0	0.0	11.1	
	TOT PCT	0.0	0.0	0.0	5.0	
3. INSTRUMENT INSTR	COUNT	3	1	0	1	5
	ROW PCT	60.0	20.0	0.0	20.0	25.0
	COL PCT	75.0	16.7	0.0	11.1	
	TOT PCT	15.0	5.0	0.0	5.0	
COLUMN TOTAL		4 20.0	6 30.0	1 5.0	9 45.0	20 100.0

**** CROSSTABULATION OF **********
C2 RATING BY N29 STORMSCOPE RATING

C2	N29	HIGHEST 0.	HIGH 1.	LOWEST 3.	NO EXPERIENCE 4.	ROW TOTAL
0. NONE	COUNT	0	2	0	5	7
	ROW PCT	0.0	28.6	0.0	71.4	35.0
	COL PCT	0.0	33.3	0.0	41.7	
	TOT PCT	0.0	10.0	0.0	25.0	
1. INSTRUMENT	COUNT	1	2	1	3	7
	ROW PCT	14.3	28.6	14.3	42.9	35.0
	COL PCT	100.0	33.3	100.0	25.0	
	TOT PCT	5.0	10.0	5.0	15.0	
2. INSTRUCTOR	COUNT	0	0	0	1	1
	ROW PCT	0.0	0.0	0.0	100.0	5.0
	COL PCT	0.0	0.0	0.0	8.3	
	TOT PCT	0.0	0.0	0.0	5.0	
3. INSTRUMENT INSTR	COUNT	0	2	0	3	5
	ROW PCT	0.0	40.0	0.0	60.0	25.0
	COL PCT	0.0	33.3	0.0	25.0	
	TOT PCT	0.0	10.0	0.0	15.0	
COLUMN TOTAL		1 5.0	6 30.0	1 5.0	12 60.0	20 100.0

**** CROSSTABULATION OF **********
C2 RATING BY N50 ATC WEATHER RATING

C2	N50	HIGHEST 0.	HIGH 1.	LOW 2.	LOWEST 3.	ROW TOTAL
0. NONE	COUNT	1	1	4	1	7
	ROW PCT	14.3	14.3	57.1	14.3	35.0
	COL PCT	16.7	14.3	66.7	100.0	
	TOT PCT	5.0	5.0	20.0	5.0	
1. INSTRUMENT	COUNT	3	3	1	0	7
	ROW PCT	42.9	42.9	14.3	0.0	35.0
	COL PCT	50.0	42.9	16.7	0.0	
	TOT PCT	15.0	15.0	5.0	0.0	
2. INSTRUCTOR	COUNT	1	0	0	0	1
	ROW PCT	100.0	0.0	0.0	0.0	5.0
	COL PCT	16.7	0.0	0.0	0.0	
	TOT PCT	5.0	0.0	0.0	0.0	
3. INSTRUMENT INSTR	COUNT	1	3	1	0	5
	ROW PCT	20.0	60.0	20.0	0.0	25.0
	COL PCT	16.7	42.9	16.7	0.0	
	TOT PCT	5.0	15.0	5.0	0.0	
COLUMN TOTAL		6 30.0	7 35.0	6 30.0	1 5.0	20 100.0

**** CROSSTABULATION OF **********
C2 RATING BY N51 FSS WEATHER RATING

C2	N51	HIGHEST 0.	HIGH 1.	LOW 2.	LOWEST 3.	NO EXPERIENCE 4.	ROW TOTAL
0. NONE	COUNT	0	3	2	1	1	7
	ROW PCT	0.0	42.9	28.6	14.3	14.3	35.0
	COL PCT	0.0	42.9	33.3	33.3	100.0	
	TOT PCT	0.0	15.0	10.0	5.0	5.0	
1. INSTRUMENT	COUNT	1	1	3	2	0	7
	ROW PCT	14.3	14.3	42.9	28.6	0.0	35.0
	COL PCT	33.3	14.3	50.0	66.7	0.0	
	TOT PCT	5.0	5.0	15.0	10.0	0.0	
2. INSTRUCTOR	COUNT	1	0	0	0	0	1
	ROW PCT	100.0	0.0	0.0	0.0	0.0	5.0
	COL PCT	33.3	0.0	0.0	0.0	0.0	
	TOT PCT	5.0	0.0	0.0	0.0	0.0	
3. INSTRUMENT INSTR	COUNT	1	3	1	0	0	5
	ROW PCT	20.0	60.0	20.0	0.0	0.0	25.0
	COL PCT	33.3	42.9	16.7	0.0	0.0	
	TOT PCT	5.0	15.0	5.0	0.0	0.0	
COLUMN TOTAL		3 15.0	7 35.0	6 30.0	3 15.0	1 5.0	20 100.0

**** CROSSTABULATION OF ****
C2 RATING BY N32 CMD RATING

C2	N32	HIGHEST 0.	HIGH 1.	LOW 2.	ROW TOTAL
0. NONE	COUNT	5	2	0	7
	ROW PCT	71.4	28.6	0.0	35.0
	COL PCT	45.5	25.0	0.0	
	TOT PCT	25.0	10.0	0.0	
1. INSTRUMENT	COUNT	3	4	0	7
	ROW PCT	42.9	57.1	0.0	35.0
	COL PCT	27.3	50.0	0.0	
	TOT PCT	15.0	20.0	0.0	
2. INSTRUCTOR	COUNT	1	0	0	1
	ROW PCT	100.0	0.0	0.0	5.0
	COL PCT	9.1	0.0	0.0	
	TOT PCT	5.0	0.0	0.0	
3. INSTRUMENT INSTR	COUNT	2	2	1	5
	ROW PCT	40.0	40.0	20.0	25.0
	COL PCT	18.2	25.0	100.0	
	TOT PCT	10.0	10.0	5.0	
COLUMN TOTAL		11 55.0	8 40.0	1 5.0	20 100.0

**** CROSSTABULATION OF ****
C2 RATING BY N33 TV WEATHER RATING

C2	N33	HIGH 1.	LOW 2.	LOWEST 3.	ROW TOTAL
0. NONE	COUNT	2	2	3	7
	ROW PCT	28.6	28.6	42.9	35.0
	COL PCT	100.0	33.3	25.0	
	TOT PCT	10.0	10.0	15.0	
1. INSTRUMENT	COUNT	0	2	5	7
	ROW PCT	0.0	28.6	71.4	35.0
	COL PCT	0.0	33.3	41.7	
	TOT PCT	0.0	10.0	25.0	
2. INSTRUCTOR	COUNT	0	1	0	1
	ROW PCT	0.0	100.0	0.0	5.0
	COL PCT	0.0	16.7	0.0	
	TOT PCT	0.0	5.0	0.0	
3. INSTRUMENT INSTR	COUNT	0	1	4	5
	ROW PCT	0.0	20.0	80.0	25.0
	COL PCT	0.0	16.7	33.3	
	TOT PCT	0.0	5.0	20.0	
COLUMN TOTAL		2 10.0	6 30.0	12 60.0	20 100.0

****** CROSSTABULATION OF ******************
C2 RATING BY N34 AM WEATHER RATING

C2	COUNT / ROW PCT / COL PCT / TOT PCT	N34 HIGHEST 0.	HIGH 1.	LOW 2.	LOWEST 3.	NO EXPERIENCE 4.	ROW TOTAL
0. NONE		0	1	2	2	2	7
		0.0	14.3	28.6	28.6	28.6	35.0
		0.0	25.0	22.2	50.0	100.0	
		0.0	5.0	10.0	10.0	10.0	
1. INSTRUMENT		0	2	3	2	0	7
		0.0	28.6	42.9	28.6	0.0	35.0
		0.0	50.0	33.3	50.0	0.0	
		0.0	10.0	15.0	10.0	0.0	
2. INSTRUCTOR		0	0	1	0	0	1
		0.0	0.0	100.0	0.0	0.0	5.0
		0.0	0.0	11.1	0.0	0.0	
		0.0	0.0	5.0	0.0	0.0	
3. INSTRUMENT INSTR		1	1	3	0	0	5
		20.0	20.0	60.0	0.0	0.0	25.0
		100.0	25.0	33.3	0.0	0.0	
		5.0	5.0	15.0	0.0	0.0	
COLUMN TOTAL		1 5.0	4 20.0	9 45.0	4 20.0	2 10.0	20 100.0

****** CROSSTABULATION OF ******************
C2 RATING BY N35 VOR ON CWD OUTPUT

C2	COUNT / ROW PCT / COL PCT / TOT PCT	N35 ADD 0.	NO CHANGE 2.	ROW TOTAL
0. NONE		0	7	7
		0.0	100.0	35.0
		0.0	36.8	
		0.0	35.0	
1. INSTRUMENT		0	7	7
		0.0	100.0	35.0
		0.0	36.8	
		0.0	35.0	
2. INSTRUCTOR		0	1	1
		0.0	100.0	5.0
		0.0	5.3	
		0.0	5.0	
3. INSTRUMENT INSTR		1	4	5
		20.0	80.0	25.0
		100.0	21.1	
		5.0	20.0	
COLUMN TOTAL		1 5.0	19 95.0	20 100.0

**** CROSSTABULATION OF **********
C2 RATING BY N36 NDB ON CWD OUTPUT

C2	N36	ADD 0.	DELETE 1.	NO CHANGE 2.	ROW TOTAL
0. NONE	COUNT	5	0	2	7
	ROW PCT	71.4	0.0	28.6	35.0
	COL PCT	35.7	0.0	40.0	
	TOT PCT	25.0	0.0	10.0	
1. INSTRUMENT	COUNT	5	0	2	7
	ROW PCT	71.4	0.0	28.6	35.0
	COL PCT	35.7	0.0	40.0	
	TOT PCT	25.0	0.0	10.0	
2. INSTRUCTOR	COUNT	1	0	0	1
	ROW PCT	100.0	0.0	0.0	5.0
	COL PCT	7.1	0.0	0.0	
	TOT PCT	5.0	0.0	0.0	
3. INSTRUMENT INSTR	COUNT	3	1	1	5
	ROW PCT	60.0	20.0	20.0	25.0
	COL PCT	21.4	100.0	20.0	
	TOT PCT	15.0	5.0	5.0	
COLUMN TOTAL		14 70.0	1 5.0	5 25.0	20 100.0

**** CROSSTABULATION OF **********
C2 RATING BY N37 ROUTE ON CWD OUTPUT

C2	N37	ADD 0.	DELETE 1.	NO CHANGE 2.	ROW TOTAL
0. NONE	COUNT	2	1	4	7
	ROW PCT	28.6	14.3	57.1	35.0
	COL PCT	28.6	50.0	36.4	
	TOT PCT	10.0	5.0	20.0	
1. INSTRUMENT	COUNT	2	0	5	7
	ROW PCT	28.6	0.0	71.4	35.0
	COL PCT	28.6	0.0	45.5	
	TOT PCT	10.0	0.0	25.0	
2. INSTRUCTOR	COUNT	1	0	0	1
	ROW PCT	100.0	0.0	0.0	5.0
	COL PCT	14.3	0.0	0.0	
	TOT PCT	5.0	0.0	0.0	
3. INSTRUMENT INSTR	COUNT	2	1	2	5
	ROW PCT	40.0	20.0	40.0	25.0
	COL PCT	28.6	50.0	18.2	
	TOT PCT	10.0	5.0	10.0	
COLUMN TOTAL		7 35.0	2 10.0	11 55.0	20 100.0

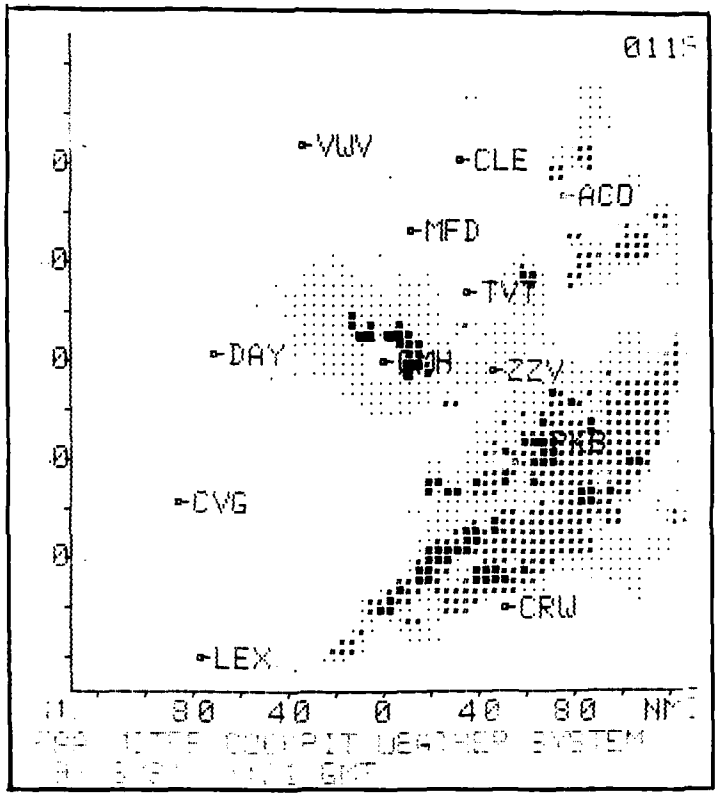
**** CROSSTABULATION OF **********
C2 RATING BY N58 COMPASS ROSE ON CWD OUTPUT

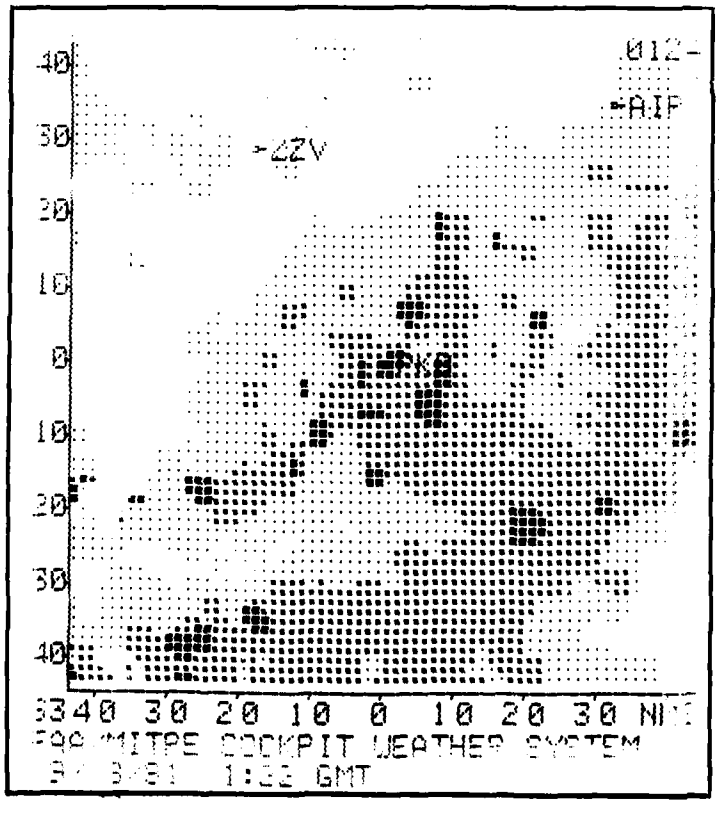
C2	COUNT / ROW PCT / COL PCT / TOT PCT	N58 ADD 0.	DELETE 1.	NO CHANGE 2.	ROW TOTAL
0. NONE		1 14.3 50.0 5.0	1 14.3 100.0 5.0	5 71.4 29.4 25.0	7 35.0
1. INSTRUMENT		0 0.0 0.0 0.0	0 0.0 0.0 0.0	7 100.0 41.2 35.0	7 35.0
2. INSTRUCTOR		1 100.0 50.0 5.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 5.0
3. INSTRUMENT INSTR		0 0.0 0.0 0.0	0 0.0 0.0 0.0	5 100.0 29.4 25.0	5 25.0
COLUMN TOTAL		2 10.0	1 5.0	17 85.0	20 100.0

**** CROSSTABULATION OF **********
C2 RATING BY N59 MY POSITION ON CWD OUTPUT

C2	COUNT / ROW PCT / COL PCT / TOT PCT	N59 ADD 0.	NO CHANGE 2.	ROW TOTAL
0. NONE		6 85.7 37.5 30.0	1 14.3 25.0 5.0	7 35.0
1. INSTRUMENT		4 57.1 25.0 20.0	3 42.9 75.0 15.0	7 35.0
2. INSTRUCTOR		1 100.0 6.3 5.0	0 0.0 0.0 0.0	1 5.0
3. INSTRUMENT INSTR		5 100.0 31.3 25.0	0 0.0 0.0 0.0	5 25.0
COLUMN TOTAL		16 80.0	4 20.0	20 100.0

Appendix C. Recorded Weather Situation.





Appendix D. Pilots' Comments.

Question Number	Comments
1	Assumption on #14 is that the relay is by voice.
	Would rather see output on a black and white or color CRT about the size of the stormscope and mounted in the panel.
2	Control board display should be liquid crystal (LCD).
	If such a device is available, it should be merged with other equipment on board the aircraft, e.g., if a stormscope is installed, then the output device already exists for the weather uplink equipment.
	LED's wash out very badly in direct sunlight.
	Too many keys on control unit
	Control unit mounted on knee board with printer underseat or on floor would be best.
3	Listings 28-34. Assumption is that we are talking about severe weather, not fog, low ceilings.
5	Learning curve is steep with box. Industry will work out packaging.
	Show direction of movement and + or - for change in intensity.
	As in any opinion "choice" answers, nearly every question could require a qualification with the choice. Basically, I'm favorably impressed with the service as proposed--when fully implemented. As tested, "other actions" would have involved using Pittsburg and Charleston printouts of information and/or use of ATC radars--a service I consider best IF proximity and workload permits.
	Personally, I feel a CRT presentation, with the proposed sequence call-up capability, would enhance safety and lessen radio time for single-pilot IFR operation. Naturally, cost of the system is a predominant consideration for those of us who need it most.
9	Visibility of printout at night is questionable.
10	Having 2 VOR's for locating my position is essential. Suggestion that position of plane be shown on printout is perfect.
	Addition of position marker.
	Answers are intended to show general excitement with this system as a long-needed aid, but some concern over distractions associated with data input. Maybe programmable keys??

12 Bearing in mind that I am a "Sunday pilot". If the printout were presented heading at the top, orientation to the map would be quicker as it would easily overlay the map as I orient it to my flight path.

Display orientation should be selectable.

On printed display - north up. On CRT - heading up.

14 I would corroborate this information with ATC. Also ATC would give pertinent and immediate PIREPS and cloud levels (tops, bottom of second layer, etc.). Advantage of this system is planning capacity.

16 I feel the key to the question is whether or not the plane is equipped with an autopilot or not. The autopilot is the key to having time to interpret what is presented by the printer.

Some difficulty could be experienced depending on location of unit and degree of turbulence.

17 Once system was familiar, distraction would be "somewhat"; at first it is considerable. Autopilot is very helpful.

20 Who knows in real turbulence? Good to have a horizontal ridge or bar across bottom to anchor hand on, or perhaps a solid button-post in lower left corner to put thumb on. A telescoping shade might help washout of display in bright light.

Appendix E. Precis No. 16.

TECHNICAL RESULTS - PRÉCIS

OHIO UNIVERSITY/AVIONICS ENGINEERING CENTER

SUBJECT: APPLICATION OF LORAN AND FAA/MITRE COCKPIT WEATHER SYSTEM TO FLIGHT IN THUNDERSTORM AREAS **No.** 16

A 1½ hour flight in heavy weather has been successfully completed which shows that the TI9900 Loran Receiver produces usable data in the presence of lightning and documented precipitation static. The FAA/MITRE cockpit weather system provided the initial information which allowed routing of the flight to the precipitation areas. This was the first actual weather use of this system.

A fast moving cold front moved through Ohio during the afternoon of October 1, 1981, setting off some level three and four thunderstorm activity as indicated by the National Weather Service WSR-74C radar located at Columbus, Ohio. At 1715 EDT N7AP, the Ohio University DC-3 flying laboratory, departed on a flight plan route to the northeast of Athens. After becoming airborne, the FAA/MITRE cockpit weather system on board the DC-3 was activated and the printout of the Columbus weather radar picture uplinked over the Zanesville VOR showed the precipitation areas now to be south of Athens. The flight route was then changed with ATC radar confirming the significant weather to be south of Athens.

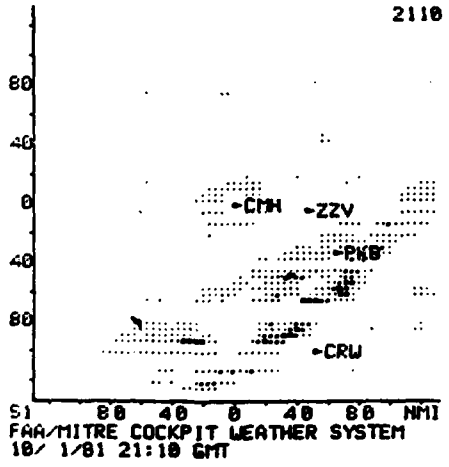


Figure 1

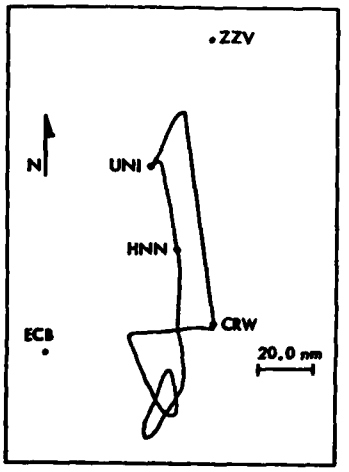


Figure 2

Figure 1 shows a copy of the printout received as the DC-3 proceeded northeastbound out of Athens. Figure 2 shows the flight route accomplished during the flight from 1715 EDT to 1945 EDT.

The track derived from the TI9900 Loran Receiver was observed and flown on a cockpit CDI display. The track produced in digital form was not recorded due to an existing incompatibility in output and a relatively new Byte-Bucket digital cassette recorder. A hand record of the track was prepared from references to the Vortac and Loran indications.

The flight encountered moderate to heavy rain and light to moderate turbulence, there was lightning above and around the aircraft as the flight progressed. During the flight the instrumentation for the p-static dischargers on the aircraft showed the aircraft transversing areas of high static fields as the polarity and magnitude varied quite dramatically. The aircraft was consistently discharging at 300-500 microamperes in both positive and negative point corona. The S/N values from the TI9900 did vary approximately 20 dB during the flight with the receiver indicating no deceptive or erratic performance. At one point in the flight when the aircraft was encountering high p-static discharging rates with increased electrical activity above and around the aircraft, the TI9900 did lose cycle track on the Dana and Carolina Beach stations of the 9960 rate for approximately 20 seconds while track on the Seneca, N.Y. was preserved. The receiver produced no blunder points and continued to provide a consistent position output. The S/N values for the two stations dropped to about -15 dB S/N during the cycle track loss which then promptly returned to normal. The total flight duration was 2.5 hours and produced no other cycle track loss. The Loran data was used continually to position the aircraft during various segments of the route.

Future flights are planned to identify and separate the lightning and p-static effects on the Loran C reception.

R. H. McFarland
J. D. Nickum
October 6, 1981

VII. GLOSSARY

ATC	Air Traffic Control
CRT	Cathode Ray Tube
CWD	Cockpit Weather Display
FAA	Federal Aviation Administration
IFR	Instrument Flight Rules
MSL	Mean Sea Level
NDB	Nondirectional Beacon
NM	Nautical Mile
NOTAM.	Notice To Airmen
NWS	National Weather Service
PIREPs'	Pilot Reports
RF.	Radio Frequency
SPSS.	Statistical Program for the Social Sciences
VFR	Visual Flight Rules
VOR	Very High Frequency Omnidirectional Radio Range
WX	Weather

SUPPLEMENTARY

INFORMATION

AD-A114646

ERRATA

13
DOT/FAA/RD-82/14

EVALUATION OF THE
FAA/MITRE WEATHER
DATA DEVICE

Delmar G Pullins

The number for this report should have been RD-82/13 instead of RD-82/14.

Replace cover and title pages with the attached.

ARD-10d
Released July 27, 1982

DOT/FAA/RD-82/13

Systems Research &
Development Service
Washington, D.C. 20590

Evaluation of the FAA/MITRE Weather Data Device

Delmar G. Pullins

Avionics Engineering Center
Department of Electrical Engineering
Ohio University
Athens, Ohio 45701

January 1982

Final Report

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16. Abstract

Evaluation of cockpit weather display unit. Results of pilot experiences using National Weather Service (NWS) ground weather radar data uplinked to the cockpit via land lines to a Very High Frequency Omnidirectional Radio Range (VOR) and via the VOR voice channel to the aircraft VOR receiver then decoded and displayed on a printed paper format. NWS weather radar information is available on demand using this system.

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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