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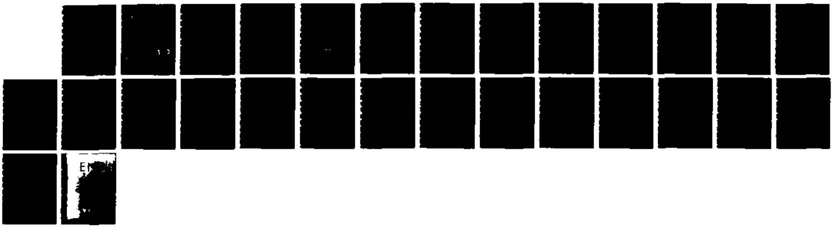

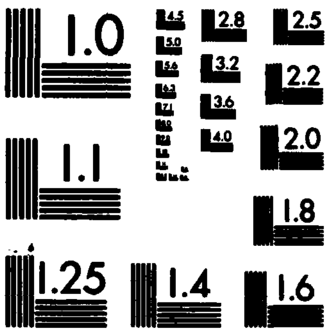
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Technical Note 5-84

EMULATION OF A VOICE INTERACTIVE DOPPLER NAVIGATION SET

Robert G. Hackenberg
Frank J. Malkin

March 1984

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U. S. ARMY HUMAN ENGINEERING LABORATORY

Aberdeen Proving Ground, Maryland

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Software emulating the operation of the Doppler Navigation Set entirely by voice commands is described. The software, written in Microsoft BASIC using a vocabulary of 67 words, is implemented on the Interstate Electronics VRT 103 Voice Recognition Terminal. Procedural diagrams illustrating the man-machine interaction occurring during the program's subroutines are included.

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EMULATION OF A VOICE INTERACTIVE DOPPLER NAVIGATION SET

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March 1984

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CONTENTS

EMULATION OF A VOICE INTERACTIVE DOPPLER NAVIGATION SET

INTRODUCTION

The visual and manual workloads of Army helicopter pilots have reached the limits of their capacities because of the "out-the-window" visual demands of flying at or below treetop level while monitoring aircraft displays, and the requirement of both hands and both feet to control a helicopter's flight. Also, maps, checklists, and tactical notes must be referred to while flying. However, with the advent of computer technology, integrated controls and displays using keyboards and other function keys are being introduced into Army helicopter cockpits, increasing the pilots' visual and manual workloads.

Voice interactive technology, which encompasses computer recognition and generation of speech, provides the potential for reducing the visual and manual workload by changing some of the visual and manual tasks to auditory and speech tasks. The pilot is afforded the capability of making inputs by speaking to onboard systems and receiving output from these systems in the form of speech synthesis. After many years of research and development, voice interactive technology is approaching the point where it may be seriously considered for airborne applications. However, before voice technology can be successfully employed in the helicopter environment, several technology and human factors issues must be resolved. Developing an algorithm that provides for the use of a natural form of communication consistent with the lexicon of Army helicopter pilots and, at the same time, conforms to software and hardware restraints involves human factors issues that remain unresolved. For example, it is desirable to avoid an unnatural command such as "ENTER" when inputting data by voice.

Because the Doppler Navigation Set (DNS) incorporates functions such as entering data and requesting information using voice, the development of software that emulates voice control of the DNS serves as an effective vehicle to conduct human factors research relative to voice technology applications.

PURPOSE

The purpose of this report is to describe a preliminary approach to the development of software that emulates the operation of the AN/ASN 128 Doppler Navigation Set using voice interactive technology.

DOPPLER NAVIGATION SET

The Doppler Navigation Set is a computer-based system that uses radar to provide navigational information for the crew. The display unit is shown in Figure 1. The set contains two rotary knobs to select functions,

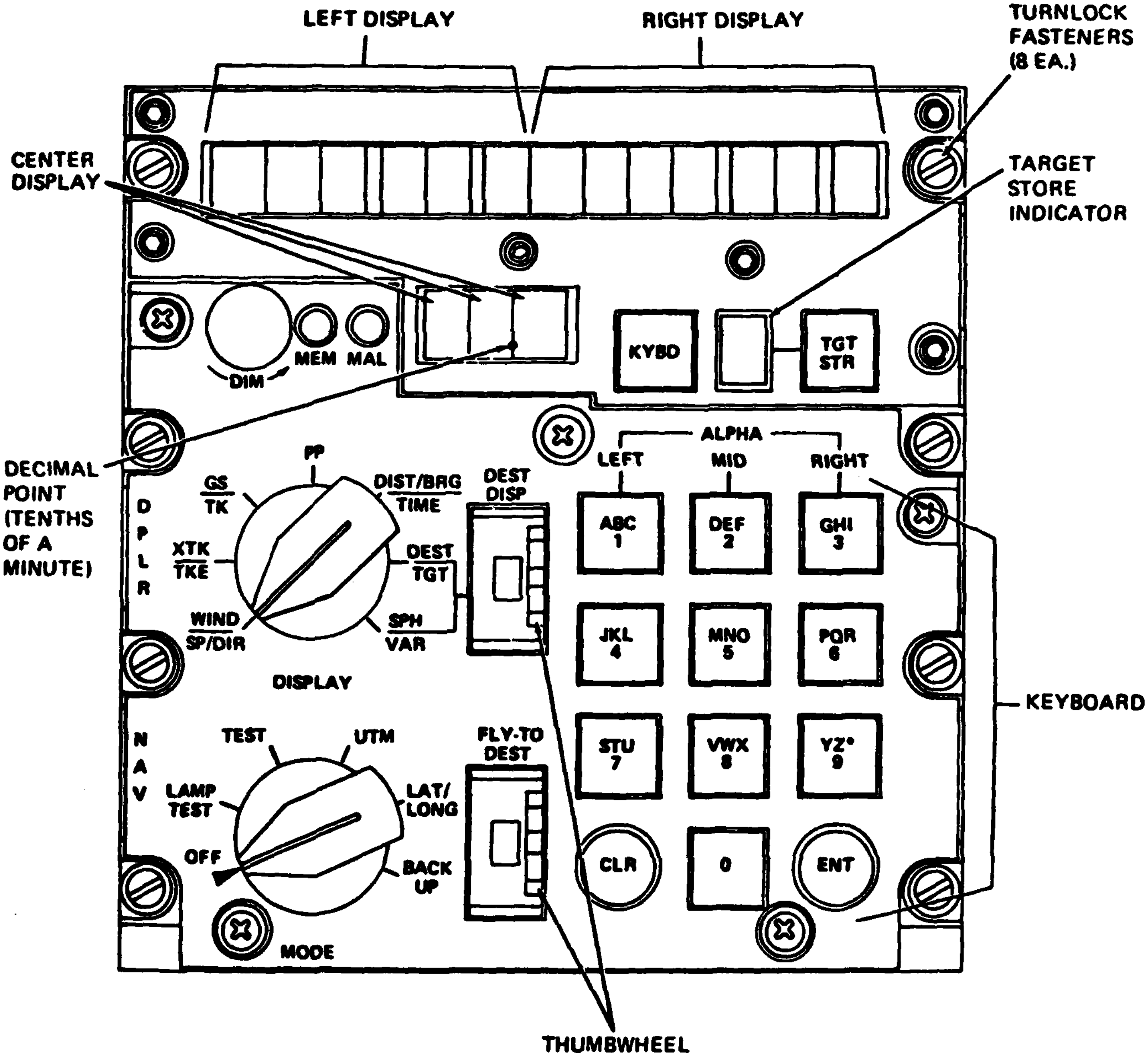


Figure 1. Doppler Display Unit.

two thumbwheels to select specific waypoints, three displays that show a variety of information, and a keyboard through which data is entered. A total of 12 registers can be selected. These consist of waypoints 0 through 9, HOME, and PRESENT POSITION. HOME is the final destination of a mission. PRESENT POSITION is a register that keeps track of the helicopter's location at all times. As the helicopter moves, this register is constantly updated by the computer. Because the DNS loses accuracy over a period of time, it is occasionally necessary to update the contents of the PRESENT POSITION register with more current data such as the coordinates for a known landmark or a waypoint that the helicopter is flying over. Registers 6 through 9 are used to designate either waypoints or targets.

The DNS functions in either a Universal Transverse Mercator (UTM) navigational mode of operation or a latitude/longitude mode. The UTM is used more often, and therefore it is the mode of operation discussed in this report. Before the DNS can function, it must be initialized. To determine the map coordinates for a specific location, the DNS must have data for the spheroid, the magnetic variation from true north, the zone, and the grid coordinates. All of these are used in the UTM system of map projection. The nature of this data will be explained later.

The use of the DNS requires a considerable amount of the operator's visual and mental attention because of the complex data entry procedures. For example, two key strokes must be used to enter a letter. To enter the letter "C," it is necessary to depress the "1" on the keypad (the "1" contains the letters "A," "B," and "C") and then depress the "3" to indicate the letter farthest right on the "1" key. To initialize the DNS and enter one waypoint can take as many as 38 keyboard switch operations. A more detailed description of the DNS can be obtained from the Pilot's Operational Guide.[1]

VOICE CONTROL OF THE DOPPLER NAVIGATION SET

An algorithm that permits the operation of the DNS entirely through the use of voice has been implemented on the Interstate Electronics Corporation VRT 103 Voice Recognition Terminal. The software, written in Microsoft BASIC, uses a vocabulary of 67 words (See Appendix A). The vocabulary conforms to the Doppler functions and was compiled during the development of the algorithm. Appendix B contains a series of procedural diagrams illustrating the man-machine interaction occurring during the subroutines described in the following paragraphs.

[1] Singer Company-Kearfott Division. Pilot's operational guide, Doppler Navigation Set AN/ASN 128. Little Falls, NJ: Author, 1981.

Using a main voice routine, Figure 1B shows that the word "DOPPLER" is spoken in order to enter the routine that enables interaction with the DNS. Other voice interactive routines, such as those for ENGINE or COMMUNICATIONS, also could be entered from this main voice routine. However, the algorithm discussed in this report is limited only to an emulation of voice control of the DNS.

Figure 2B shows that once the Doppler mode is entered, the computer will ask "WHICH FUNCTION?" Any message coming from the computer and appearing on the video display also could be presented by means of synthetic voice through the pilot's headset. One of the following functions can be selected by verbalizing the appropriate function name:

Figure 3B	INITIALIZE
Figure 4B	CHANGE SETTINGS
Figure 5B	SET UTM
Figure 6B	READ WAYPOINT
Figure 7B	SET DESTINATION
Figure 8B	INFORMATION
Figure 9B	UPDATE FROM WAYPOINT
Figure 10B	UPDATE FROM LANDMARK
Figure 11B	SET TARGET

Exit from any one of the function subroutines results in a return to the main DOPPLER menu. In order to return to the main voice program from the DOPPLER menu, the command "EXIT" is given.

Because the DNS must be initialized before it can function, the algorithm is devised in such a way that the very first time that the DOPPLER routine is entered, there is an automatic branching to the INITIALIZE subroutine. After exiting this routine, the coordinates for each of the planned waypoints are set. At this point, the system is ready to perform its other functional subroutines. Each of these DOPPLER subroutines is briefly explained, and the full logic of each subroutine is found in the procedural diagrams, Figures 3B through 11B.

The dialogue established for the subroutines is generally standardized. Whenever the computer asks the pilot a yes/no question, "AFFIRMATIVE" is the expected "yes" answer and "NEGATIVE" is the expected "no" answer.

INITIALIZE (Figure 3B)

As previously mentioned, the first time that the DOPPLER routine is entered there is an automatic branch made to the INITIALIZE subroutine. As shown in Figure 3B, the algorithm requires entering the SPHEROID, VARIATION, and ZONE data that will be copied into all of the waypoint registers. With the current DNS, this data must be transferred from waypoint to waypoint for each of the registers that will be used. The SPHEROID data consist of two letters and a digit. The magnetic VARIATION for a particular area can be read from a typical navigational map. The

ZONE data consist of two digits plus a letter. Whenever data of this nature are entered, the software is constantly doing a validity check on the format. If inappropriate data are entered, the computer returns with the message "INVALID ENTRY" and requires starting again from the beginning of the entry. After these three pieces of data are entered, the algorithm copies them into all the waypoint registers on the premise that none will change on a particular mission. The only one that is likely to change is the ZONE. Any of these data can be altered through use of the CHANGE SETTINGS subroutine.

In the INITIALIZE subroutine, there is a provision for the coordinates of the PRESENT POSITION waypoint to be entered. The coordinates consist of two letters and eight digits. Although the term "UTM" has a broader meaning, it is being used in the DOPPLER routine to refer to a location's coordinates.

One final task that the INITIALIZE subroutine accomplishes is setting the FLY-TO-DESTINATION (FD) pointer to 1 and the TARGET (TG) pointer to 6, which are the appropriate starting values for these pointers.

CHANGE SETTINGS (Figure 4B)

This subroutine permits the operator to change the SPHEROID, VARIATION, ZONE, or UTM settings for any of the waypoints. After each change is made, the crew member is asked if another change is desired. If not, the subroutine returns to the DOPPLER menu.

SET UTM (Figure 5B)

This subroutine enters the UTM coordinates for specific waypoints. After each entry, there is an option to either set another UTM or return to the DOPPLER menu. All the settings for the particular waypoint are then displayed on the screen.

READ WAYPOINT (Figure 6B)

In order to retrieve the coordinates for a specific waypoint, the subroutine is entered and the waypoint number is given. This will provide the settings for only that waypoint. If the subroutine is entered and the command "ALL WAYPOINTS" is given, settings for all waypoints and positions of the FD and TG pointers are displayed.

SET DESTINATION (Figure 7B)

In several of the subroutines, the FD pointer is automatically moved to the next waypoint. The FD pointer can be set manually by telling the computer which waypoint it should point to. If the waypoint chosen does not contain UTM coordinates, the command will be rejected.

INFORMATION (Figure 8B)

This subroutine is entered to obtain navigational information such as distance or time to a waypoint. This information is provided for the waypoint to which the FD pointer is pointing. In order to return to the DOPPLER routine, the crew member commands "EXIT" or simply waits 30 seconds without saying anything.

UPDATE FROM WAYPOINT (Figure 9B)

If it is necessary to update the UTM coordinates stored in the PRESENT POSITION register, this subroutine is entered as the aircraft approaches the next waypoint, and the command "UPDATE" is given as the waypoint is transited. The UTM coordinates for that waypoint are then copied into the PRESENT POSITION register. Also, this procedure automatically moves the FD pointer to the next waypoint.

UPDATE FROM LANDMARK (Figure 10B)

This subroutine is similar to UPDATE FROM WAYPOINT because it updates the UTM for the PRESENT POSITION register. It differs in that the crew member enters the UTM coordinates for a landmark which has been identified. As the aircraft flies over the landmark, the command "SET LANDMARK" is given and then the UTM coordinates are entered when ready. The FD pointer is not affected.

SET TARGET (Figure 11B)

When an aircraft flies over a point that is considered a possible target, the command "SET TARGET" is given from the DOPPLER routine. The PRESENT POSITION UTM coordinates are immediately copied into the waypoint (target) register to which the TG pointer is pointing. After this occurs, the TG pointer is moved to the next value. Once the TG pointer reaches 9, it returns to 6 which is the initial value. If UTM coordinates are copied into a waypoint that already contains UTM data, the operator is asked whether the current data should be erased.

DISCUSSION

This report has described a rudimentary approach to the development of software that emulates the operation of the Doppler Navigation Set using voice technology.

Because more empirical investigations must be completed in the laboratory, this report is not intended to purport that voice technology is preferred over the keyboard as a means of interacting with the Doppler Navigation Set nor is it the report's intent to imply that the software described necessarily provides the most effective man-machine voice interaction. The software algorithm may be thought of as a "branching" approach because it starts from the top and moves down through the various cockpit functions such as communications, navigation, and subsystem monitoring. Another approach is the so-called "verb-object" approach. This approach presupposes that there are certain actions to accomplish using speech recognition technology that could be described by action verbs such as DISPLAY or SELECT. These action verbs are followed by the object to be acted upon. For example, DISPLAY WAYPOINT, DISPLAY FUEL STATUS, or SELECT CHANNEL ONE. Both of these approaches will be evaluated in the future.

This software algorithm will be used as a foundation from which to address the issues of vocabulary and syntax development, information feedback, validity checks of voice input, and error correction methods.

APPENDIX A

VOICE RECOGNITION VOCABULARY

VOICE RECOGNITION VOCABULARY

DOPPLER
ENGINE
COMMUNICATIONS
INITIALIZE
CHANGE SETTINGS
SET UTM
READ WAYPOINT
SET DESTINATION
INFORMATION
UPDATE FROM LANDMARK
UPDATE FROM WAYPOINT
SET TARGET
EXIT
SPHEROID
VARIATION
ZONE
UTM
AFFIRMATIVE
HOME
PRESENT POSITION
OFF COURSE
STEERING
DISTANCE
BEARING
TIME
UPDATE
CANCEL
SET LANDMARK
NEGATIVE
TEN
ALL WAYPOINTS
ZERO
ONE

TWO
THREE
FOUR
FIVE
SIX
SEVEN
EIGHT
NINER
ALPHA
BRAVO
CHARLIE
DELTA
ECHO
FOXTROT
GOLF
HOTEL
INDIA
JULIET
KILO
LIMA
MIKE
NOVEMBER
OSCAR
POPPA
QUEBEC
ROMEO
SIERRA
TANGO
UNIFORM
VICTOR
WHISKEY
XRAY
YANKEE
ZULU

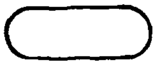
APPENDIX B

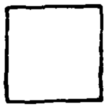
PROCEDURAL DIAGRAMS

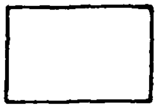
The procedural diagrams in this appendix are provided in order to illustrate the "step-by-step" interactive process between the operator and the system. The legend, below, identifies the meaning of the symbols used in the diagrams.

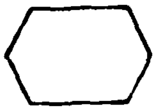

- on-page connector

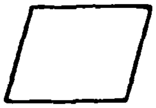

- off-page connector to operations in main voice menu


- begin/end voice communications

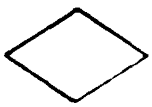

- internal computer operation


- input/output data displayed on CRT screen


- input data by voice


- return to main Doppler menu


- off-page connector to operations in main Doppler menu

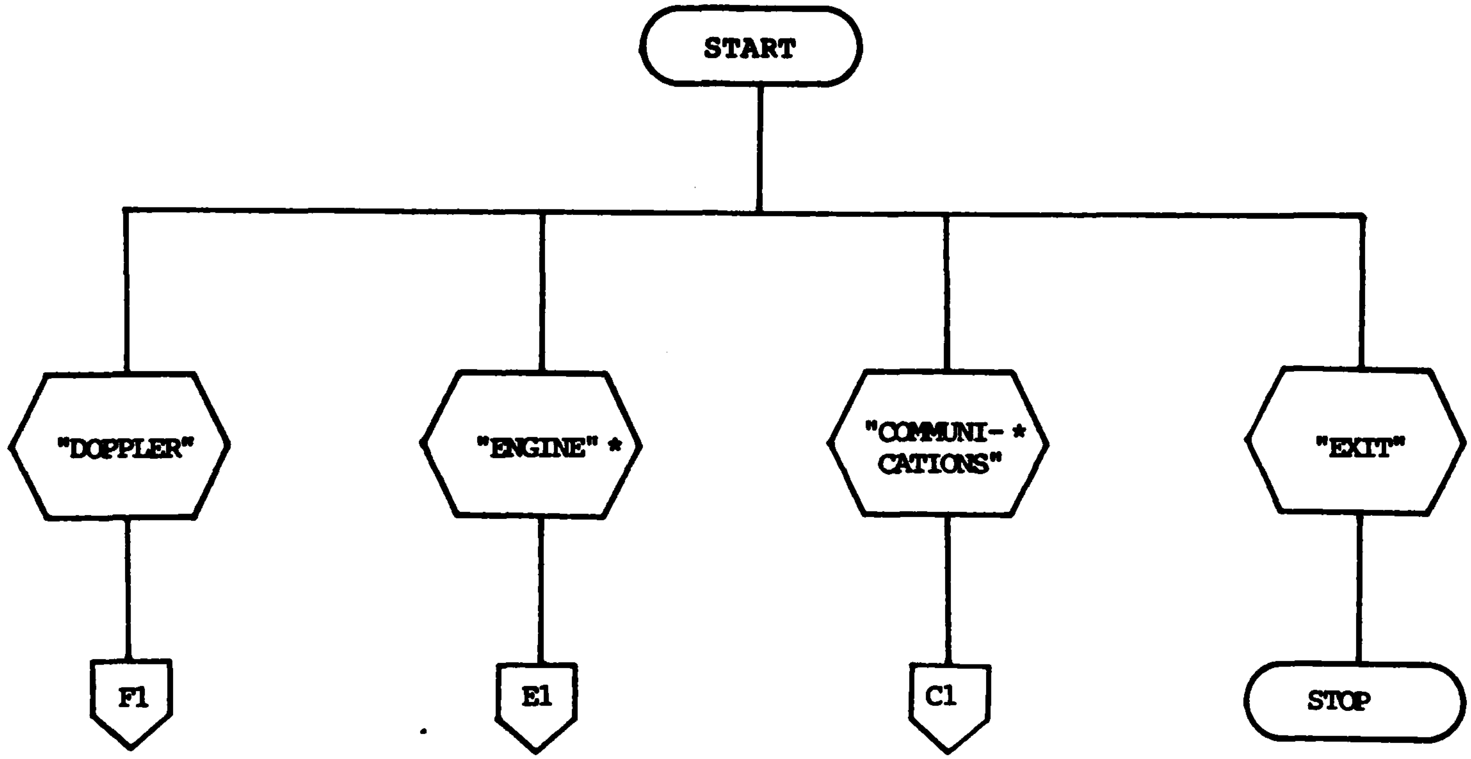

- conditional branch

N = Any number [illegible] thru 9

the waypoi[illegible]sters for HOME or PRESENT POSITION

A = Any alpha character (only the characters E or W when entering VARIATION)

X = Any number



* - Subroutines for these functions have not been developed.

Figure 1B. Main voice menu.

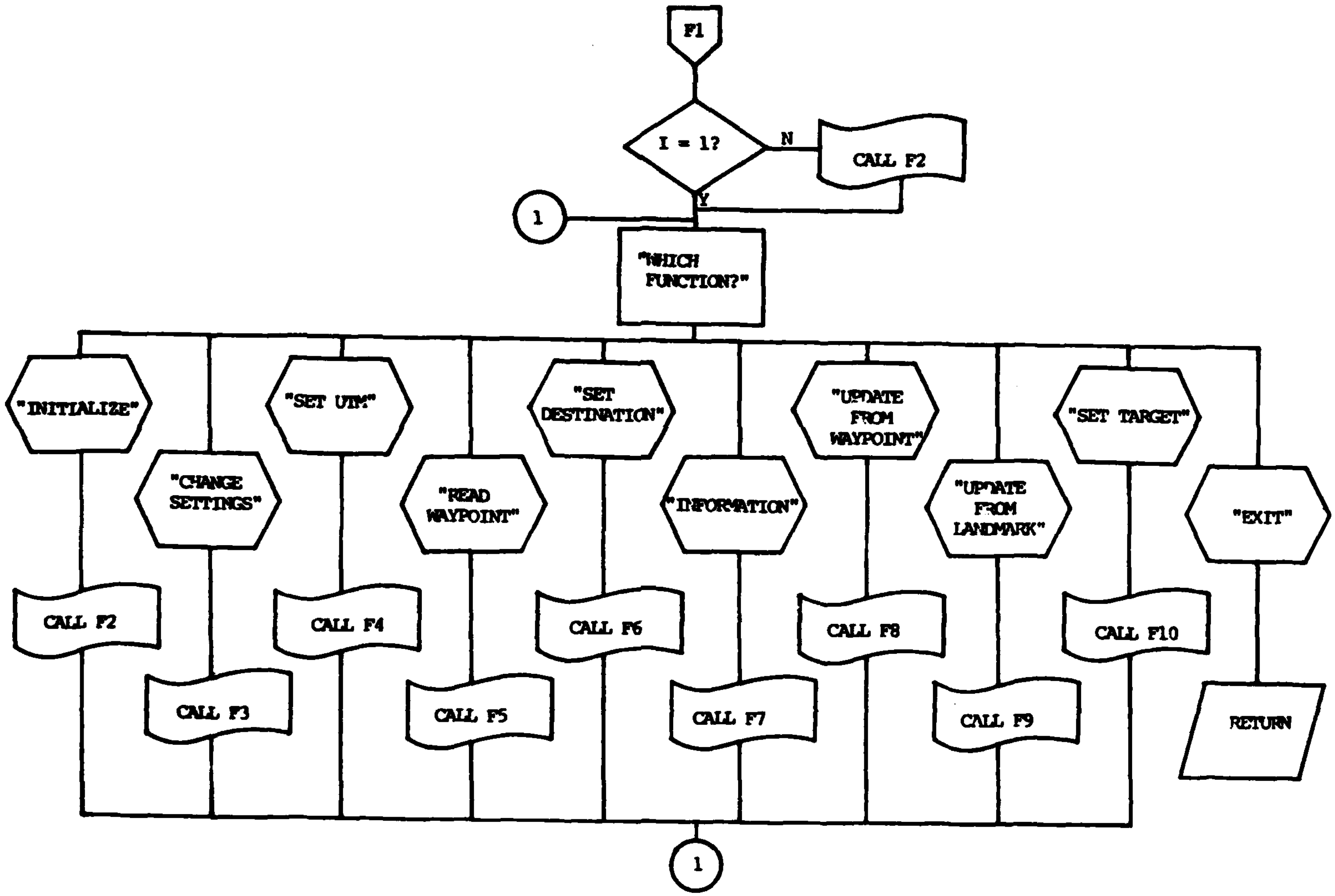


Figure 2B. Doppler menu.

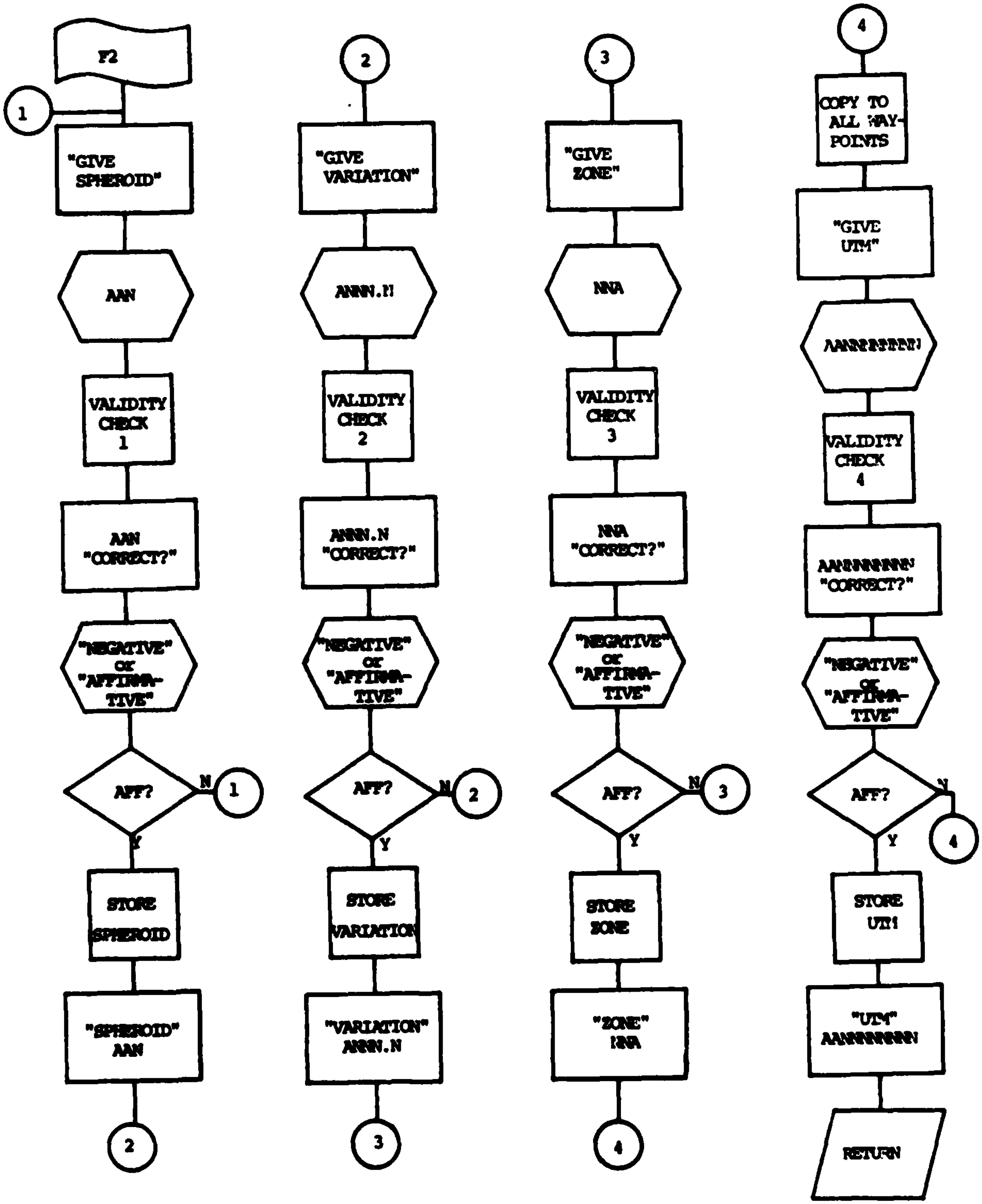


Figure 3B. Initialize.

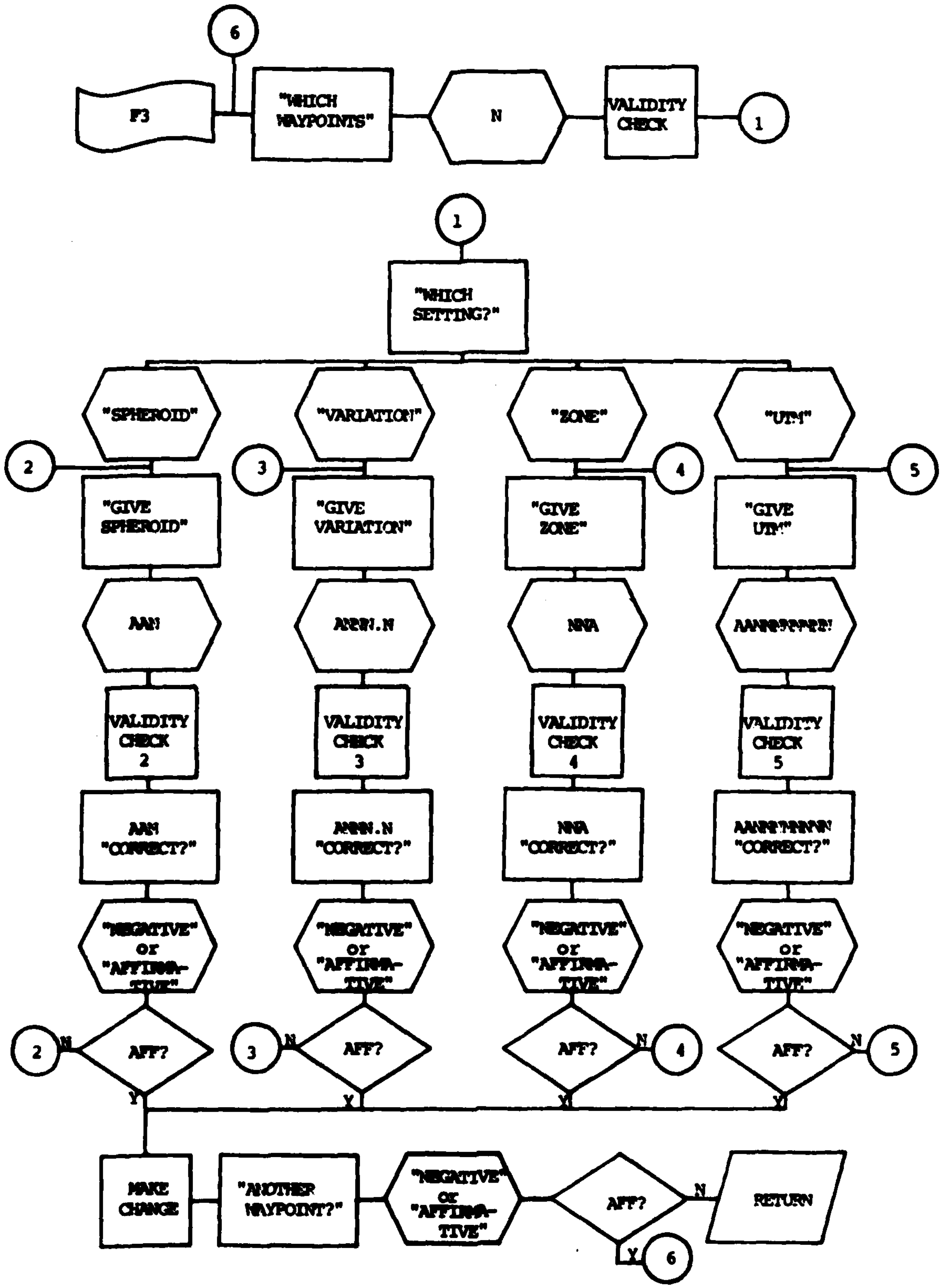


Figure 4B. Change settings.

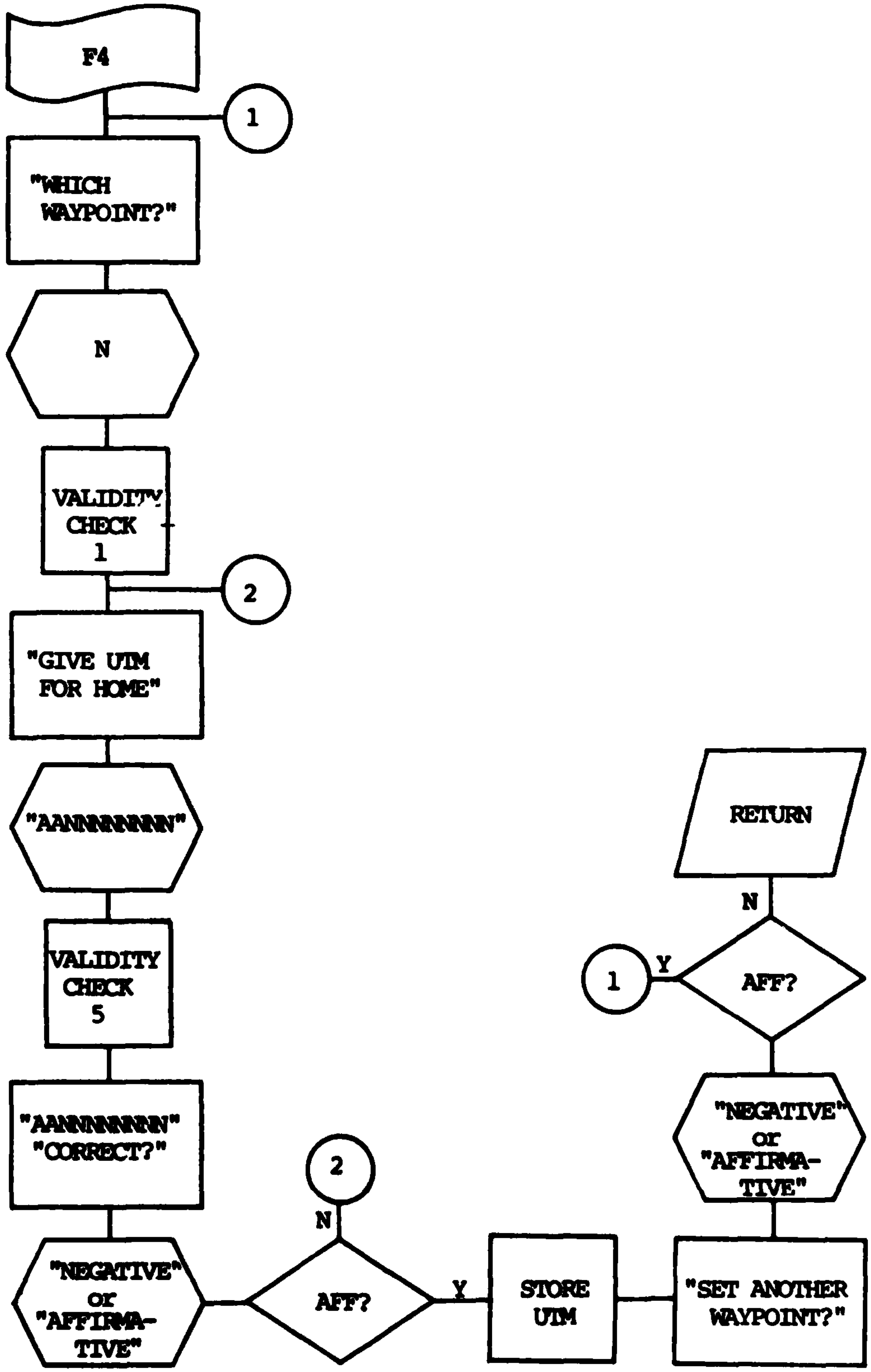


Figure 5B. Set UTM.

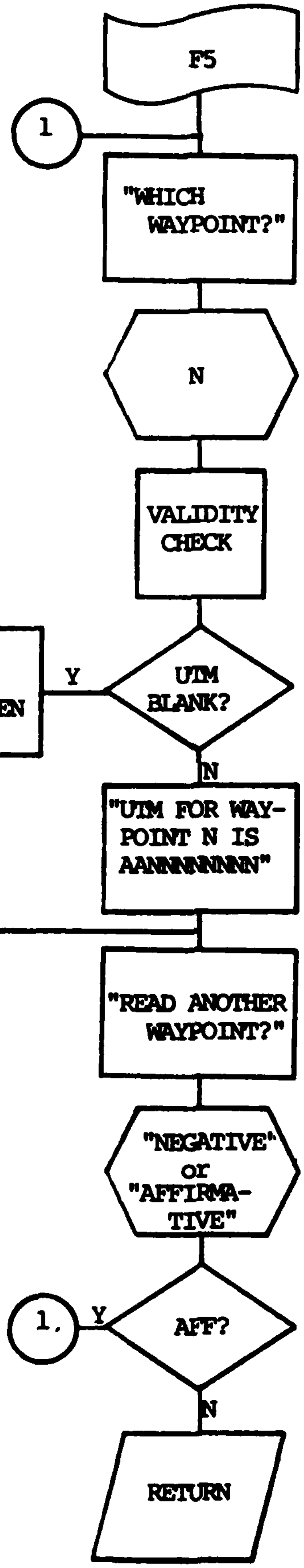


Figure 6B. Read waypoint.

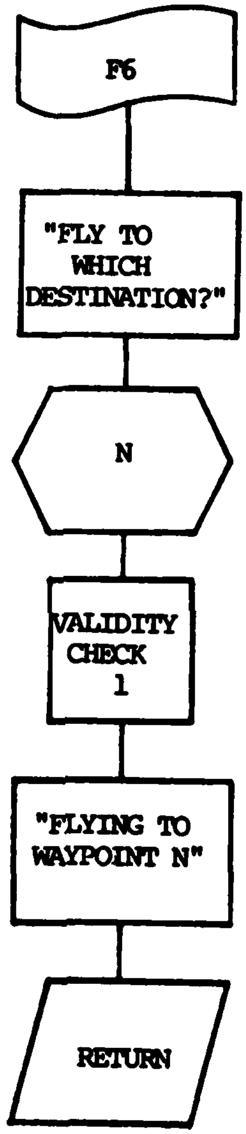


Figure 7B. Set destination.

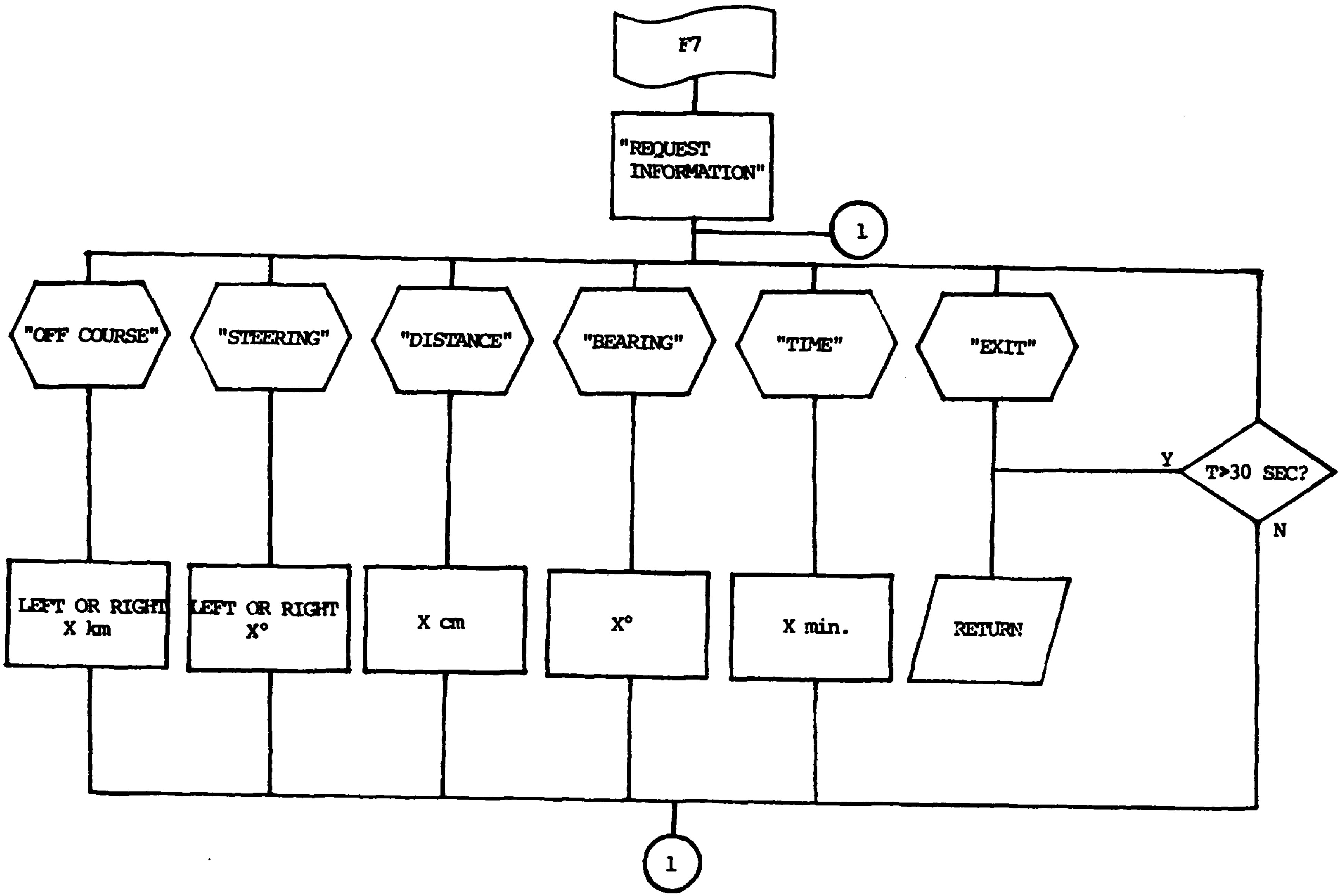


Figure 8B. Information.

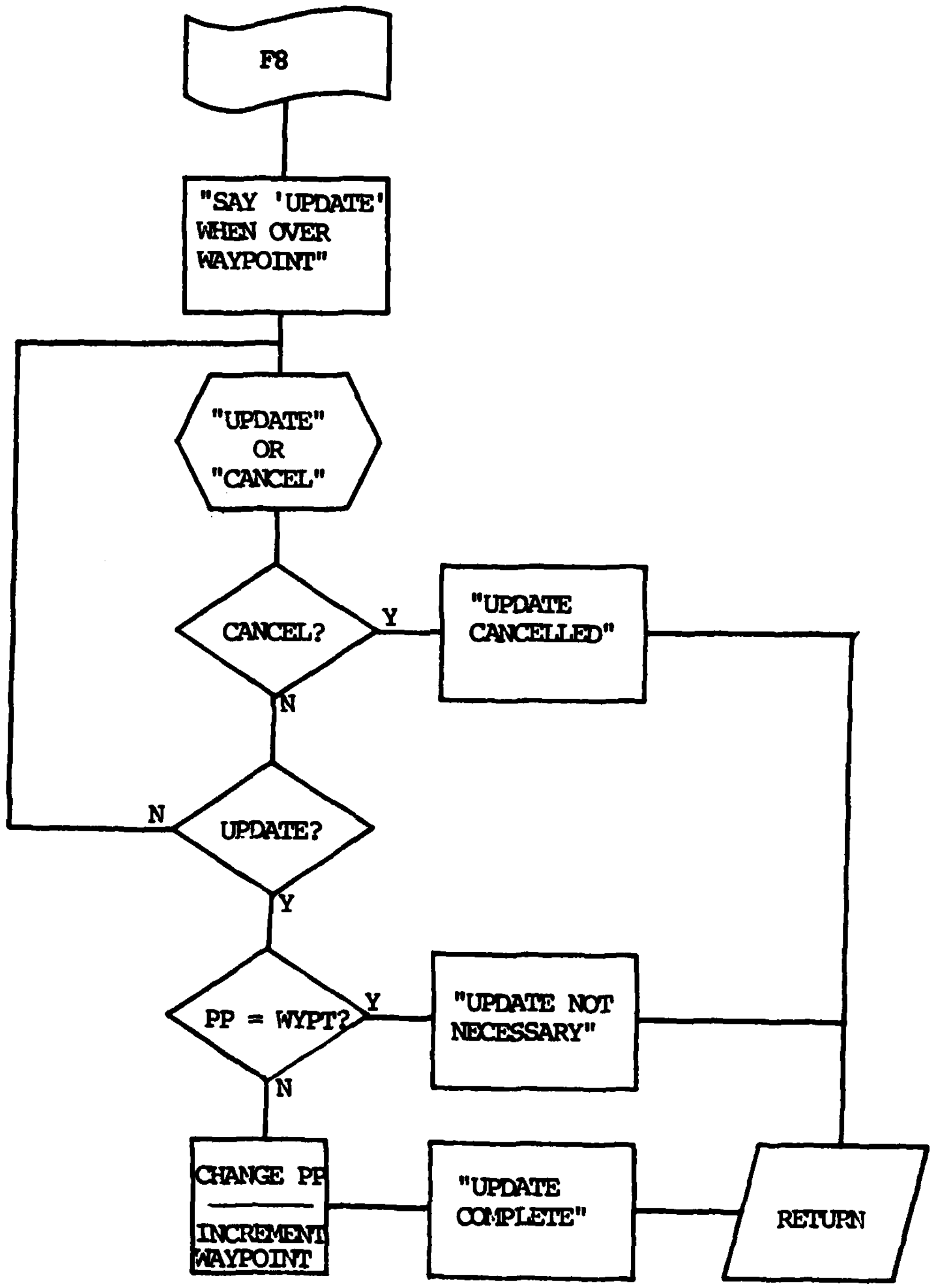


Figure 9B. Update from waypoint.

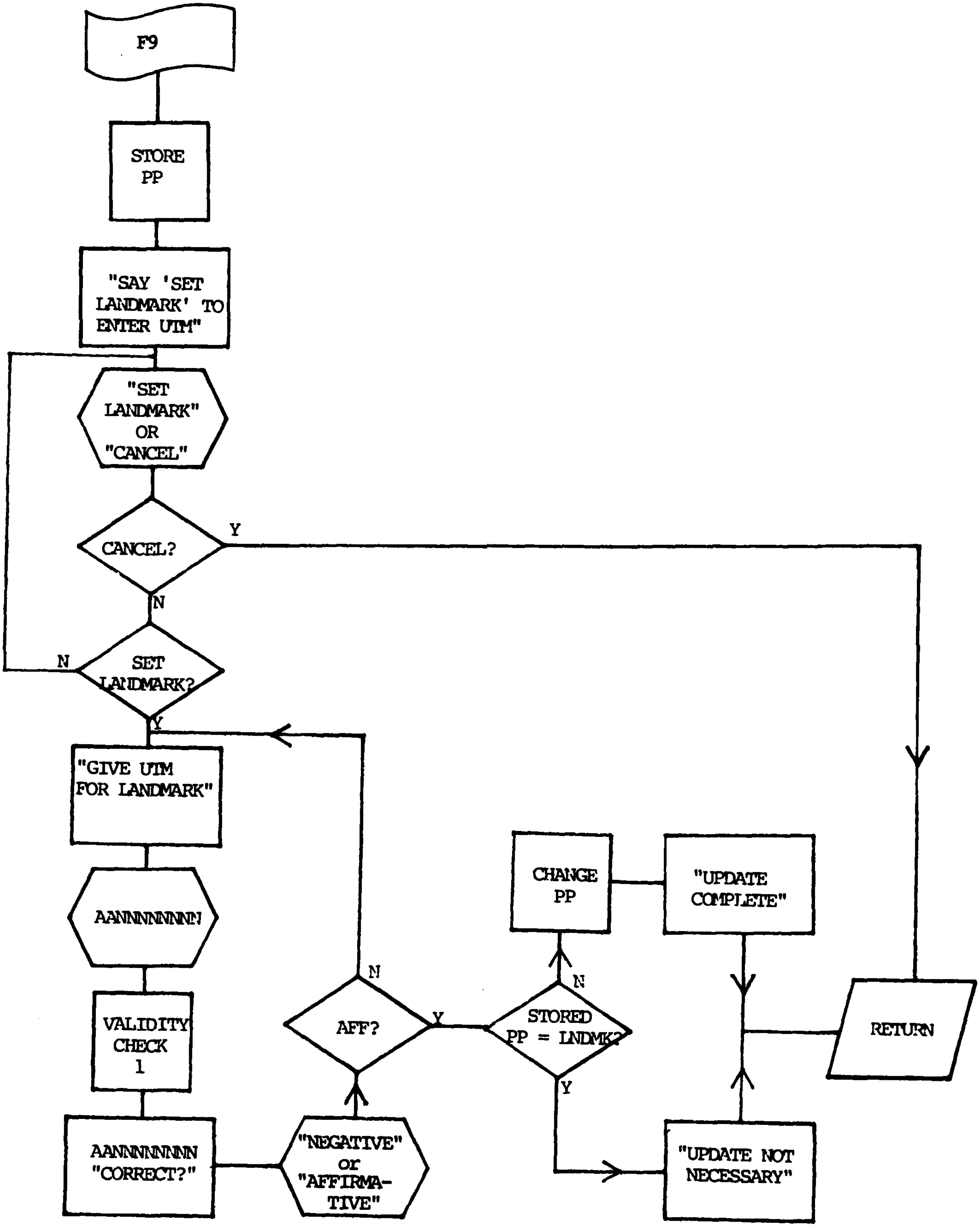


Figure 10B. Update from landmark.

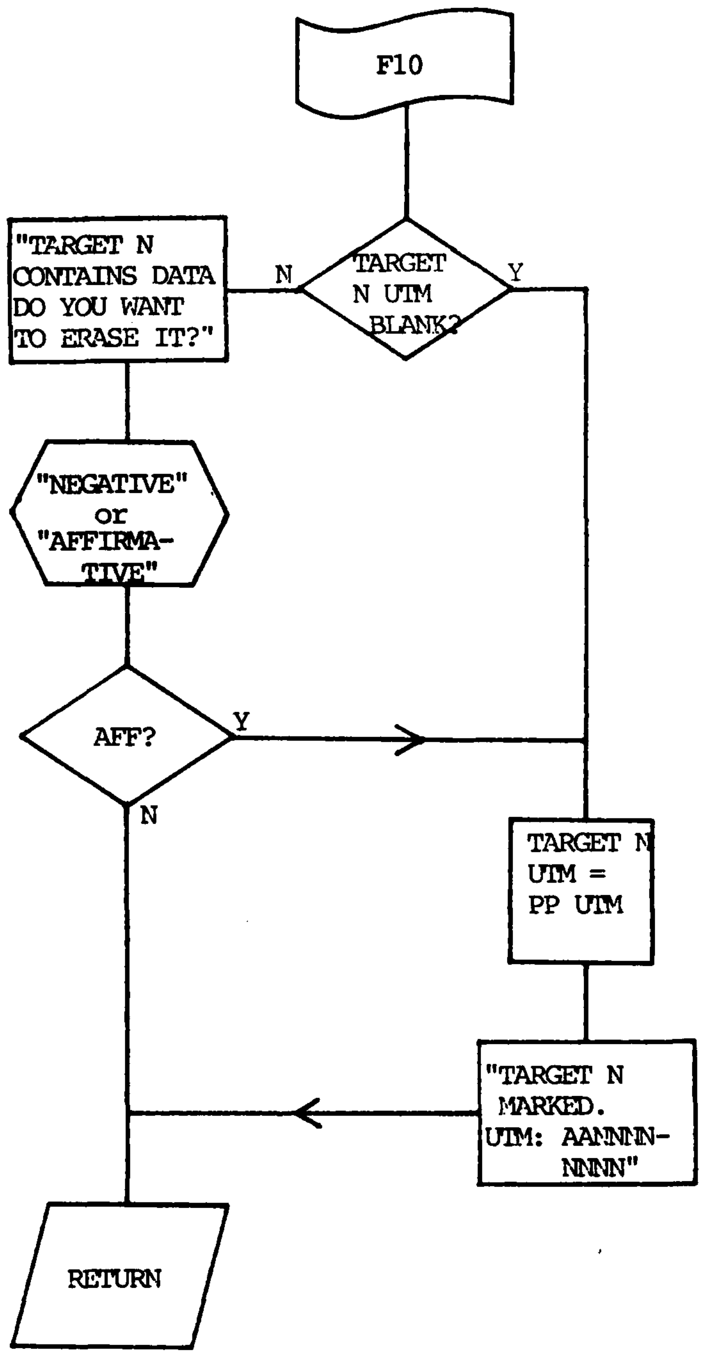


Figure 11B. Set target.

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