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ENHANCED TERMINAL INFORMATION SERVICES (ETIS) UTILIZING THE DIS--ETC(U)

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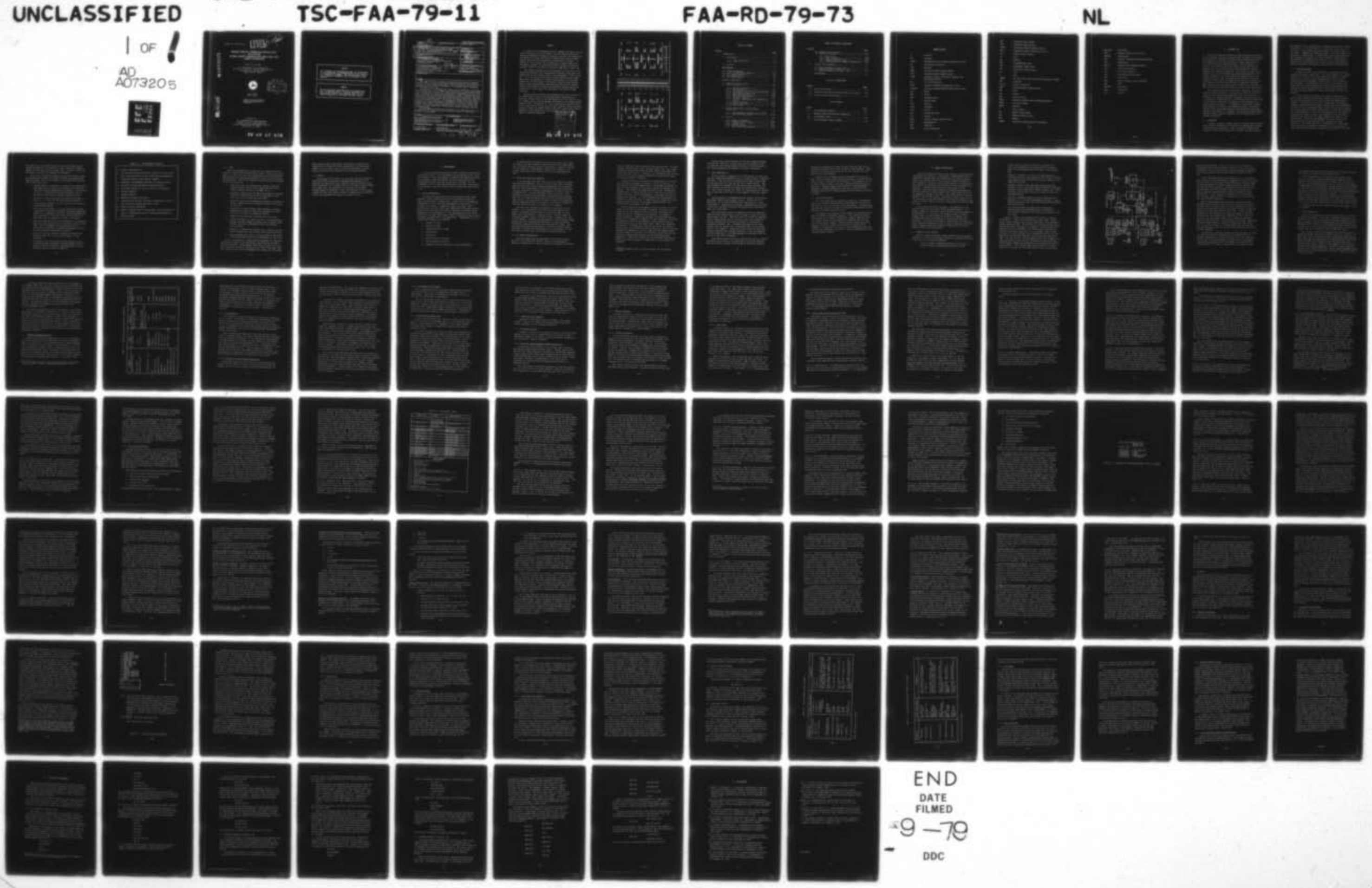

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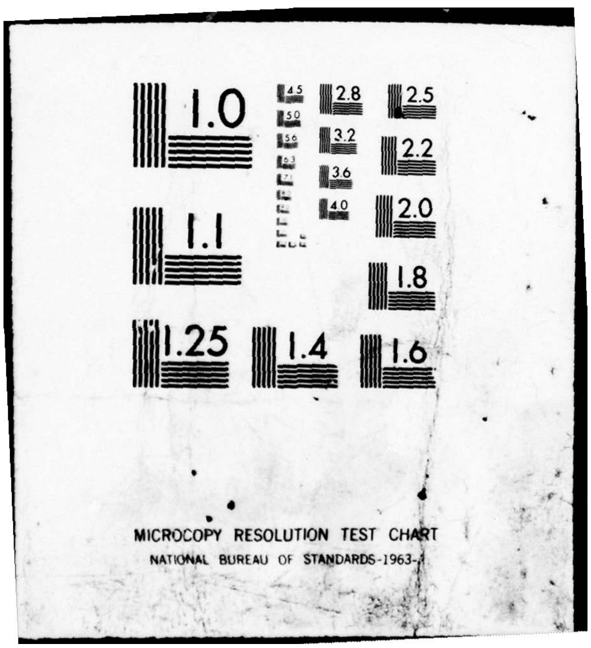
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REPORT NO. FAA-RD-79-73

LEVEL II

ENHANCED TERMINAL INFORMATION SERVICES (ETIS) UTILIZING THE DISCRETE ADDRESS BEACON SYSTEM (DABS) DATA LINK-CONCEPT DESCRIPTION

Robert W. Wisleder

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Cambridge MA 02142

JULY 1979
FINAL REPORT

Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
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Systems Research and Development Service
Washington DC 20591

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16. Abstract

This report describes a concept for providing enhanced terminal information services (ETIS) to aircraft utilizing the ground-air-ground data link capability of the Discrete Address Beacon System (DABS). ETIS is envisioned as an eventual replacement for, and significant improvement to the Automated Terminal Information Services (ATIS) in use today.

The initial step in developing the concept is the establishment of requirements for an ETIS system. This is followed by a determination of the information and data to be provided to the aircraft over the data link, and the probable sources of that data. An assumption is made that the availability of automated weather sensor systems of some form will coincide with implementation of ETIS. A detailed functional description of the system is then given, including system configuration, interfaces with other ATC automation systems, and hardware and software both at the airport and at the controlling ATC facility. Also discussed are message content and formats, controller and pilot display design considerations, criteria for dispatch of ETIS messages, and a number of operational considerations. The report concludes with several typical flight scenarios representative of different levels of aircraft, avionics, and pilot capabilities in an air traffic control environment where ETIS is implemented.

The report clearly establishes the feasibility of the ETIS system concept, and provides an overall approach from which a detailed design of the ETIS system elements can be performed.

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DABS (Discrete Address Beacon System)
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PREFACE

As part of its continuing effort to upgrade and improve the air traffic control system, the Federal Aviation Administration currently has underway a program to develop, evaluate, and demonstrate the benefits of using the Discrete Address Beacon System (DABS) digital data link for transmitting air-ground-air messages. In support of this program, the Transportation Systems Center has developed a concept for providing enhanced terminal information services (ETIS) to aircraft utilizing the DABS digital data link.

The report presented herein was prepared by the Office of Air and Marine Systems of the Transportation Systems Center under the sponsorship of the Systems Research and Development Service of the FAA. It is one of the tasks under project FA962 entitled "DABS Data Link," and presents a detailed description of the proposed concept for an ETIS system. The report includes system requirements, system configuration and functional description, message contents and formats, avionics and controller display design considerations, system inputs and interfaces, and typical flight scenarios.

The work reported herein was completed under the direction of Mr. John Bisaga, Chief of the Systems Branch, Communications Division, Systems Research and Development Service of the FAA, and Mr. Joseph Gutwein, Project Manager and Chief of the Communications Branch at TSC. Recognition for their contributions and assistance to the study effort is also given to David Spokely, Manuel Gonzalez, Frederic Pickett and Ronnie Jones of the FAA, Joseph Golab (Project Engineer), John Dumanian and Juris Raudseps of TSC, and John Leeper of Lincoln Laboratory.

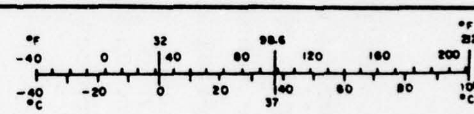
METRIC CONVERSION FACTORS

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

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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ABBREVIATIONS

AC	-	Aircraft
ALT	-	Altimeter
ALWOS	-	Automated Low-Cost Weather Observation System
AP	-	Applications Processor
APR	-	Approach
ARTCC	-	Air Route Traffic Control Center
ARTS	-	Automated Radar Terminal System
ATARS	-	Automatic Traffic (Collision) Advisory and Resolution Service
ATC	-	Air Traffic Control
ATIS	-	Automatic Terminal Information Service
AV-AWOS	-	Aviation Automated Weather Observation System
BLO	-	Below
BOS	-	Boston
BRK	-	Breaking Action
CF	-	Center Field
CLG	-	Ceiling
CLNC	-	Clearance
CLSD	-	Closed
CRT	-	Cathode Ray Tube
CTC	-	Contact
DABS	-	Discrete Address Beacon System
DCA	-	Washington DC
DEP	-	Departure
DIFF	-	Vector Difference

DVS	-	Digitized Voice System
ELM	-	Extended Length Message
ETABS	-	Electronic Tabular Display System
ETIS	-	Enhanced Terminal Information Service
FSS	-	Flight Service Station
ft	-	feet
Hg	-	Mercury
GMT	-	Greenwich Mean Time
IFR	-	Instrument Flight Rules
ILS	-	Instrument Landing System
in.	-	inch
L	-	Left
LLWSAS	-	Low Level Wind Shear Alert System (formerly SWIMS)
LOC	-	Localizer
LOC ID	-	Location Identifier
LPDS	-	Local Processor Display System
MIA	-	Miami
min	-	minute
mph	-	miles per hour
NADIN	-	National Airspace Data Interchange Network
NOTAM	-	Notice to Airmen
PRESR	-	Pressure
R	-	Right; Runway
RVR	-	Runway Visual Range
RVV	-	Runway Visibility Value
RWY	-	Runway
SIGMET	-	Significant Meteorological Information

SNW BNKS	-	Snow Banks
TFDP	-	Terminal Flight Data Processor
THDRSTM	-	Thunderstorm
TIPS	-	Terminal Information Processing System
TMP	-	Temperature
TRACON	-	Terminal Radar Approach Control
VFR	-	Visual Flight Rules
VHF	-	Very High Frequency
VOR	-	VHF Omnidirectional Range
VSB	-	Visibility
WAVE	-	Wave, Altimeter, Voice Equipment
WND	-	Wind
WND SHR	-	Wind Shear
XMTR	-	Transmitter
Y/N	-	Yes/No.

1. INTRODUCTION

The FAA currently has underway an R&D program with the objective to develop, evaluate, and demonstrate the benefits and methods of using the Discrete Address Beacon System (DABS) digital data link capability to provide two-way air-ground communication of a variety of aviation related messages. Three categories of services are envisioned under the DABS Data Link Applications Program, viz., Air Traffic Control (ATC) automation, weather delivery, and terminal information. Within each of these service categories is a set of messages and associated procedures, data sources, displays, etc., which effect the communication of information over the link, and which are evolutionary in nature, expanding as the levels of automation and services available permit. While the various services must be compatible with DABS, DABS avionics, the ATC system, and each other, it is helpful in their initial definition and design to consider them individually.

This document addresses the terminal information category of services, and specifically, it describes a concept for providing these services utilizing the DABS data link. The concept is referred to as Enhanced Terminal Information Services (ETIS), and is defined as a flight advisory service which provides information to the pilot to assist him in conducting a safe approach to or departure from an airport. It includes as a subset all information currently provided by the Automated Terminal Information Service (ATIS), plus other data such as wind shear alerts which pertain to the airport of interest. ETIS will not include routine weather (weather delivery category) and ATC communications (ATC automation category).

1.1 BACKGROUND

A pilot, in order to safely land at or depart from an airport, needs certain information to assist him in planning and carrying out the arrival or departure. This information includes such things as local weather conditions, altimeter setting, runway(s) and approach in use, and advisories regarding the particular airport of interest. It is also beneficial to alert the pilot on a real time basis to any changes which may affect the critical phases of his flight. Examples are changes in runway visual range (RVR), the approach of a thunderstorm, or detection of wind shear conditions. The information he requires is also a function of what stage of the approach (or departure) the aircraft is in. Runway and approach in use are needed early in order to review the appropriate approach procedures, while wind is most useful on final approach.

1.1.1 The System Today

In today's system, the pilot obtains the needed terminal information in one of several ways. For an IFR approach to a remote, uncontrolled airport, ATC personnel give him weather, altimeter setting, etc., at the closest reporting point, and the pilot chooses the type of approach he wishes to fly (if more than one are available). ATC personnel may be able to obtain the active runway and local wind conditions from the airport operator over a land line, or the pilot may be able to obtain this information over the VHF unicom channel if there are personnel on duty at the airport.

At most controlled airports, the terminal information is given to the pilot by ATC personnel, either the local controller or the approach controller, over the normal VHF communication channels. At the busier airports, a system known as Automated Terminal Information Service (ATIS) provides the needed information to the pilot via a recorded message without controller intervention. The ATIS is normally provided over a local or nearby VOR frequency on a continuous basis. Prior to being handed off to the approach controller, or when in range of the appropriate VOR, the pilot tunes his VOR receiver to the proper channel and listens to the ATIS message. He informs the approach controller upon initial contact that he has received the ATIS, including its alpha identifier. The alpha identifier is appended to the ATIS broadcast each time it is updated or changed by the ATC personnel to insure that the most recent version has been obtained by the pilot.

The update rate is normally about once every hour when revised weather observations are received, or upon significant change in weather or other data (active runway, etc.). Table 1-1 shows the information included in a standard ATIS broadcast.

ATIS serves an important function in the ATC system of today, and significantly reduces controller workload and communication channel loading. But it has a number of limitations and shortcomings, some of which are:

1. A human operator (controller or flight service specialist) must make the ATIS recording and update it periodically from observations obtained from instruments. The potential for error is significant and the recording may not be current for some items if operator workload is high.

2. The ATIS is available locally only when the aircraft is within line of sight of the broadcasting transmitter.

3. Tape recording equipment in use is prone to failure and is a maintenance problem.

4. Often the ATIS broadcast is of poor intelligibility due to equipment, controller recording technique, propagation effects, or a combination of these. Misinterpretation of the information, or the need to ask ATC to clarify the conditions over the normal voice link is the result.

5. Real time updating of critical information is not possible and must be done manually by the controller over the voice link. RVR, for example, must be monitored by the controller by observing instruments and changes voiced to the pilot during his approach as required.

6. The pilot must copy the ATIS information by hand if he wishes to refer to it later in the flight, or trust his memory.

7. The design of the ATIS system of today does not allow it to take advantage of advances and improvements in automation of the ATC and weather reporting systems, and increasing levels of avionics capability.

TABLE 1-1. ATIS BROADCAST CONTENTS

1.	Airport identification
2.	Sky condition below 10,000 feet; visibility if less than 7 miles, obstructions to vision, wind direction (magnetic), wind speed (knots), other weather remarks.
3.	Temperature and dewpoint (optional but normally given)
4.	Altimeter setting (optional but normally given)
5.	Instrument approach in use, or vector to be provided
6.	Landing runway(s)
7.	Takeoff runway(s)
8.	NOTAMS and Airman's Advisories
9.	"Check Density Altitude" message if temperature is 85°F or more and tower altitude 2000 feet or more
10.	Other pertinent information
11.	Phonetic alphabet code of the message, and instructions to pilot to acknowledge receipt by informing controller on initial contact

1.1.2 ETIS

With the implementation of DABS and its inherent data link capability, most of the shortcomings of today's ATIS can be eliminated or at least decreased, plus additional services and features added which are of significant potential benefit to the pilot and the ATC system. Some of the characteristics which may be included in the ETIS system are:

1. Automatic, real time reporting of terminal conditions using automated sensors with no human operator intervention required (except for NOTAMS, etc.).
2. Automatic transmissions of significant changes in information and of alerts which may be of importance to the pilot, such as detection of a wind shear.
3. Ability to tailor the information provided to the phase of flight, sending only the information needed by the pilot at that time.
4. Availability of ETIS wherever DABS coverage is present, permitting the pilot to obtain the information in sufficient time to plan his approach properly.
5. Capability for hard copy of the data in the cockpit.
6. Virtual elimination of errors and loss of intelligibility through extensive automatic digital error checking, fault sensing, and clear, unambiguous visual (or synthetic voice) displays.
7. Potential to expand ETIS availability to airports not currently equipped with ATIS without adding ground personnel.
8. Total compatibility with ATC system automation and ability to take advantage of growth and improvements in this area.

ETIS is considered as a high priority candidate for inclusion in the early stages of the evolutionary implementation of DABS data link services. This document describes a concept for the design of an ETIS system for the mid to late 1980's time frame, when it is expected that initial implementation of DABS will take place.

While aimed for this time period, the design is intended to be compatible with future ATC system enhancements and technology advances for the 1990's, and to allow for improvements and the addition of services and features as they become available.

1.2 PURPOSE

The purpose of this report is to present the ETIS concept in sufficient detail to provide a thorough understanding of its functions and operation, and to identify wherever possible those areas and details of the design which are in need of further study. It is hoped that this document will stimulate a continuing dialogue among the designers, users, and operators of the system, recognizing that the concept represents judgments and anticipation of what the government envisions as a useful service.

2. REQUIREMENTS

A set of system requirements has been established for ETIS and is described below. The requirements are an important part of the ETIS concept in that they provide a framework upon which the design is structured. Some requirements are more easily defined and achieved than others and some are not fully resolved. All are considered to be of sufficient importance to be taken into account in the design of the ETIS concept, and an attempt has been made to do so.

2.1 SYSTEM ENHANCEMENT

ETIS must have the potential of contributing to the safety, capacity, and/or productivity of the ATC system from both the users' and operators' perspectives. It must also be designed and implemented in such a way that improvements in one aspect of the system do not result in a negative effect in another. More specifically, ETIS must offer some significant, observable improvement over the ATIS system of today to warrant its further design, evaluation, and implementation. The shortcomings of ATIS listed earlier are all areas where improvements are desirable and in which a properly designed ETIS can be beneficial. Improvements in all or some of the following are required:

1. currency of data
2. accuracy of data
3. "intelligibility" of data
4. availability
5. reliability
6. human operator involvement
7. timely dispatch of alerts
8. compatibility with future ATC system enhancements.

No attempt has been made to prioritize the above for a number of reasons, the most important being that priorities depend upon the individual viewpoint (pilot or controller). However, with few, if any, exceptions, improvement to any one of the above is sufficient justification for further effort in the development of ETIS.

2.2 PILOT AND CONTROLLER WORKLOAD

It is desirable that ETIS result in a net reduction in pilot and controller workload. While it is clear that such a reduction would be beneficial to the system and welcomed by all concerned, there are other improvements listed earlier which are also attractive and sufficient to warrant implementation of ETIS if they can be demonstrated. The most important factor is, however, that regardless of what other improvements and benefits are achieved, they must not result in any increase in pilot or controller workload. There is no shortcoming in today's system of disseminating terminal information that is so severe as to justify an ETIS concept that adds to the user or operator's net workload.

The term "net workload" is important to understand in this context. It is conceivable that an ETIS system would add new tasks or procedures that the pilot or controller does not have today, while eliminating or reducing others. The net change in resulting workload in each case must be zero or negative for ETIS to be acceptable. Analysis and measurement of this workload change, however, are not straightforward and may be an area requiring considerable evaluation before finalizing the ETIS design. Workload variations from the perspective of the user are not always consistent with that from the perspective of an observer, or even with that of another user, which makes evaluation difficult.

2.3 ATC SYSTEM COMPATIBILITY

The ETIS concept must be compatible with the ATC system of the mid to late 1980's and beyond. There are three distinct aspects to compatibility. First, ETIS must be designed to function with the DABS data link, technically and operationally. Its data formats, message update rates, message lengths, etc. must conform to DABS provisions and avionics designs, and be consistent with other data link services. Similarly, its interfaces with the rest of the ATC system for message coordination, extraction of data, etc. must be properly designed.

Second, ETIS must be suitable for implementation in the mid to late 1980's when DABS is expected to be first deployed. It must operate in an environment which is mixed DABS and ATCRBS, as well as an environment in which some aircraft are equipped with neither. This initial implementation must utilize technologies available now, or within the next two to three years at most, to insure sufficient time for development, procurement, and test of hardware and software. If ETIS eliminates the conventional ATIS broadcast at some locations, it should have the capability of providing a similar service to non-DABS-equipped aircraft (e.g. digitized voice broadcast over VHF).

Finally, ETIS must be designed in such a way that it will be capable of taking full advantage of advances in avionics technology and of improvements in the ATC system, particularly as increased levels of automation are achieved. An example is runway assignment. Studies are underway to develop software to automate the assignment of runways at larger terminals. ETIS must be designed so that this information can be extracted and dispatched to the pilot at the proper time,[1] should this capability be achieved. It should also allow for the use of this data to further tailor the information sent to the pilot, such as RVR when more than one approach is in use. When low cost remote weather sensing systems are available, ETIS software should allow for the addition of uncontrolled airports to those which have ETIS capability. Indeed, any airport with an instrument approach procedure and within coverage of a DABS sensor is an eventual ETIS candidate.

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[1]Strictly speaking, this is an ATC function, not an advisory service.

Simply stated, ETIS must work in the early DABS environment with the ATC system as it exists then, and be designed to grow in capability and services offered consistent with the growth in ATC system automation and advances in avionics technology.

2.4 USER COMPATIBILITY

Aviation today is comprised of a broad variety of pilots and aircraft representing numerous levels of sophistication, capability, and needs. They all utilize essentially the same airspace, and for the most part, fly into and out of the same airports. ETIS must therefore be designed with the single-engine aircraft, VFR pilot in mind, as well as the commercial airline pilot flying a 747. And it must consider all levels of sophistication in between. Only in this way can it serve a large segment of the user population.

For the purpose of developing an ETIS concept, this requirement comes down to three primary factors: avionics cost vs. capability, IFR vs VFR operations, and single pilot vs. multi-crew cockpits. Capability for eventual implementation at smaller airports not currently served by ATIS could also be considered under this requirement.

The ETIS concept should be compatible with very elementary DABS data link display devices such as might be found on a small single-engine aircraft. While the level of service provided and ease of operation may not be the same as for a more expensive, airline installation, ETIS services should be available to a "minimally equipped" user. (Minimally equipped has not been defined, and the concept will of necessity make certain assumptions in this regard.) Furthermore, ETIS should not remove any service available today without replacing it with an equivalent or better substitute. Non-DABS-equipped aircraft must still be able to obtain ATIS information.

ETIS should provide services to VFR aircraft not on a flight plan which are arriving at or departing from an ETIS terminal. Provisions should be made in the design to obtain any required information regarding the flight in order that ETIS may be provided over the data link if the aircraft is DABS equipped. Again, the level of service and ease of use in this case may not be as great as for an IFR flight.

Finally, ETIS information must be presented in such a way that it can be readily understood and absorbed by the single pilot crew, as well as the multi-crew situation. As an example, the use of clear textual formats with easily understood abbreviations is important. Message timing and procedures for acknowledgement of messages or message segments must take into account the crew configuration and task loading during the busy terminal area phase of flight.

2.5 COST EFFECTIVENESS

The cost/effectiveness, measured in terms of a cost/benefit ratio, is a primary consideration in the design of the ETIS system, just as it is for any ATC system improvement. Cost/effectiveness must be taken into account for both the system operator (FAA) and for the various classes of users.

No attempt will be made at this stage of the concept development to perform cost/benefit analyses. This exercise actually must be part of an overall cost/benefit study of DABS data link as a whole, and would be incomplete if attempted for just the ETIS system alone. However, attention must be given during the design of the ETIS concept to cost sensitive areas such as complexity, flexibility, reliability, and technology trends, and how they are affected by the services under consideration and the various design tradeoffs.

3. CONCEPT DESCRIPTION

The ETIS concept described in this section is based upon the requirements of Section 2. The problem is approached from the viewpoint of determining what information of an advisory nature (other than traffic) does the pilot need in order to conduct a safe approach or departure, when and how should it be provided to him, and how can the DABS data link best be used to perform this function. To answer these questions, others must also be addressed: What information should be transmitted automatically and what should be by pilot request only? When should the pilot be informed of changes in the data? How often should the data be updated? What are the sources of the data? What is the role of the controller in the ETIS concept? Note that the approach taken is not to simply replace ATIS with a system that utilizes the DABS data link.

All of these questions, and others, are addressed to the extent possible in the concept design presented herein. In so doing, a number of issues are raised for which no clear answer can be determined. In such cases, an attempt is made to clearly identify the issue and alternative solutions or designs, and recommend one or more alternatives as being perhaps the most desirable. To finalize the design in these areas, the results of other planned and ongoing activities, such as pilot and controller surveys, demonstration and evaluation flight tests, and cost/benefit studies will be necessary.

3.1 SUMMARY OF ETIS CONCEPT

The ETIS concept describes a means whereby various terminal information services are provided to pilots via the DABS data link. It consists of the following elements:

1. A set of terminal information services consisting of various messages containing weather data, airport

status, alerts, and other advisories of benefit to a pilot, and dispatched in accordance with the requirements of the different phases of flight in the terminal area.

2. Hardware at airports to collect and input ETIS data, including interfaces with weather sensor systems, displays, input terminals and associated processing equipment, and communication links.

3. Software resident in the DABS data link applications processor (AP) at the controlling ATC facility to generate messages, process input data, handle requests, etc. This processor also performs functions related to other data link applications.

4. Avionics, including displays, keyboard input devices, processors, etc. on board DABS equipped aircraft. These avionics are shared with other DABS surveillance and data link applications.

5. A set of operational procedures and system design characteristics which determine what information is sent at what time and how the pilot and controller access the system.

Figure 3-1 depicts the proposed ETIS system in a typical installation. A local processor/display system (LPDS) located at the airport obtains local weather observations from automated weather sensor systems. The controller or airport operator enters certain additional information as required, including runway and approaches in use and NOTAMS. The LPDS processor performs any necessary input data processing, error checking, sensor system polling, etc., and interfaces with a modem that provides the communication link with the DABS data link applications processor (AP). The LPDS display, also installed at the local airport, will, where available, be the Terminal Information Processing System (TIPS) display planned for installation in many tower cabs during the mid-1980's. This display/input terminal enables the local controller to access the local ETIS data as well as provide any

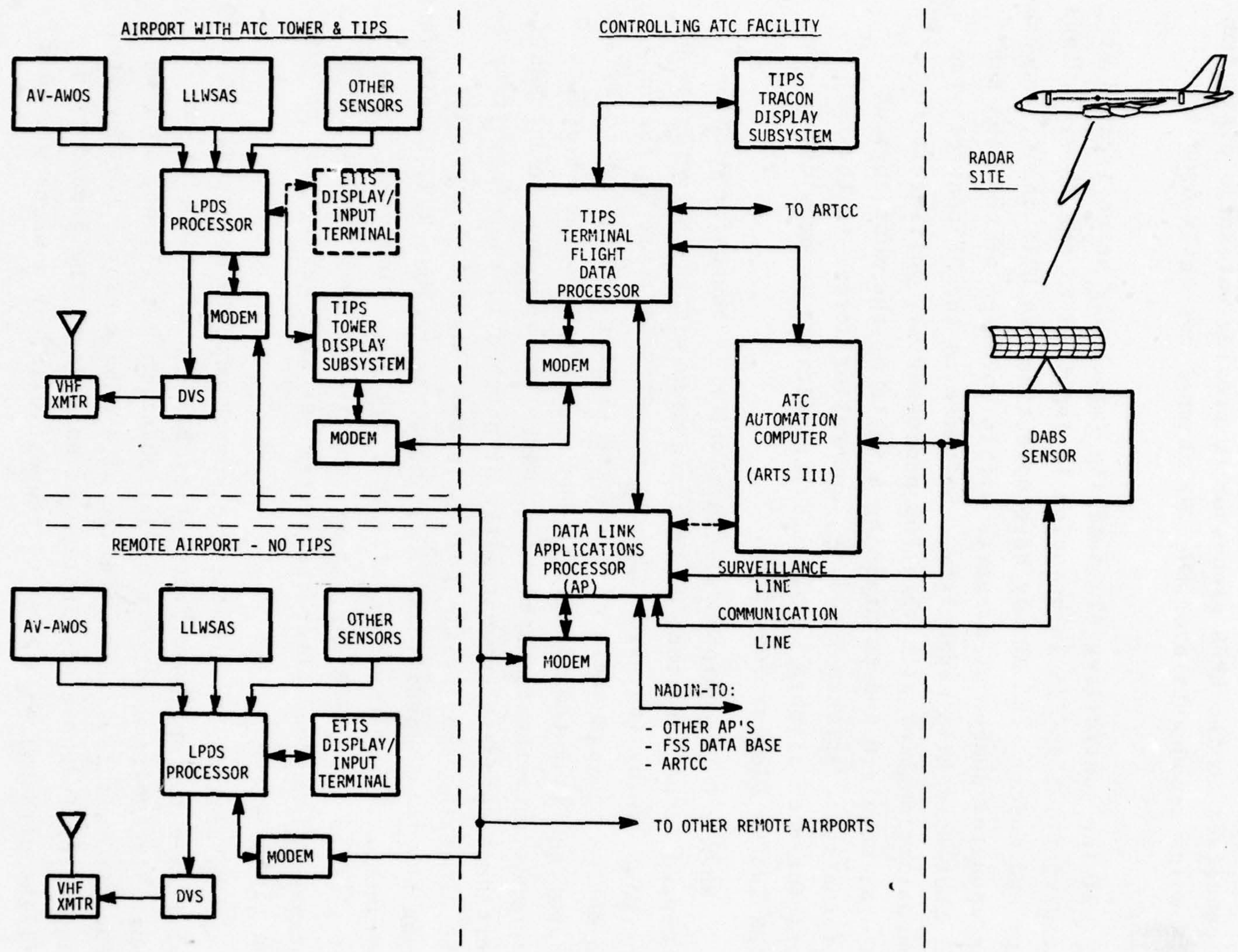

FIGURE 3-1. ETIS SYSTEM CONCEPT

necessary manual inputs. Also, at most if not all locations, particularly those with ATIS today, a digital voice system (DVS) is connected to the LPDS processor to provide automatic digitized ETIS voice broadcasts over the VHF channel currently used for ATIS.

At the controlling ATC facility (which may be co-located at the airport) the ETIS information is inputted to the AP via a land line and modem. The AP may have more than one ETIS input, depending upon the number of airports within coverage of the DABS sensor that have ETIS capability. Software in the AP controls the communication link with the LPDS processor(s), polling it for data as required and maintaining a table of the most current information. At this facility, controller access to the ETIS data for each airport within its jurisdiction is provided by the TIPS TRACON Display Subsystem.

When a DABS-equipped aircraft which is bound for a ETIS-equipped airport reaches a specified area within the coverage of the DABS sensor (60 mile radius), the ETIS software in the AP formats a message whose contents are similar to ATIS of today and dispatches it automatically to the aircraft. As the aircraft proceeds into the terminal area, makes its approach, and lands, pertinent data are automatically dispatched to the aircraft by the AP at the appropriate points in the flight and depending upon the local conditions. Such data may include RVR, significant parameter changes such as altimeter setting, wind shear alert, etc. On a calm, VFR day, it is conceivable that the only ETIS message dispatched after the initial arrival message may be wind on final approach.

In addition to automatic dispatch of ETIS messages, the pilot will have the option of requesting ETIS information for any suitably equipped airport at any point in his flight, as long as the aircraft is within coverage of a DABS sensor. Furthermore, any aircraft whose destination is unknown to the ground (VFR flight perhaps) will have to request ETIS, or a means provided for communicating the aircraft destination to the ground system. This aspect is discussed in more detail later.

ETIS messages will be displayed in the cockpit using a variety of data link displays which depend upon the size of the aircraft and sophistication of avionics that the pilot can afford. Some minimum capability will be required for the number of alphanumeric characters and/or storage registers of the display so that the avionics can handle, although perhaps not display at one time, an entire ETIS message, which includes airport advisories and may be 200 or more characters in length. A CRT or printer type of display provides the most capability for long messages. Display design will be influenced by the other services to be provided by the DABS data link, since it is not likely that any data link service will have a dedicated display (except perhaps ATARS).

The following sections discuss in detail each aspect of the ETIS concept.

3.2 ETIS INFORMATION

Most of the information to be provided by ETIS is contained in today's ATIS report. The primary difference between the two is that with ETIS the information is continually updated, critical data or changes in data are automatically sent, and messages are dispatched at the points in the flight where they are most needed. For ETIS, it is also necessary that analog data be converted to a digital form to be compatible with the DABS data link.

The two major sources of information for the ETIS system are automated weather sensors and a manual keyboard or terminal. In the former category, several systems are currently under development by the FAA, including Aviation Automated Weather Observation System (AV-AWOS) and Automated Low-Cost Weather Observation System (ALWOS), both of which provide unmanned, real-time reporting of surface weather condtions. The ETIS concept assumes the existence of AV-AWOS, ALWOS, and/or other similar automated weather sensor systems, and obtains most, if not all, weather data inputs from such a system.

It should be emphasized that responsibility for development of AV-AWOS, ALWOS, etc. lies with those of the FAA responsible for the collection and dissemination of weather information, not with the DABS data link or ETIS designers. ETIS is to be viewed as an effective, efficient means of automatically disseminating these data. If such automated weather observation capability is not available when DABS data link is implemented, some manual observations for ETIS will be necessary, or ETIS implementation must be delayed. The important point is that the DABS data link program will not undertake an independent automated weather sensor system development effort.

The following paragraphs provide a discussion of the various data items to be included in ETIS and the status of weather sensor development necessary to provide each item. Table 3-1 summarizes the sensor system output parameters assumed to be available as inputs to ETIS, and is based on the current AV-AWOS draft specification[1] except where another probable source of data is indicated. Although the sensors themselves are not the responsibility of the data link designers, the discussion included here is considered important to define completely the ETIS concept and the underlying assumptions behind it.

3.2.1 Runway and Approach in Use

Runway(s) and instrument approach(es) in use are included in the initial ETIS message, and include both arrival and departure runways, if different. This information must be entered manually with a keyboard by a local controller, FSS specialist, or by the airport operator at smaller fields. Through careful software design and preformatting, and, if necessary, by tailoring the software to the individual airport it is expected that keying in this data will be a simple task, and need only be done when a change in arrival/departure configuration is made. It is possible that

[1] FAA, "Specification for Aviation-Automated Weather Observation System (AV-AWOS) - Draft," FAA-ER-450, December 12, 1978.

TABLE 3-1. WEATHER SENSOR SYSTEM OUTPUT PARAMETERS

PARAMETER	RANGE	RESOLUTION	PROBABLE SOURCE
Cloud Height (3 layers)	0-7000 Feet	100 feet (below 5000 feet) 500 feet (above 5000 feet)	AV-AWOS
Cloud Coverage	0-1.0	0.1	AV-AWOS
Prevailing Visibility	0-8.0 miles	1/16 mile (0 - 3/8 mile) 1/8 mile (1/2 - 2 miles) 1/4 mile (2 1/4 - 2 1/2 miles) 1 mile (>2 1/2 miles)	AV-AWOS
Precipitation (See 3.2.3)	None/Rain/Freezing Rain/Hail	Yes/No	AV-AWOS
RVR	0-6000 Feet	100 feet	RVR Sensor System
Center Field Wind	0-360°/0-125 knots	10°/1 knot	AV-AWOS
Runway (Sector) Wind	0-360°/0-125 knots	10°/1 knot	LLWSAS
Temperature	-80° to +140° F	1° F	AV-AWOS
Dewpoint	-80° to +140° F	1° F	AV-AWOS
Altimeter Setting	28.00 - 32.00 in. of Hg	.01"	AV-AWOS
Thunderstorm Alert (See 3.2.8)	-	Yes/No	AV-AWOS
Wind Shear Alert (See 3.2.8)	-	Yes/No	LLWSAS

algorithms will be developed to assign runways and approaches to aircraft automatically in the very busy terminal areas. This software will probably reside in ARTS or TIPS, but would likely be designed to select a runway for an aircraft from the predetermined approach/departure configuration. It is this predetermined configuration that would be included in the initial ETIS message, and would still be a manual input since it probably will always require a decision by a human. However, the automatic assignment of a runway will be used by the ETIS software as an enhancement in its delivery of some services. (See Section 3.3.2.3).

3.2.2 Sky Condition

Sky condition includes the height of cloud layers and portion of sky covered. This data will be obtained automatically from some type of ceilometer, and should provide data on at least three layers up to an altitude of 7,000 feet or more above the surface. It will be included in the initial ETIS message, and any significant changes transmitted to arriving aircraft which have received the initial ETIS message.

Some technology development must take place in this area to provide a suitable sensor. The widely used rotating beam ceilometer is not an attractive candidate. It is designed for interpretation by a human observer, has limited altitude capability, and suffers from high installation and maintenance costs. It has been used successfully, however, in limited field tests of AV-AWOS by the FAA and National Weather Service. Efforts underway to develop a suitable laser ceilometer show promise in meeting the height, cost, and reliability requirements of an automated sky condition sensor. The ETIS concept assumes the availability of such a sensor.

3.2.3 Prevailing Visibility and Precipitation

Prevailing visibility will be given in miles and fractions thereof (if less than 2 1/2 miles) as a part of the initial ETIS message, and if less than 2 miles, at the final approach fix of non-precision approaches. Any significant changes will also be transmitted to arriving aircraft any time after they have received the initial ETIS message. Included as part of these messages will be an indication of the obstructions to visibility, such as rain, fog, etc.

Visibility is another area where some advances in technology are necessary. It is desirable that visibility be measured with a range of at least eight miles. Transmissometers are limited in range to considerably less than this, require a large area of multi-site installations, and have high maintenance costs. The back scatter device used in the AV-AWOS tests suffered from unrealistically low values under certain conditions. The forward scatter meter promises to come closest to the ETIS requirement, and it is assumed that such capability will exist in the timeframe of interest.

Obstruction to visibility is less certain to achieve in an automated, unmanned fashion. AV-AWOS tested devices which provided "precipitation yes/no" (tipping bucket rain guage), "freezing rain yes/no" (aircraft-type icing detector), and a momentum type hail detector. All of these devices have some problems which render them unlikely as suitable weather sensors. The National Weather Service is currently involved in a program to develop laser technology to detect and distinguish between rain, snow, fog, drizzle, and clear, with further refinements and estimation of mixtures planned. Lithometeor detection is also being studied for classifications such as dust, haze, smoke, etc. The latter is not planned for evaluation until 1982.

It is likely that automated techniques will be available by the mid-80's to provide at least major classification of visibility obstructions, with improvements coming along as technology advances. This will not depend on ETIS or DABS data link, but is highly beneficial in its own right to provide, for example, weather observations at remote uncontrolled fields which have instrument approach procedures. The ETIS concept will assume the existence of some automated capability, with increasing levels of sophistication as time goes on.

3.2.4 RVR (Runway Visual Range)

RVR is available directly from the transmissometer-based RVR system used today, with a straightforward interface easily implemented. It may also be obtained from AV-AWOS if an interface with the RVR system is implemented.

RVR will be provided in the initial ETIS message for the runway(s) in use and at the outer marker, but only if it is less than 6000 feet. Runway visibility (RV) will be provided if it is used instead of RVR. Significant changes in RVR will also be given any time after the initial ETIS message has been sent. Mid-point and roll-out RVR will be included in all RVR messages if available.

3.2.5 Winds and Wind Shear Alert

Center field wind direction, velocity, and gust factor will be given in the initial ETIS message, and at or just after the outer marker or final approach fix. Anemometers with outputs readily interfaced with a digital transmission system are available to provide this data.

It is also proposed that sector or runway wind information be provided where available from LLWSAS (Low Level Wind Shear Alert System) or other sensor systems. This information, for the runway of interest, would be transmitted at the outer marker or final approach fix along with center field wind (which could also be obtained from LLWSAS). Knowledge of the wind closer to the final approach/touchdown zone appears to have value in the conduct of a safe approach, particularly under conditions of varying winds, frontal passage, thunderstorm activity, etc. But this point is still open for debate due to the lack of availability of sensors at most airports, differences in their locations around the airport geometry, and the possibility of misinterpretation of the data. More time, experimental study, and experience with installations such as LLWSAS are necessary in order to get a better feel for the desirability of providing this data. The ETIS concept includes this capability on the assumption that it will prove to be beneficial in some form, and that subitable operational procedures will be worked out. (The ETIS design must be such that questions of this sort, when resolved, can be readily implemented into the system, or appropriate modifications easily made.)

In any case, wind shear alerts will be provided when detected by the LLWSAS equipment as soon as they occur, and will be included in the initial ETIS message for some period of time, perhaps five minutes, following time of detection. Center field wind, the sector or runway wind associated with the shear, and their vector difference, if the latter is determined to be useful, will be transmitted in the alert message. (See Sections 3.3.2.2.7 and 3.3.2.3.2 for further discussion of wind shear alert.)

3.2.6 Temperature and Dewpoint

Temperature and Dewpoint will be included in the initial message. Sensors are readily available for these functions, either separately or with combined capability.

3.2.7 Altimeter Setting

Altimeter setting will be included as part of the initial ETIS message, and will also be transmitted to all aircraft at every incremental change of .01 inches. Digital barometers suitable for this function are readily available.

3.2.8 Pressure, Temperature and Thunderstorm Alerts

Certain data may be useful in the terminal area to warn of approaching thunderstorms and gust fronts. Various studies have been and are being conducted to determine if information regarding pressure jumps and/or rapid drops in temperature at several points around the periphery of an airport might be used to detect, track, and predict the path of thunderstorms. Other means may be developed for reliably detecting thunderstorm activity in an automated fashion.

The ETIS concept includes the capability to send this type of data to aircraft in the area when detected. While it is difficult to anticipate at this time what form this data will be in, it is safe to assume at least the existence of a simple thunderstorm alert message, with capability to add data regarding location, direction of travel, speed, etc., as this becomes available. Similar capability is called for in the current AV-AWOS specification. It is proposed that, at least for initial implementation, alerts based on pressure jumps and rapid drops in temperature be included. These may prove to be valuable in and of themselves, and may be all that is available at the smaller airports. These alerts will be generated by algorithms contained within AV-AWOS, ALWOS, etc.

3.2.9 Density Altitude

At those airports at an altitude of 2000 feet or more, and when the temperature exceeds 85°F, ETIS software in the AP will calculate the density altitude and include this data in the initial ETIS message. No additional input data are required, and the criteria for including it or not can be easily changed. The values selected above represent the criteria used today to add "Check Density Altitude" to an ATIS broadcast.

3.2.10 Airport Advisories

Airport advisories include all airport status information, special notices, advisories, and other terminal information, both temporary and semi-permanent in nature, that are necessary or helpful for safe operation in the terminal area. Also included is identification of any SIGMETS or AIRMETS which are currently in effect. (The text of the SIGMET or AIRMET would not be a part of the ETIS message.) Examples which could be part of an ETIS message include runway braking action reports, ice patches, closed runways or taxiways, noise abatement procedures, construction equipment, out of service nav-aids, special instructions for VFR arrivals, etc. The possibilities are numerous and vary greatly in length, frequency of use, criticality, and format.

Most airport advisories must be entered manually using the keyboard terminal at the airport. The wide variations in this type of information result in some manual typing by the controller being unavoidable. But steps can be taken to minimize this requirement through careful design of the operating software. Once an advisory or NOTAM is entered, it will be included in all initial ETIS messages until removed or changed. Thus, semi-permanent advisories such as "VFR arrivals contact approach control on 126.6" are entered once and no further action is required. Data which are frequently but not always given, depending upon local conditions, can be pre-stored and simply retrieved by the controller for inclusion in the ETIS. (This operation would be required only when adding or deleting a pre-stored ETIS advisory, not with each message.) A similar preformatted capability would allow retrieval of a frequently used ETIS advisory with one or more parameters to be inserted by the controller. An example is "Braking action poor by a 727," where the underlined data is entered by the controller.

3.2.11 Time of Day

It may be desirable to include with each initial arrival and departure ETIS message the time of day at which the data were obtained by the weather sensor system. If required by operational procedures implemented with data link, this time tag can then be passed on to the controller by the pilot at initial contact, just as is done with the ATIS alpha identifier today. However, the real time nature of ETIS, with updates (change messages, alerts, etc.) being provided automatically to the aircraft after receipt of initial ETIS, obivates the need for this exchange between pilot and controller. Rather, an acknowledgement to the controller "I have data link ETIS" should be sufficient and a time tag on each message is not required.

Other ETIS messages could include GMT time to indicate when an event was detected, or when the message went into effect. An example is any of the alert messages. Again, however, the real time nature of ETIS is such when a message is received by the aircraft, it is understood in all cases that it is current as of the last fraction of a minute. In any event, if it is determined that

3.3 SYSTEM CONFIGURATION AND FUNCTIONAL DESCRIPTION

The ETIS system on the ground is made up of the LPDS at each terminal location providing ETIS services, and system operating software in the AP located at the controlling ATC facility. A single, full duplex land line with appropriate modems on either end connects the AP with the LPDS. Interfaces with other ATC automation functions are provided through the AP. (See Figure 3-1). The paragraphs below describe the functions of these primary system elements.

3.3.1 Local Processor Display System (LPDS)

Each airport for which ETIS is to be provided must have an LPDS installed to gather, format, and output ETIS data. The levels of complexity and capabilities of the available automated weather observation systems, and other local factors may vary among different installations depending upon airport size, traffic, system cost, and other factors. But in all cases, the LPDS consists of a processor (probably some type of microprocessor) with appropriate interfaces to the local automated weather observation system(s), and one or more display/input terminals. In addition, a digitized voice system (DVS) may be included at many locations, particularly those with ATIS services today. The DVS allows non-DABS aircraft to receive an initial ETIS broadcast over a VHF channel just as they receive ATIS today, but without human intervention in recording the data. The DVS is driven by the LPDS processor and outputs the same basic real time data as the data link. The DVS also provides ETIS for departures at those sites remote from the DABS sensor which do not have DABS coverage down to the surface. (See Section 3.3.2.2.2.)

The following paragraphs contain detailed discussions of the functions of the LPDS processor, display/input terminal, and DVS.

3.3.1.1 LPDS Processor - The LPDS processor performs the local data processing and control functions necessary to collect, format, and output the locally derived ETIS information. It is envisioned that this LPDS processor is dedicated to ETIS, and therefore is a major part of the new equipment required for implementing ETIS. Its importance also lies in the fact that it connects all weather data and ETIS keyboard inputs to the AP with a single communication link. The alternative is tieing AV-AWOS, LLWSAS, and terminal inputs directly to the AP, which will service more than one ETIS and may be remotely located. This results in proliferation of the number of communication lines and their associated lease costs, lower reliability, etc. Furthermore, the LPDS processor enables the local controller or airport operator to have direct access to ETIS information independent of the integrity of the link to the AP, or the AP itself. The LPDS is therefore a stand-alone system capable of providing the ETIS data directly to the controller and over the VHF voice channel using the DVS without any connection to the AP. This provides an important fail soft capability, as well as an independent means of providing ETIS information to non-DABS-equipped aircraft.

One alternative that should be mentioned is the possibility of combining the functions of the automated weather sensor system processor (AV-AWOS) with those of the LPDS processor into a single integrated system. There are some potential advantages to this approach, including a reduction in the amount of hardware, elimination of a computer-to-computer communication link, and avoidance of unnecessary and duplicative data processing, all of which impact cost and reliability. And the ETIS concept assumes the existence of an AV-AWOS type system to provide weather observations, so wherever ETIS is implemented, AV-AWOS must be also. Conceptually, combining the two could result in a very neat package.

However, it is not clear at this stage whether or not the objectives, requirements, design constraints, etc. of ETIS and AV-AWOS are consistent, and their combination of mutual benefit. Also, an argument can always be made for decentralized or distributed processing in cases such as this. At least for the sake of clarity in presenting the concept, a separate, stand-alone LPDS processor is assumed. However, the data link and weather system designers should give careful consideration to combining these two functions.

The major functions of the LPDS processor are described below.

3.3.1.1.1 Interface with Automated Weather Sensor Systems - In the time frame of interest for the ETIS concept (mid to late 80's) some type of automated weather observation system or systems (AV-AWOS, ALWOS, WAVE, LLWSAS) will probably be available, and, in fact, implemented at a number of locations. These unmanned observation systems will provide real-time continuous surface observations for local consumption and for distribution over the normal weather communication networks. To obtain most, if not all, of the weather data parameters required for ETIS (See Table 3-2, Section 3.3.2.2) the LPDS will simply interface with one or more of these colocated automated observation systems. The detailed design of these interfaces is not important for the purposes of developing the ETIS concept. The sensor systems may be polled by the LPDS processor, or the outputs provided continuously or on an interrupt basis by the sensor systems. What is important is that the LPDS design and that of AV-AWOS, ALWOS, LLWSAS, etc., be compatible, and the appropriate interfaces developed early in the design process. (As stated earlier in Section 3.2, the automated weather sensor systems themselves are not the responsibility of the ETIS or DABS data link designers, although their presence and capabilities are included as part of this ETIS concept.)

3.3.1.1.2 Process Weather Data - The LPDS processor will process the weather data to the extent necessary to put it in a form suitable for use by the ETIS software in the AP. The processed data will also be outputted to the local display to provide a complete real-time ETIS report to the controller, and to the DVS for broadcast to non-DABS-equipped aircraft.

The processing required will depend upon the form of the input data and the requirements of the AP, display, and DVS. It is expected that all of the required averaging, smoothing, and other massaging of data including conversion to digital form, will be done by the AV-AWOS (or ALWOS or WAVE) prior to transmission to the LPDS processor. Any pressure drop, temperature drop and/or thunderstorm alerts are also expected to be detected by the automated weather sensor system and transmitted to the LPDS processor. Similarly, the wind shear alert is detected by the LLWSAS system, and is an input to the LPDS processor.

3.3.1.1.3 Interface with Applications Processor - The LPDS processor outputs locally derived data to the AP via modems and a single land line. This line may be time shared with other LPDS processors, and should require no more than 1200 bits per second. The interface will probably employ a polling scheme with the AP polling each LPDS processor on a periodic or as required basis. Only data which have changed need be transmitted during a poll, but this will depend upon the detailed design of the interface. Certainly, there is no need to repeat NOTAMS, active runway, etc., with each poll. Depending upon the polling rate, a means may be required whereby the LPDS processor signals the AP that an alert (wind shear, etc.) has been received, so that the AP may give immediate attenuation to dispatching it.

3.3.1.1.4 Interface with the Display/Input Terminal - The LPDS processor serves two primary functions via the interface with the display/input terminal. It receives input data from the terminal in the form of operator entered data (NOTAMS, active runway, advisories, etc.), and outputs the locally derived data in a format suitable for display to the controller or airport operator. Included is the storage of preformatted messages and other software functions to assist the operator in entering information. The display refresh rate is controlled by the LPDS processor, and will be on the order of once every 10-15 seconds. Again, depending upon the design of this interface, it may only be necessary to send data that have changed, rather than to repeat the entire set of data.

This interface will actually be with TIPS in those locations where it is installed. It may also drive more than one terminal in some cases (see Section 3.3.1.2).

3.3.1.1.5 Drive a Local Digitized Voice System - The LPDS processor will include an interface to drive a local DVS, which in turn transmits over a local VOR or other VHF channel. This capability may not be utilized at all locations, but should be provided as an available output from the LPDS processor. The specific interface will depend on the DVS design and how best to share the necessary functions. It is conceivable that the vocabulary could be stored in the LPDS processor memory, and the ETIS message outputted to the DVS in the form of reconstructed digital speech. Alternatively, word storage could be a function of the DVS, and some type of coded output from the LPDS processor would drive the DVS. Bit rate for the first case may be as high as 24,000 bps, depending upon the technology used, but would certainly be greater than 2400 bps. If word storage is within the DVS, a bit rate of only about 128 bps is required.

The data outputted by the LPDS processor to drive the DVS comprises a complete ETIS message, much the same as the ATIS broadcast of today. Although the data are updated in real time, it is only provided on a broadcast basis, so that alerts, RVR, sector winds, etc., cannot be directed to specific aircraft during specific phases of flight. As with ATIS today, once the non-DABS-equipped aircraft has received the ETIS broadcast, any alerts or other significant changes to the data must be given to the pilot by the controller.

3.3.1.1.6 Self-Test - The LPDS processor will perform some self-testing and integrity monitoring of the various interfaces, particularly the automated weather sensor system inputs. Because the LPDS is envisioned as a stand-alone system in that it is capable of providing complete ETIS data to the local controller or airport operator without connection to the AP, it is important that the validity of the data be assured prior to its acceptance, and that system errors be detected. The sensor system itself will have some self-monitoring capability. In addition, the LPDS processor will have sufficient capability, consistent with that of the sensor system, to insure that data are received correctly, that they pass some form of reasonableness tests, and that sensor outages have been detected and are flagged.

3.3.1.2 Display/Input Terminal - The display/input terminal serves two primary functions with regard to ETIS. It displays in real time the complete set of ETIS data derived from local automated sensor systems and manual inputs, and it provides a means whereby the controller or airport operator can enter manual data for inclusion in ETIS messages. In actual fact, this display/input terminal is likely to be a TIPS display subsystem in those locations where TIPS is available. Otherwise, a dedicated display/input terminal for the ETIS function will be required. A conventional CRT with full ASCII keyboard is a likely candidate.

Whether or not TIPS is available, the LPDS may include other display/input terminals located elsewhere at the airport. Display of ETIS in the pilot's lounge or airport manager's office, for example, makes sense at the large airports. But more than one input keyboard is unlikely since it provides direct access to the LPDS processor for making changes in ETIS data.

The terminal displays the complete ETIS information in real time, being updated several times a minute by the LPDS processor. Alert messages are clearly indicated through flashing, dedicated display area, audible warning, or a combination of these. The display format is designed so that the data can be easily read and interpreted by the controller. The display must be suitable for installation in a tower cab environment, and readable under conditions of bright sunlight. (See Section 3.6.) If time tags are required, they can be added by the LPDS or the AP, but would likely be included in the data from the automated weather sensor system, as it is with AV-AWOS.

The terminal also provides a means for manually entering data such as airport advisories, runway in use, etc. Both the display and keyboard are used for this function. The operator (controller, etc.) may call-up for display preformatted messages for which he may fill in certain data, review the entire message, then enter it into the current ETIS information. He may also manually compose a complete airport advisory or other message by typing it in via the keyboard. Again, the display is used to review and correct the message prior to entry into the current ETIS.

The LPDS terminal will be used to exercise diagnostic routines to check system performance and to input manually observed data in cases of automated sensor failure. It will also be used to modify preformatted messages and to generate and store new ones.

It is important to note that with a DVS connected to the LPDS processor, its fixed vocabulary will limit the words, phrases, and terminology used in the manually inputted advisories, etc. Care in the design of the vocabulary should prevent any problems in this regard.

3.3.1.3 Digitized Voice System (DVS) - Some type of DVS capability for airports which have ETIS serves a very important purpose. It promises complete elimination of the manually operated ATIS system of today, while still providing equivalent or better service to non-DABS-equipped aircraft. Assuming that it will be a long time before all aircraft are DABS equipped, DVS should receive careful consideration. DVS also provides ETIS for departures at those remote ETIS equipped airports where DABS coverage does not extend down to the surface.

The basic function of the DVS is to broadcast the ETIS information over a local VOR or other VHF channel utilizing digitized (or synthetic) speech. The data is received from the LPDS processor either in some coded form or as actual digital speech (see Section 3.3.1.1.5). The DVS processes the coded data as required, retrieving pre-stored digitized words from memory, or selecting the proper phonemes in the case of synthetic speech. The digital speech is converted to analog form and transmitted over the VHF channel.

The DVS operates in a broadcast mode only, having no discrete address capability over the VHF channel. It functions in a manner similar to the recorded ATIS broadcast of today. A pilot tunes to the DVS frequency, listens to the broadcast, and records the pertinent information. He does not remain on the DVS frequency, so any alerts or significant changes in data must be given to him by the controller, as well as RVR and wind on final approach, as is current practice. Thus, the DVS completely eliminates the need for the conventional ATIS broadcast, and derives its real time data automatically from the ETIS system. The result is an overall reduction in controller workload.

3.3.2 ETIS Operating Software

The ETIS operating software is located in the AP at the controlling ATC facility, and services one or more ETIS installations within coverage of the associated DABS sensor. As pointed out earlier, this concept assumes a separate AP dedicated to data link applications requirements. In future operational DABS systems, these processing functions may, in fact, be combined with other DABS functions and be performed in a DABS processor. This implementation detail is not important for the purposes of presenting the ETIS concept.

The functions of the ETIS operating software are the following:

a. Collect and process ETIS data from the LPDS's

b. Generate and format ETIS messages

c. Dispatch ETIS messages

d. Interface with TIPS

e. Exchange data with other AP's.

The paragraphs below describe each of the above functions in detail.

3.3.2.1 Collect and Process ETIS Data - The ETIS operating software within the AP collects and processes all the locally generated real-time ETIS data from each LPDS within coverage of the associated DABS sensor. These data are processed by the ETIS software to the extent necessary to put them in a form suitable for use in ETIS messages. The data are then stored within the AP and are continuously available for insertion into an ETIS message.

The extent of processing of the ETIS data within the AP depends upon the characteristics of the data as received from the LPDS, and may in fact prove to be minimal since the concept calls for stand-alone capability for the LPDS in providing essentially complete ETIS information for local consumption. However, some data processing is likely to remain a function of the ETIS software, such as wind shear vector difference calculations, density altitude, and detection of conditions below VFR minimums. Nevertheless, all of these functions can be performed by the LPDS processor.

The stored ETIS data is updated several times per minute by polling each LPDS under control of the ETIS software. A single, full duplex, time-shared interface at around 4800 bps is a suitable interface for this function, based on the number of parameters to be transmitted, update rates of 3-4 times per minute, and 8-10 airports with ETIS per AP. However, considering that current plans call for initially deploying TIPS at locations that are prime candidates for ETIS (high and medium activity terminal environments), an alternative interface between the AP and LPDS is through TIPS (see Figure 3-1). This offers the advantage of fewer land lines and recognizes that the LPDS will probably interface directly with the local TIPS tower display subsystem anyway. (See Section 3.3.1.2.) This alternative may reduce the flexibility of the ETIS design, however, and the current TIPS design makes provisions for manual input of locally observed weather only. This is not viewed as a serious obstacle, however.

3.3.2.2 Generate and Format ETIS Messages - The ETIS operating software generates and formats all ETIS messages utilizing the stored ETIS data. More specifically, the ETIS software establishes the required contents of the message, extracts the necessary data from the memory area for the airport of interest, inserts and properly formats the data in the message, and hands over the message to the AP communications control software. The specific format of the message at this point depends upon the design of the interface between the ETIS operating software and the communications control software within the AP. The format at this interface could be anywhere from a highly coded, final form ready for uplink to the aircraft, to simply a string of ASCII characters representing the data elements to be transmitted. The details of this interface will be handled in the design of the AP software, and the data link message formats and protocol.

Table 3-2 shows the various messages which are generated by ETIS, their content, and when they are dispatched. They are discussed in Section 3.3.2.3.

3.3.2.2.1 Initial Arrival ETIS - The Initial Arrival ETIS is sent to all aircraft whose destination is the airport of interest at a predetermined point upon arrival in the terminal area. (See Section 3.3.2.3.1.) It is also sent to any aircraft requesting ETIS for a specific location. The contents of the message include essentially all ETIS data, as indicated in Table 3-2, with the exception of runway wind. Any alerts are included if applicable, and RVR and density altitude only if the criteria for their inclusion are met. (See Sections 3.2.4 and 3.2.9). Time of day may be included at the beginning of this message primarily for unique identification of the data (replacing the alpha designator of ATIS).

3.3.2.2.2 Departure ETIS - Depature ETIS is sent upon request to an aircraft prior to its departure. (See Section 3.3.2.3.2). Its contents are essentially the same as the initial arrival ETIS with the exception that approach in use and RVR are not included. Time of day maybe included for the same reason as for initial arrival ETIS.

TABLE 3-2. ETIS MESSAGE TYPES

MESSAGE TYPE	CONTENT	WHEN DISPATCHED
1. Initial Arrival ETIS	1,2,3,4,5,6*,7,10, 11,12,16*,17,18, (8,9,13,14,15)**	Prior to arrival at entry fix.
2. Departure ETIS	1,3,4,5,6*,7,10,11, 12,16*,17,18, (8,9, 13,14,15)**	Upon pilot request
3. Final Approach	4* or 6*,7,8,	Near outer marker or final approach fix
4. Change-Runways in Use	1	When changed
5. Change-Approach in Use	2	When changed
6. Change-Altimeter Setting	12	When value changes by pre-determined amount
7. Change-Visibility and/or Precip. Type	4,5	When value changes by pre-determined amount
8. Change-Ceiling	3	When value changes by pre-determined amount
9. Change-RVR	6	When value changes by pre-determined amount
10. VFR Minimums	13,4	When conditions go below VFR minimums
11. Airport Advisories	17	When put into effect
12. Wind Shear Alert	7,8,9	When detected
13. Pressure Jump Alert	12,13	When detected
14. Temp. Drop Alert	10,14	When detected
15. Thunderstorm Alert	15	When detected
16. Pilot Request Response	As requested	Upon receipt

MESSAGE CONTENTS

1. Runway(s) in Use (Approach and Departure)
2. Approach(es) in Use
3. Sky Condition
4. Prevailing Visibility
5. Precipitation Type
6. RVR
7. Center Field Wind
8. Runway or Sector Wind (Only for Runway(s) in Use)
9. Center Field/Runway Wind Vector Difference (speed, direction)
10. Temperature
11. Dewpoint
12. Altimeter Setting
13. Rate of Barometric Pressure Rise (__ inches Hg in ___ minutes)
14. Rate of Temperature Drop (___ degrees F in ___ minutes)
15. Thunderstorm location, direction, speed (if available)
16. Density Altitude
17. Airport Advisories
18. Time of Day of ETIS Data (if required)

*If conditions warrant.
**Only when the associated alert is in effect.

The technical feasibility of providing departure ETIS via data link is not yet clearly established, due to the uncertainties regarding DABS coverage down to the surface. This is particularly true for those ETIS equipped airports remote from the DABS sensor. In these cases, it is unlikely that departure ETIS can be provided by data link, and use of the DVS over the VHF channel will be necessary (as it is today). Arrival ETIS and all other messages prior to final approach will be sent via data link at these locations. Once the aircraft begins to descend on final, however, there will be a point prior to touchdown where DABS coverage will be lost. Standard operating procedures must be implemented to account for these situations to insure that all pertinent data reaches the pilot, either via data link or voice.

The situation regarding departure ETIS at those airports co-located with the DABS sensor is less clear. While there may be DABS coverage on parts of the airport surface, there will almost surely be areas where blockage from structures, etc., will prevent reliable data link operation. If this in fact is the case, and ETIS cannot be satisfactorily provided at these locations, the VRS broadcast over the VHF channel will again be used.

This question of DABS coverage on the surface adds another argument in favor of implementing the DVS broadcast along with ETIS.

3.3.2.2.3 Final Approach Data - This ETIS message contains center field wind, runway wind, and RVR or prevailing visibility, whichever is appropriate for the approach in use, but only if the RVR is less than 6000 feet of if visibility is less than 2 miles. (See Sections 3.2.3 and 3.2.4.) The message is automatically sent after the aircraft has been cleared for the approach.

The ETIS software monitors RVR and prevailing visibility, and based on the approach in use, determines whether or not to include either of these parameters in the final approach data message. Runway in use is used by the software to determine which RVR and runway wind data to include in the message.

In those instances where more than one runway is in use for landing, a number of alternatives exist. The simplest is to include merely the wind and RVR data for all runways in use and depend on the pilot to ignore all but the one of interest to him. Second, the assigned runway can be obtained from TIPS if an algorithm is developed for this purpose or if entered by the controller. Provisions are made in the message structure of TIPS for this capability. Third, surveillance data and altitude filtering can be used by the ETIS software to determine which runway an aircraft has been assigned. Finally, the pilot can be asked to enter via keyboard the assigned runway which would either be downlinked for use by ETIS software, or merely serve to filter the data as received onboard the aircraft.

The first alternative is unattractive to the pilot, but may be acceptable. The last alternative is not only unattractive to the pilot, but increases his workload as well, and is likely to be unacceptable. Option three is more complex to implement in the ground system, but is certainly feasible. DABS will provide sufficient accuracy and resolution to distinguish between parallel runways when both are in use. This alternative becomes more attractive if surveillance data are used by ETIS for other purposes and by other data link services. (See Section 3.3.2.3.)

The second alternative seems most attractive for several reasons. Airports with multiple instrumented runways which are used simultaneously are generally the larger ones, and therefore most likely to have TIPS. If the assigned runway is either determined by an algorithm or entered by the controller, ETIS software can easily use it and no additional workload is required of pilot or controller. And if the controller is required to enter the assigned runway via TIPS solely for ETIS, it does not represent a net increase in workload since he will not then be required to provide RVR or wind to that aircraft on final approach.

It is proposed that the ETIS software obtain runway assignment from TIPS when more than one is in use. When TIPS is not available or no runway assignment is present in TIPS, surveillance data will be used to distinguish between runways.

3.3.2.2.4 Parameter Change Messages - Parameter change messages are automatically transmitted to an aircraft when a parameter changes by certain predetermined criteria. Change messages are advisory in nature, as distinguished from alerts, which warn of potentially hazardous conditions. The contents of the message are the new value of the parameter. As indicated in Table 3-2, changes in runway or approach in use, altimeter setting, visibility and/or precipitation type, ceiling, and RVR are included in this category.

The criteria for dispatching change messages are discussed in Section 3.3.2.3.2. The ETIS software will send the appropriate change message to all aircraft which have received an initial arrival or departure ETIS message.[1] However, runway and approach in use change messages will not be sent to an aircraft already established on approach, that is, an aircraft which has received the final approach data message.

3.3.2.2.5 VFR Minimums Message - When the ceiling and/or visibility drop below VFR minimums (1000 feet and 3 miles respectively), a message indicating conditions below VFR minimums is sent to all aircraft which have received the initial arrival or departure ETIS. The message contains the current ceiling and visibility values. This message is aimed primarily at VFR aircraft desiring to land at or depart from the airport to warn them that VFR flight

[1] This necessitates creation of a table of aircraft and their status within the ETIS software.

cannot be conducted in the area and to file IFR if they are qualified. The message is also useful for IFR operations to alert them of the deteriorating conditions, and will be sent to these aircraft as well.

It is expected that the value of the ceiling (lowest cloud layer covering 60% or more of the sky) will be a direct input from the automated weather sensors. However, it could be easily calculated by the ETIS software from the sky condition data if necessary.

3.3.2.2.6 Airport Advisory - These messages are the result of additions or changes to the Airport advisories pertaining to a given airport. All aircraft which have received an initial arrival ETIS, or the departure ETIS, will be sent an Airport advisory message when it has been inputted by the controller. The content of the message is the Airport advisory itself, and is automatically added to all initial arrival or departure ETIS messages as well.

3.3.2.2.7 Alert Messages - Alert messages are intended to inform the pilot on a real-time basis of the existence of, or potential existence of, hazardous conditions in the terminal area. The alerts as envisioned here involve wind shear and thunderstorm activity, but others may be developed in the future, such as wake vortex detection. All alerts are sent to all aircraft which have received the initial arrival or departure ETIS.

Wind shear alerts are obtained directly from the LLWSAS, which compares center field wind with each of five boundary winds and generates an alert when the vector difference exceeds 15 knots (nominally). The contents of this ETIS alert message are the center field and appropriate sector winds (magnitude and direction). The difference between these two winds, magnitude only or both direction and magnitude, can also be provided if this is considered useful to the pilot. If not available directly from LLWSAS, it can be readily calculated by the ETIS software. Alternatively, the runway and crosswind components of the various winds, with respect to the active runway, could be calculated by the ETIS software and presented to the pilot. The preferable approach is not clear at this time, and other alternatives are certainly possible. More study, experimentation, and pilot feedback are required to select a suitable approach. However, implementation of any of these by the ETIS software should be straightforward.

Detection of pressure jumps and/or rapid temperature drops have potential use as thunderstorm alerts. Prior to the development of more accurate, reliable thunderstorm detection and monitoring capability, these data may prove beneficial in providing an early warning to the pilot of conditions in which thunderstorm activity might occur. While specific numbers are difficult to specify at this time, and are not the responsibility of the DABS data link designers, a temperature drop on the order of 3-5°F in 5 minutes, or a pressure jump of around 2 millibars in 2 minutes, are representative. The results of current activities in this area will help firm up these numbers. These alerts would be detected by AV-AWOS (or ALWOS, etc.) and the data may include the rate of change of the parameter, which could be sent along with the new value in the data link message.

Depending upon the sophistication and capability of thunderstorm detection equipment, the location, direction, and speed may all be available for a thunderstorm alert message. Frequent updating would keep pilots informed of the storm's progress. The ETIS software will not perform any of the detection algorithms, but merely forward the data in an alert message. The actual detection and tracking algorithms will be part of AV-AWOS or other automated weather observation system, including the rate of update based on speed of movement and proximity to the airport.

3.3.2.2.8 Pilot Request Responses - ETIS must be capable of responding to a pilot request for any part or all of the ETIS data for a specified location. A VFR pilot passing through the area may only want altimeter setting, or a pilot planning his approach may just want to check the winds. The following are suggested subsets of ETIS data that can be requested by the pilot:

1. Full ETIS (Initial Arrival ETIS)
2. Sky Condition
3. Prevailing Visibility/Precipitation
4. Winds (center field plus active runway)
5. Altimeter Setting
6. RVR (active runway)
7. Temperature/Dewpoint
8. Approaches/Runways in Use
9. Airport Advisories
10. Discontinue.

Added to all of these requested data messages will be any alerts which are currently in effect for the terminal involved.

The means by which the pilot generates a request of the above type is dependent upon many factors in addition to the ETIS concept itself, and can not be established at this point. Avionics design and cost tradeoffs, message coding, other types of request messages, pilot preference, etc. must all be considered. One reasonable approach is to present the pilot with a "menu" of the above data request types after he enters a general ETIS request input to his avionics. He then selects the desired data subset by simply entering the corresponding number identification. (An entry of the location identifier would also be required.) This is all handled within the avionics itself, the downlink request message being sent only after the specific selection is complete. The pilot should also have the option of selecting a "one time" only request versus automatically receiving any updates of the data initially requested. The ability to request discontinuation of ETIS service should also be provided. All of these requests can be handled within the above approach by selection of suitable menu

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ETIS REPORT REQUEST  LOC ID _ _ _
               REPORT TYPE _
               UPDATES? Y/N _
REPORT TYPES:

1-FULL ETIS     2-SKY CONDITION
3-VISIBILITY    4-WINDS
5-ALTIMETER     6-RVR
7-TEMP/DEW PT   8-RWY/APR IN USE
9-ADVISORIES    0-DISCONTINUE
```

FIGURE 3-2. CANDIDATE ETIS DOWNLINK REQUEST "MENU" AND FORMAT items. Figure 3-2 shows a possible avionics display format for generating an ETIS request message based on a 10 line, 32 character per line display format.

Other schemes are possible, as are other groupings of the data elements. The latter is the most important factor to the ETIS concept, however, and the ETIS software must be designed to recognize and respond to specific ETIS requests in whatever form is established. It must also be capable of providing ETIS data to other AP's in response to pilot requests which occur outside the coverage area of the corresponding DABS sensor. (See Section 3.3.2.4.)

3.3.2.3 Dispatch ETIS Messages - All ETIS messages are dispatched under control of the ETIS operating software. This function includes determining when the criteria have been met for dispatching a message, what type of message is involved, and what aircraft are to receive it. It also includes discontinuing ETIS service at the appropriate time.

There are three types of criteria or events which indicate when a message should be dispatched: phase of flight or aircraft location, a change or occurrence in the ETIS data, and pilot request. When one of these events occurs, a specific ETIS message must be generated by the software and dispatched to one or more aircraft, depending upon the type of message involved and the event which triggered it. There are also three conditions under which ETIS services are discontinued for a particular aircraft: after landing, after departing the airport, or upon pilot request. The paragraphs below discuss these conditions and criteria in more detail, and relate them to the various message types. (Refer to Table 3-2.)

3.3.2.3.1 Phase of Flight or Aircraft Location - There are two points in the flight of an aircraft arriving in an ETIS-equipped terminal area at which an ETIS message is automatically dispatched. The first of these occurs a short time prior to the aircraft being handed over from enroute to approach control (near the feeder or coordination fix). This point varies, depending upon the terminal involved and the route by which the aircraft is approaching, but is generally 20-50 miles out. When an aircraft whose destination is an ETIS-equipped airport arrives in the vicinity of this point, the initial arrival ETIS message will be automatically sent.

There are several alternatives for dispatching this message, each of which require aircraft destination information. Surveillance data can be used by the ETIS software to detect arrival at a specific point, or perhaps arriving within a fixed radius of the airport which encompasses all feeder fixes. A second alternative is detection of the handoff event between enroute and approach control, available from TIPS or ARTS. However, this is inconsistent with today's procedures, which require the pilot to obtain ATIS prior to this. A third alternative is to dispatch the message at some fixed time (5-10 minutes) prior to the aircraft's estimated time of arrival (ETA) at the feeder fix, also available from TIPS or ARTS. However, the accuracy of this ETA with respect to actual aircraft arrival time may not be sufficient for this application. The recommended approach is to use surveillance data, and establish a fixed radius at each airport as the criterion for dispatching the message.

In some cases, an aircraft may be landing at an ETIS-equipped airport but no destination information is contained in TIPS or ARTS. An example is a VFR flight with no flight plan on file. In this case, it is the pilot's responsibility to request the ETIS, which is always available, and which is similar to today's procedure for obtaining ATIS. The ETIS software will assume from this request that the aircraft is bound for the airport for which ETIS was requested, and will treat it as a normal arrival from this point on. An alternative way to handle this situation is to automatically request destination information via the data link from any DABS-equipped aircraft which is within coverage but does not have a destination associated with it. The destination information would have to be entered by the pilot. However, there is no apparent advantage to this approach; it is more complex and less flexible for the pilot, and is therefore not recommended.

Another factor which must be considered in dispatching the initial arrival ETIS message is the case in which an airport with ETIS capability is located near the outer boundary of the DABS sensor coverage. Aircraft approaching this airport may not be within coverage of the associated DABS sensor until well beyond the point at which initial arrival ETIS must be sent. In other words, the point at which the message is to be sent is within coverage of another DABS sensor. The AP associated with this second DABS sensor must obtain the ETIS data from the first AP and dispatch it at the proper time. This points out the need for netting together of the AP's as discussed in Section 3.3.2.5. If there is no adjacent DABS sensor, the pilot is forced to obtain the initial arrival ETIS from the DVS over the conventional VHF channel.

The second point in an arrival aircraft's flight when ETIS messages are dispatched is somewhere near the outer marker or final approach fix. The final approach data message is automatically sent to the aircraft at this point by the ETIS software. The message can be dispatched based on surveillance data, or the handoff from approach to local controller can be used. The latter event will be available from TIPS and occurs at the same time in the flight that this data is given today by the local controller. However, if surveillance data is to be used by ETIS for other purposes, it can be used equally well here.

3.3.2.3.2 Change in ETIS Data - Certain ETIS message types are dispatched when a significant change occurs in the ETIS data. Included in these message types are alerts, VFR minimums, and parameter change messages, as defined in Table 3-2. The ETIS software dispatches these messages when the appropriate predetermined criteria are met, or when certain types of incoming data messages or alerts are received from the automated weather sensor systems. Depending on the message type, it may be dispatched to all aircraft in the area or only to individual aircraft.

The criteria for dispatching these messages are straightforward in some cases, but not so easily determined in others. Change messages are intended to provide an update to the pilot of a parameter he has already obtained from the initial arrival or departure ETIS, and so the amount of change significant enough to trigger such a message must be carefully established. The DABS data link designers are not responsible for determining these criteria, but rather for implementing them within the ETIS software as required. Nevertheless, some discussion of what these criteria might be in each case is in order.

Under current weather reporting procedures defined in the Federal Meteorological Handbook (FMH-1) certain events or changes in parameters lead to the issuance of a Special Observation(SP). When an SP pertains to a given airport, all arriving aircraft under approach control are informed of the SP by the controller until the ATIS is appropriately updated and is being received by arriving aircraft. The current AV-AWOS specification calls for automatic detection and dissemination of SP's based on essentially the same criteria as defined in FMH-1. It is reasonable to assume, therefore, that the primary criterion for dispatch of a parameter change message by ETIS should be the receipt of an SP from AV-AWOS.

In addition to the receipt of SP's, it may be desirable for other parameter changes or events to cause the dispatch of an ETIS change message. Because data link with ETIS will relieve the controller of giving such messages by voice, and of updating the ATIS tape, it may, in some instances, be beneficial to give the pilot updates triggered by smaller changes in the parameter than is done manually today. The real time, automated aspect of ETIS has the potential for significantly improving the amount, quality, and timeliness of such data while actually reducing controller workload. This should be considered by the designers of the weather dissemination criteria, but must also be carefully weighed against the danger of saturating the link and the cockpit with too much information.

The paragraphs below contain discussions of the criteria to be used for the dispatch of each of the message types which depend on a parameter change or other occurrence.

<u>Change in Runways or Approach in Use</u> - This change message is straightforward. It is dispatched to all aircraft[1] except those which are already established on final approach, when the change has been made by the controller via the LPDS display/input terminal of the TIPS tower display subsystem.

<u>Change in Altimeter Setting</u> - Altimeter setting is critical to all phases of flight. The most reasonable approach is to dispatch this message to all aircraft whenever a change of .01 inches occurs. Because the altimeter setting normally changes at very slow rates, this should not result in excessive altimeter setting updates to the aircraft.

Under today's procedures, the approach controller provides the current altimeter setting upon initial contact with the pilot, and may or may not update this if small changes occur, depending upon the current conditions and his own judgment. If a pressure jump of at least .02 inches in less than four minutes occurs, and is sustained for at least 20 minutes, an SP is issued by the weather observer, and this will be passed on by the controller. AV-AWOS calls for a similar pressure detection algorithm which will result in a pressure jump alert being dispatched by ETIS. (See "Alert Messages" below.)

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[1] In these discussions, "all aircraft" refers to those aircraft which have received either an initial arrival or departure ETIS prior to the event occurring.

Change in Visibility and/or Precipitation Type - Visibility change messages will be dispatched to all aircraft upon receipt of an appropriate SP from AV-AWOS. The visibility change criteria which result in an SP being issued are the following:

Prevailing visibility (rounded to reportable values) decreases to less than, or if below, increases to equal or exceed:

1. 3 miles
2. 2 miles
3. 1 1/2 miles
4. 1 mile
5. All nationally published landing minimums applicable to the airport
6. Values established locally because of their significance to local aircraft operations.

With regard to precipitation, AV-AWOS currently calls for the capability to detect precipitation, freezing rain, and hail (optional). Initial detection of freezing rain and hail will result in an SP being issued. ETIS will dispatch a visibility precipitation change message upon receipt of either the freezing rain or hail SP, or when precipitation is positively noted in a normal observation message from AV-AWOS. As the sophistication of precipitation and obstructions to visibility sensors increases, additional criteria may be established for dispatching this type of change message. This will require simple ETIS software changes in the AP to implement.

Change in Ceiling/Sky Condition - Ceiling/Sky Condition change messages will be dispatched to all aircraft upon receipt of an appropriate SP from AV-AWOS. The ceiling change criteria which result in an SP being issued are the following:

The ceiling (rounded to reportable values) forms or dissipates below, decreases to less than, or if below, increases to equal or exceed:

1. 3,000 feet
2. 1,000 feet
3. 500 feet
4. All nationally published landing minimums, applicable to the airport.

Sky condition change criteria which result in an SP being issued and therefore an ETIS change message, are the following:

A layer of clouds or obscuring phenomena aloft is present below:

1. 1,000 feet and no layer aloft was reported below 1,000 feet in the preceding observation
2. The highest published landing minimum, including circling minimums, applicable to the airport and no sky cover aloft was reported below this in the previous observation.

These criteria appear to be sufficient, at least for the time being, for use by ETIS to dispatch ceiling and sky condition changes. Again, additional criteria, or smaller change increments, may be appropriate and can easily be accommodated by the ETIS software.

Change in RVR or RVV - The current procedures for issuing RVR and RVV values to arriving and departing aircraft, according to the FAA manual "Air Traffic Control" (7110.65A) are the following:

a. Issue touchdown RVR or RVV for the runway in use as follows:
    1. When prevailing visibility is 1 1/2 miles or less
    2. When RVV is 1 1/2 miles or less
    3. To departing aircraft when RVR is 6,000 feet or less
    4. By local control or final controller for arriving aircraft when RVR is 4,000 feet or less
    5. By approach control when RVR is 6,000 feet or less
    6. When the RVV or RVR indicates that the visibility is below the published minima for the particular approach being executed.

b. If installed, issue mid and rollout RVR information whenever the value of either is less than 2,000 feet and less than touchdown RVR.

In addition, controllers will issue RVR or RVV updates to the aircraft in the terminal area during marginal conditions according to their own judgment and, of course, upon pilot request. The only additional criterion in use is that an SP is issued when RVR (highest value in preceding 10 minutes) passes through 2,400 feet from either direction.

RVR (or RVV) is critical information to the pilot under poor visibility conditions. Most knowledgable sources will agree that providing more timely, frequent, accurate readings to the pilot, without adding to the controller workload, is a highly desirable goal. Therefore, it is apparent that a completely new set of criteria is needed for automatically dispatching RVR changes to the cockpit using data link.

In the extreme, RVR values could be provided continuously when below a certain threshold, such as 6,000 feet. Actually, the updates would be at the RVR sensor system update rate of 15 seconds. However, this may have data link loading implications and probably saturates the cockpit with new messages that frequently contain the same data as before. Visually monitoring this data, particularly while on final approach, is not desirable. Avionics with a voiced output for RVR would be a potentially attractive alternative to the visual display.

But a better approach would seem to be to establish a set, or sets, of incremental change criteria which would trigger a new RVR or RVV change message. These increments may depend on the absolute value of the reading (smaller increments as the RVR or RVV decreases), the phase of flight (smaller when on final approach), the direction of change (larger for positive changes) and the type of approach (smaller for precision approaches). As an option, perhaps, "continuous" readout, as described earlier, could be provided upon pilot request.

Other factors may enter into the establishment of these criteria, and no attempt to finalize them will be made here. It is important, however, to make clear the fact that the automated, computer-controlled dispatch of RVR and RVV, without any action by the controller, can be rather easily implemented according to any reasonable set of criteria. It is therefore important to determine from the start what data under what conditions are useful to the pilot, and design the software accordingly. The current procedures should be used as a starting point only for the design of a much improved, and less labor intensive means of providing RVR to the cockpit.

VFR Minimums - This message is automatically dispatched to all aircraft when either the ceiling and/or visibility drops below VFR minimums (1,000 feet and 3 miles, respectively). It will not be sent to an aircraft which is already on final approach.

Airport Advisories - Airport Advisories are dispatched to all aircraft immediately after they have been entered into the ETIS system by the controller using the LPDS display/input terminal or the TIPS tower display subsystem.

Alert Messages - Alert messages are dispatched to all aircraft as soon as they are detected. The criteria for determining alert conditions are discussed in Section 3.3.2.2.7, and will actually be implemented by the automated weather sensor system processor. The alert itself is therefore an input to the LPDS processor which will immediately transfer the alert data to the ETIS software within the AP for dispatch by data link.

The question of how often an alert message should be repeated over the data link must be addressed, and whether or not a message such as "alert cancelled" is required when the conditions improve. It is desirable to avoid a proliferation of repeated alert messages and cancellation messages saturating the pilot and the link. Therefore, some reasonable frequency for repeating the alert while the conditions exist should be established, consistent with the characteristics of the sensor system involved (time constant, sampling rate, etc.). No cancellation message is really required, since the alert is understood to be in effect for a length of time equal to the repetition period, For example, LLWSAS has a 7-second sample rate and uses wind sensors with filter time constants on the order of 30 seconds. Therefore, a repeat interval (and alert validity time) on the order of a minute would seem reasonable. The pilot understands that a wind shear alert is in effect for one minute after detection unless the alert is repeated.[1] Similar criteria can be established for thunderstorm alerts and others.

3.3.2.3.3 Pilot Request - The final criterion for dispatch of an ETIS message is receipt of a pilot request. The ETIS software assembles a message containing the requested ETIS data and dispatches it to the requesting aircraft. Updates are automatically provided if specified by the pilot. (See Section 3.3.2.2.8.).

The primary message type which falls within this category is departure ETIS. While it may be desirable, and certainly is possible, to automatically dispatch the departure ETIS, it does not appear that there is a clear cut event or time reference which could be used reliably as a general criterion. The one possibility, perhaps, would be to dispatch it immediately after acquisition of the DABS transponder. However, the pilot may be busy with other preflight activities at this time and not be ready for ETIS. A preferable approach is for the pilot to request ETIS when he is ready, just as he does today to obtain ATIS. In this way, departure ETIS is obtained when the pilot is ready in a simple, reliable manner which fits well within his normal predeparture planning activities.

[1]The LLWSAS tower display remains in alert status for about 45 seconds after the last sample which exceeded the wind shear alert threshold. An audible alarm occurs only at the onset of the alert condition.

The other message type which falls within this category is the general pilot request for individual subsets of the ETIS data. As indicated earlier (see Section 3.3.2.2.8), the detailed designs of the pilot request procedure, message formats, etc., are not a part of this study. The ETIS software, however, will be capable of responding to these requests and will send the appropriate data immediately upon receipt of the request message.

3.3.2.3.4 Termination of ETIS - The first of three conditions under which ETIS is terminated is immediately following the aircraft's landing at the destination airport. This can be detected by an algorithm which uses surveillance data (position and altitude) to establish a "landing zone" around the airport, within which an aircraft is considered on the ground. The zone encompasses the general airport boundaries and extends perhaps a 100 feet or so from the surface. When an aircraft receiving ETIS services has passed into this zone and has remained there for a fixed time period, ETIS services are terminated. The time delay, on the order of a minute or two, is to guard against dropping a missed approach. Manual means for terminating ETIS, such as a controller entry, are possible but have negative implications with regard to workload and are therefore not recommended.

The departure of an aircraft from the airport area is the second condition under which ETIS is terminated. This can be detected by an algorithm which establishes a "departure zone" similar to the landing zone described above. Its radius may be somewhat larger then the airport boundary to insure that wind shear alerts are still provided to the aircraft as long as it is within a hundred feet or so of the surface. Other ETIS services which are useful to the pilot beyond this point in his departure are altimeter setting changes and thunderstorm alerts. These can be provided by ETIS for some additional volume of airspace around the airport, but at some stage in the flight, these and other message types must be taken over by other enroute data link services such as weather delivery.

The final event which leads to termination of ETIS is a request by the pilot. This option must be left open to the pilot who, for whatever reason, does not want additional ETIS messages to be sent via data link. The request would normally be via a downlink message, as illustrated in Section 3.3.2.2.8, but should also be available by voice request to the controller.

3.3.2.4 Interface with TIPS - The interface between the LPDS and the TIPS tower display has been discussed earlier. (See Section 3.3.1.1.4.) However, the ETIS concept as presented here assumes an interface between the AP and the TIPS Terminal Flight Data Processor (TFDP) to obtain certain data and to provide ETIS information for display in the TRACON and the ARTCC. While alternatives can be identified in most cases (for example, much of the data and the TRACON interface could be provided through ARTS), an interface with the TIPS TFDP is highly desriable. The following is a summary of the functions of this interface.

<u>Aircraft Destination</u> - This information is necessary to automatically dispatch the correct initial arrival ETIS only to those aircraft bound for a particular airport. It will be available for both IFR and VFR flights from TIPS. An alternative is to obtain destination from ARTS if available, and/or request destination via data link if unknown. See Sections 3.3.2.2.1 and 3.3.2.3.1.

<u>Assigned Runway</u> - For the case of multiple active runways for landing, the runway assigned to a particular aircraft is information necessary for the ETIS software to select only the corresponding RVR and wind data for transmission to that aircraft on final. It also enables determination of below minimum conditions for the runway of interest to that aircraft. Assigned runway may be available in TIPS, if algorithms are developed for automatically carrying out this function or if entered by the controller. Alternatives include sending data for all active runways to all aircraft, using DABS surveillance data to distinguish between runways, or having the pilot or controllers enter the assigned runway manually. See Section 3.3.2.2.3.

Handoff Between Controllers - There are two cases where a handoff event may be used by ETIS as an alternative to surveillance data: triggering of the initial arrival ETIS and the final approach data message. In both cases, a handoff event occurs at or near the appropriate time, and these events are available from TIPS or ARTS. See Section 3.3.2.3.1.

Interface With LPDS - As pointed out earlier, an alternative to a direct interface between the AP and the LPDS is through TIPS. The concept calls for an interface at the local airport between the LPDS and the TIPS tower display system, which is in turn tied to the central TIPS terminal flight data processor, and could serve as the LPDS to AP interface. See Section 3.3.2.1.

Display of ETIS Data in the TRACON - Access to ETIS data by controllers in the TRACON is obtained using the TIPS TRACON Display Subsystem. The ETIS software in the co-located AP, through its interface with TIPS, provides the ETIS data for each airport within coverage of the associated DABS sensor. Display format and procedures for accessing the data must be incorporated into the final TIPS design. The alternative of a dedicated ETIS display in the TRACON does not seem warranted and is not recommended. (See Section 3.6.)

Display of ETIS Data in the ARTCC - Approach control for many remote airports is provided by the ARTCC. While not likely to be initial candidates for ETIS, eventually some of these airports will be equipped and will therefore necessitate access to the ETIS information by the controlling ARTCC. TIPS will not include displays in the ARTCC, but the TDFP will interface with the ARTCC computer (National Airspace System - NAS). A possible candidate display is ETABS (Electronic Tabular Display System) which is being planned for implementation in ARTCC's in the early 1980's. A dedicated ETIS display, similar to that used in non-TIPS towers, can also be considered, although this does not seem to be warranted. An alternative to a TIPS interface is NADIN (National Airspace Data Interchange Network). In any case, the ETIS software in the AP must provide ETIS data for each airport whose approach control is provided by that ARTCC. The funtional operation, formats, etc., of this display and that of the TRACON display are essentially the same. (See Section 3.6.)

The ETIS software interface with TIPS will be implemented between the AP and the TIPS terminal flight data processor, which are likely to be co-located. Some data must be provided automatically by TIPS (e.g., handoffs), while other data can be provided automatically or on request from ETIS. The design itself is not important at this point, but it does seem likely that potential data link services other than ETIS will find this interface necessary (e.g., clearance delivery). The design must take this into account.

3.3.2.5 Exchange of Data with Other APs - Two aspects of the ETIS concept depend upon the exchange of ETIS data among AP's. The first is the requirement that an aircraft have access to any ETIS data from any location. Thus an aircraft 200 miles from its destination must be able to request ETIS for that location, even though it is well beyond coverage of the corresponding DABS sensor (60 miles) and its AP. This is accomplished by interconnection or netting of the APs. A pilot request for ETIS not included in the ETIS software of the AP receiving the request is forwarded to the appropriate AP, where the response message is generated and sent to the originating AP for transmission to the requesting aircraft.

The second aspect which calls for netting of the APs involves dispatching the initial arrival ETIS as described in Section 3.3.2.3.1. Aircraft approaching an ETIS equipped airport located near the boundary of coverage of the DABS sensor which includes that airport may not be within coverage of that sensor at the point when initial arrival ETIS is to be dispatched. In this case, the AP associated with the adjacent DABS sensor whose coverage the aircraft is under must obtain the ETIS from the adjacent AP and send it to the aircraft. Furthermore, when control is transferred to the final DABS sensor, some status data may have to be transferred between the AP's to confirm what ETIS data has been sent to the aircraft.

(This is probably also true for data link functions other than ETIS.)

In this latter case, all ETIS message types and capabilities must be available to the aircraft while under coverage of either of the DABS sensors, including alerts and below minimums messages. For this reason, it may be preferable to maintain a complete ETIS data base within the AP for each airport for which that AP may have to provide ETIS data on a routine basis. In other words, rather than an adjacent AP requesting ETIS data, it would automatically be sent a complete ETIS update each time the controlling AP polls the appropriate LPDS. This is a tradeoff which must be made when the detailed interface design is carried out. It is expected that the netting of AP's will be accomplished utilizing National Airspace Data Interchange Network (NADIN).

3.4 AVIONICS

Data link avionics consist of displays and input devices, plus message processing, memory and interface electronics to provide compatibility with the DABS transponder and data link design. These avionics will be shared among the various data link applications, ETIS included, and their design will therefore be influenced by the overall data link concept, of which ETIS is only one part. Nevertheless, it is of interest to discuss the relationships between the ETIS concept and the data link avionics design, bearing in mind that other factors must eventually be considered as well.

The avionics design per se is up to the avionics manufacturers, the airlines, ARINC, etc. In discussing avionics design in the context of the ETIS concept, the intent is simply to focus attention on those aspects of the ETIS concept which will influence that design and therefore the human factors, cost, flexibility, reliability, etc., of the data link avionics.

3.4.1 Range of Capability

ETIS must be available to as large a percentage of the potential user population as possible. This includes the large commercial jet, the single-engine aircraft in a VFR flight, and everything in between. The data link avionics which the commercial air carrier can afford to install in his fleet will have considerably more capability than that of the average private pilot. ETIS, and all data link applications for that matter, should be designed in such a way that the primary part of the service, if not all, can be provided to a minimally equipped aircraft.

It is expected that some minimum data link capability will be required for an aircraft to be considered DABS data link equipped. The DABS data link design provides a means for the avionics to indicate capability in its reply messages, so that services can be tailored as required. While a minimum capability has not been determined, it is reasonable to assume it will require display of at least a short message (15-20 characters) and some provisions for pilot input, probably alphanumeric such as the touch-tone keyset. With the cost and availability of solid state memory so attractive now, it is also reasonable to assume that all data link avionics will include some memory capability so that the avionics may receive and store messages which are too long for its limited display. These avionics must also include some means for the pilot to then have access to the various stored message segments.

At the other extreme, data link avionics which include CRT displays with large message display capabilities, printers, and highly flexible pilot input devices have virtually no limit (imposed by the avionics itself) to the data and message exchanges which can take place. ETIS should therefore be designed so as not to restrict unnecessarily its use by aircraft that are fully equipped.

3.4.2 Message Size and Coding

The initial arrival or departure ETIS is the longest of any ETIS message type. It can be divided into two parts, the normal data being one part, and the airport advisories, etc. the other. To display the first part with suitable abbreviations, somewhere on the order of 100 characters are required for the case with three active runways. (See Figure 3-3.) The airport and advisories can require any number of characters. While an upper limit is hard to estimate, 200 characters or more are conceivable.

The first part of the ETIS message can be coded rather easily, perhaps in two or three different forms or types depending upon the airport, so that only parameter values need be included in the data link message. (See Figure 3-3.) Combined with "intelligent" avionics which recognizes the ETIS message type, a standard format of labels can be applied from avionics memory to the parameters received over the link and the complete message displayed. Similarly, alert messages, final approach data, etc. can be coded with the message type and then only the parameter values transmitted. The avionics would fill in the blanks, so to speak, with standard text from memory. Coding of this type combined with intelligent avionics permits sending most ETIS data portions (excluding the advisories) in three or four DABS Comm-A[1] interrogation/reply cycles, with the worst case (e.g., three active runways) requiring perhaps up to six Comm-A messages. The intelligent avionics required here is reasonable to assume for the minimum capability case, as it essentially requires prestored memory capacity, the cost of which is low and getting lower as indicated earlier.

The second portion of the initial arrival ETIS (airport advisories) is not readily encoded and must be transmitted in a free text format. Assuming eight characters can be handled by a Comm-A message, four or five such messages are required for rather short advisories, and 20-25 for a given ETIS are easy to envision. This latter case is clearly unacceptable, and would call for use of the extended length message (ELM) Comm-C[1] capability of DABS.

[1]Comm-A ground-to-air interrogations include 56 bits in a data link message. Each Comm-A interrogation must be acknowledged by an individual reply from the aircraft transponder. Comm-C interrogations are intended for more efficient transmission of long ground-to-air data link messages. Each includes an 80-bit message field and up to 16 Comm-C interrogations can be transmitted in a single burst and acknowledged with a single transponder reply.

ETIS [DCA 1806]

SKY [25S] / [33S] / [58B]

VSB [1/2] [RF]

WND [26] / [04] / [00]

TMP [46] / [44]

ALT [3004]

APR [ILS22L] / [RVR 51]

APR [ILS24] / [RVR 49]

DEP [24]

DATA

BRK F 22L 707.

TXWY G CLSD.

VFR AC CTC APR 126.8

AIRPORT ADVISORIES

TEST: ETIS for DCA at 1806 Greenwich. Sky is 2500 scattered, 3300 scattered, 5800 broken; visibility 1/2 mile in light rain and fog; wind from 260 degrees at 4 knots, no gusts; temperature 46°; dewpoint 44°; altimeter setting 3004. ILS 22L approach in use with RVR at 5100 feet. ILS 24 approach in use with RVR at 4900 feet. Departures on Runway 24. Braking action is fair on runway 22L by a 707. Taxiway G is closed. VFR aircraft contact approach on 126.8.

NOTE: [ ] indicates transmitted data.

Time tags may not be required.

FIGURE 3-3. TYPICAL INITIAL ETIS MESSAGE

Combining the two parts of the EITS message, about seven COMM-A messages, and on up, are required, assuming encoding of the first part. At some point, Comm-C will be required, depending upon what limit is established on successive Comm-A interrogation/reply cycles. However, the number four is currently being considered for this limit, which implies that ETIS, at least initial arrival and departure messages, may require Comm-C capability in the avionics. This is significant because it is not intended at this time to require Comm-C capability on all DABS transponders. Therefore, ETIS could easily be unavailable to some significant share of the users.

Several alternatives can be postulated. The coded first portion of the ETIS (and the most critical) can be transmitted first as a series of Comm-A messages. The airport advisory portion can then be sent as a Comm-A message or as separate groups of four Comm-A;s (or whatever the limit is). The first case measn the non-Comm-C equipped aircraft will not get the advisory portion, and must obtain this via the DVS/VHF channel, negating much of the advantage of the data link service. The second case seems unacceptable primarily because it in effect defeats the purpose of the ELM function of the link, and has serious capacity implications. A third alternative is, of course, to require Comm-C capability for minimum data link equippage, and send the ETIS as all ELM. This represents the most efficient and consistent use of the link, and depending upon the avionics cost impact and other implications of requiring ELM capability, may be the best solution. Another consideration is what other data link services may also require similar ELM capability.

The recommended approach is a slight variation of the third alternative. All initial arrival, departure, and other lenghty ETIS messages (e.g. a new advisory), are sent via Comm-C, while alerts and the shorter change messages whose lengths meet the appropriate criteria are transmitted as Comm-A's. Thus, an aircraft with a Comm-A/B transponder only will receive alerts and critical updates, but must obtain initial ETIS over the DVS broadcast. To receive full ETIS service, the transponder must have Comm-C capability as well. A pseudo-Comm-D reply capability is required for link compatibility only, but no actual downlink ELM's need be transmitted. This enables ETIS (and other data link services) to utilize the ELM mode (Comm-C) while not requiring avionis to have the higher power, greater cost capability of transmitting ELM's. Receipt of ELM's by the avionics does not have a significant impact on cost, as it essentially requires an increase in memory size, a relatively inexpensive addition.

3.4.3 Display Size

Figure 3-3 and Section 3.4.2 indicate that even with coding of the ETIS data parameters, and using intelligent avionics, the display of just the data portion of the initial arrival ETIS requires a display size on the order of 100 characters. This is a considerable requirement for implementation in a low-cost, minimum configuration, although CRT and printer technologies are advancing rapidly and may actually be quite suitable for the small single-engine aircraft in the mid-1980's. Physical size of the display must also be considered, since panel space is limited in all aircraft.

Alternatives to displaying all of the message at once are feasible, requiring only that the avionics be able to receive and store the entire message as received over the data link. For example, each line of data in Figure 3-3 is 16 characters or less (including spaces). Each line or segment of data could be called-up sequentially by the pilot with only a 16 window display and a message advance push button. Accessing an individual segment in the middle of the message would require more sophisticated display controls, but could be provided. Limiting each airport advisory segment to sixteen characters may be somewhat of a problem; however, it is not impossible.

Another alternative would have the ETIS software dispatch only one segment of the message (say 16 characters) at a time and wait for a pilot response before dispatching the next one. The only advantage to this is elimination of the memory requirement in the avionics, not a significant factor. The disadvantages are increased complexity on the ground, increased pilot workload, poor link efficiency, and excessive time to receive the entire ETIS. This alternative is not recommended.

For the better equipped aircraft, a display of the entire ETIS at one time with automatic (or pilot option) printing of it is readily achievable and attractive. One can even envision dedicated display windows at special locations on the instrument panel for key data such as altimeter setting, alerts, RVR, etc. An important point here is that the ETIS design, as well as that of the link and message coding must not limit the potential flexibility and capability of the avionics in trying to accommodate the minimum configuration user. At the same time, while the minimum capability user will pay some kind of penalty, it must be reasonable in terms of cost/performance tradeoffs.

3.4.4 Message Storage

ETIS messages can be rather long and contain a considerable amount of data. It may be beneficial to the pilot to be able to store some (or all) of this data for later reference. This is certainly true of other candidate data link services such as clearance delivery.

Two basic methods of storing data are an on-board printer or a solid state memory in the avionics. A printer, along with a volatile display, allows the pilot to automatically record all messages received, or, at his option, to print only messages he wishes to retain. Thus, "paper management" need not be a problem.

A pilot may also wish to select only portions of an ETIS message for printing. This requires a bit more avionics complexity, but the simplest method may be to allow line by line selection of those portions of the message to be printed. An alternative would utilize the fact that with coded data and intelligent avionics, the avionics already must recognize and interpret individual parameters within the ETIS data. Simple pilot control functions would allow selection of some of these for printing, or the avionics could be designed to automatically store only certain preselected parameters.

All of the above discussion applies essentially to solid state memory as an alternative to the printer. An additional consideration is pilot access to the data. Selective addressing, last in first out recall, and scrolling of memory contents are examples of alternatives that must be considered.

The only factor in these discussions which may be influenced by the design of the data link and ETIS software is the selective storage of individual data parameters. As indicated above, automatic storage of selected parameters, as well as one pilot-controlled method, depends on encoded data and parameter recognition by intelligent avionics. The discussion in Section 3.4.2 concludes that encoding of ETIS data will probably be necessary. This latter point is an additional argument in support of that conclusion.

3.4.5 Pilot Inputs and Requests

An attempt has been made in developing this ETIS concept to minimize the pilot actions required for obtaining ETIS data. While the ATIS system now in use requires the pilot to tune to a designated VHF channel and listen to the broadcast information, automatic transmission of this information to the pilot via data link is looked upon as an improvement over ATIS (although by no means the only improvement). However, certain ETIS functions will require pilot inputs, and the ETIS design must therefore take into account the impact on pilot workload and avionics design.

Required inputs should be short and simple. Asking a pilot to key in complex, lengthy request messages is a sure way to defeat the benefits and acceptance of ETIS, or any other data link service. For example, to request an individual ETIS parameter, a one or two character code designating ETIS, a three-letter LOC ID code, plus a single digit or letter specifying the parameter desired is all that should be necessary from the pilot to obtain that parameter.

On more sophisticated avionics, the ETIS designator may be a dedicated function button with a "menu" automatically displayed from which the pilot selects the code for the parameter he desires. (See Figure 3-2.) For the minimal avionics, the designator code may be entered manually by alphanumeric keys. In either case, only three to six keystrokes are required, which is reasonable. Full alphanumeric capability is required to take full advantage of ETIS, although the concept does not require any pilot input for routine service under normal circumstances. However, minimizing the requirements for use of the alphanumeric inputs is an important goal, particularly since the low-cost installations will probably incorporate a touch-tone type keyset with two entries per letter. For example, it may not be necessary for a pilot requesting ETIS for his destination to enter a location identifier if his destination is in the TIPS data base, and is "understood" by the ETIS software.

Another possible pilot input requirement is acknowledgement of or responses to messages (WILCO, UNABLE). The ETIS concept does not call for any such responses because the service is advisory in nature, and the technical acknowledgement received by the computer verifies that the correct data was received in the cockpit. "Compliance" with the message is not a factor with advisories such as ETIS, since the information is for the pilot's benefit in planning and conducting his approach or departure. Furthermore, verbal indication by the pilot on initial contact with the approach or ground controller that he has received ETIS by data link is included in the concept, and is a sufficient "human interchange" of status, just as today.

There is an argument that for critical data such as RVR or wind shear alert, it is necessary that the controller verify that correct data have been received by the pilot. The question of controller responsibility enters into this, but such arguments are based on the system as it works today, and understandably so. Initial use of data link may, in fact, call for verbal or data link confirmation by the pilot or controller of certain ETIS messages. However, as experience, familiarity, and confidence in the data link are gained, operational procedures should be tailored to take advantage of the data link capabilities and minimize what can be agreed upon as unnecessary human involvement.

3.5 MESSAGE DISPLAY FORMATS

The specific format of the ETIS messages as displayed to the pilot is a function of avionics design, since the assumption is made that the data as it is transmitted over the link will be encoded. In other words, wind can be displayed as:

WIND FROM 240 DEGREES AT 10 KNOTS, GUSTING TO 21 KNOTS

or:

WND 24/10/21

or anything in between from the same coded data received over the link. A display of avionics system may even have dedicated windows or areas for certain data. However, it is useful to at least give some indication as to how each data link message type shown in Table 3-2 might be displayed by the avionics. Table 3-3 gives one example and an explanation for each message type.

3.6 CONTROLLER DISPLAYS

Controllers in the tower, TRACON, and ARTCC must have access to ETIS data, even though ETIS automatically dispatches its information over the DABS data link. Link or hardware failures and unequipped aircraft are just two reasons why the controller must be kept informed of the current ETIS of interest to him.

This concept proposes the use of the TIPS display where available, which eventually should include all TRACONS and nearly all towers. A specific display is not proposed for the ARTCC, but ETABS is a possible candidate. Dedicated displays could be used in any of these locations, and may be required where TIPS (or some other suitable integrated display) is not available.

The following paragraphs present several considerations to be made in designing the ETIS display for the controller, whether or not it is integrated with other functions. The interest here is not to provide a specific design but to point out some of the

TABLE 3-3. TYPICAL MESSAGE DISPLAY FORMATS

MESSAGE TYPE	TYPICAL DISPLAY FORMAT	EXPLANATION
1. Initial Arrival ETIS	See Figure 3.3.	See Figure 3.3.
2. Departure ETIS	See Figure 3.3.	See Figure 3.3.
3. Final Approach Data	CF WND 27/6/0 R22L WND 25/5/0 RVR 48/47/49	Center Field Wind: 270° at 6 knots, zero gusts. Runway 22L: Wind 250° at 5 knots, zero gusts, RVR 4800 ft touchdown, 4700 ft mid-point, 4900 ft rollout.
4. Change-Runways in Use 5. Change-Approach in Use	DCA RWY CHNG APR LOC 31 DEP 24	Runway change at DCA: Approach in use is localizer runway 31. Departures on runway 24.
6. Change-Altimeter Setting	DCA 0652 ALT 2997	DCA at 0652 GMT: Altimeter 2997
7. Change-Visibility and/or Precipitation	DCA 1804 VSB 1.0 -S	DCA at 1804 GMT: Visibility one mile in light snow.
8. Change-Ceiling	DCA 1806 CLG 16B	DCA at 1806 GMT: Ceiling is 1600 ft broken.
9. Change-RVR	DCA 1100 RVR 22L 21/23/21	DCA at 1100 GMT: RVR runway 22L, 2100 ft touchdown, 2300 ft midpoint, 2100 ft rollout.

NOTE: Time tags may not be required.

TABLE 3-3. TYPICAL MESSAGE DISPLAY FORMATS (CONTINUED)

MESSAGE TYPE	TYPICAL DISPLAY FORMAT	EXPLANATION
10. VFR Minimums	DCA 2106 BLO VFR VSB 2.0 CLG 08	DCA at 2106 GMT: Below VFR minimums. Visibility 2.0 miles, ceiling 800 feet.
11. Airport Advisory	Varies widely - See Figure 3-3.	See Figure 3-3.
12. Wind Shear Alert	DCA 1957 ALERT: WND SHR R31R WND 27/24/0 CF WND 30/2/10 DIFF 09/22	DCA at 1957 GMT: Wind Shear Alert. Runway 31R wind 270° at 24 knots. Center field wind 300° at 2 knots, gusts to 10 knots. Vector difference is 90° at 22 knots
13. Pressure Jump Alert	DCA 0615 ALERT: PRESR JUMP ALT 2989 + .06/1 MIN	DCA at 615 GMT: Pressure Jump Alert. Altimeter setting 2989. Rise of .06 inches in one minute.
14. Temperature Drop Alert	DCA 0606 ALERT: TMP DROP TMP 51 -5/4 MIN	DCA at 606 GMT: Temp. Drop Alert: Temperature 51°. Drop of 5°F in four minutes.
15. Thunderstorm Alert	DCA 1219 ALERT: THDRSTM 2 NE/W/14	DCA at 1219 GMT: Thunderstorm alert. Storm is 2 miles NE of field, traveling west at 14 mph.

Note: Time tags may not be required.

factors which evolve from the ETIS concept and must be taken into account in the actual design.

3.6.1 Data Format

The data must be presented in a clear, easily readible form, and in such a way that the controller can quickly pick out one specific data item of interest, such as altimeter setting. While a highly compressed format, such as the standard sequence reports over Service A, may be satisfactory, more easily readable form with each data item labeled should be much more acceptable. This is particularly appropriate since the data are real time variant, and not "frozen" for long periods of time. Also, a dedicated area of the display for alerts, with appropriate audible warning, should be considered.

If TIPS is to be utilized, some changes to its display concept may be required. It currently provides no display of ETIS (or ATIS) as such, and includes only a single, 68 character line for weather, which appears in the compressed, sequence report format, and a single line for status (advisories, etc.). As a minimum, the controller should be able to request ETIS on the TIPS display with a quick action key, and receive an expanded presentation of all data with each item labeled. Alerts would appear in a designated area automatically when they occur. In this way, no expansion of the display itself is necessary, nor is elimination or reduction of any of its current capabilities, while quick, easy access to ETIS data is provided.

3.6.2 Time of Validity

For cases of non-DABS-equipped aircraft which receive initial ETIS only over the DVS, and do not receive any updates (as with ATIS), it may be necessary to provide some means for the controller to determine the validity of the ETIS data which may have been obtained by the pilot well in advance of being handed over to approach control. While a number of alternatives are possible, a straightforward method is to include GMT time with each ETIS message broadcast by the DVS. As stated in Section 3.2.11, it is not clear that a time tag is required for normal ETIS via data link.) The controller display of ETIS would then include a "validity time," which is the oldest GMT time for which the ETIS data are still valid.

This validity is the function of the changes occurring in the data, and depends on the rate and magnitude of the changes. For example, any change message (such as altimeter setting, visibility, etc.) will result in the validity time being increased to the time of the change message. Similarly, any alert or a new airport advisory etc., results in a revised validity time. Other changes in the data of a less critical nature will not immediately affect the validity time. Small fluctuations in temperature or wind, for example, will not change the validity time, while slow, gradual trends will, once a significant increment has been accumulated. The overall consideration is that the validity time remain constant as long as it provides an accurate representation of the terminal conditions.

When validity time changes, an indication of some type should be provided to the controller, including which data have changed. The controller can then provide this new data to any non-DABS-equipped aircraft under his control. In this way, there is no need to provide a complete new ETIS report to these aircraft, only the parameter that has changed, and the controller is given a specific indication as to when the change is significant enough that an update should be given.

The algorithms for controlling validity time can reside in either the LPDS processor or the ETIS software in the AP. However, in order to preserve the stand-alone feature of the LPDS, the algorithms will have to be included as a function of the LPDS processor. The validity time then also becomes a part of the ETIS data transmitted to the AP.

3.6.3 Message Delivery Status

A means must be provided to inform the controller of an unsuccessful attempt by DABS to send an ETIS message to an aircraft. Because ETIS messages are advisory in nature and are normally dispatched automatically without any controller action, there is no general requirement that he review each one prior to its being transmitted, such as is likely to be the case for ATC messages (vectors, altitude assignments, etc.) Furthermore, with no WILCO response to ETIS messages required, the controller has no pilot feedback to indicate successful delivery of messages. Thus, he has no continuous display of ETIS message delivery status for each aircraft, nor does he require such a display. But when a message fails to be delivered, for whatever reason, the controller must then be informed of the exact situation.

Some general indication to initially get the controller's attention can be used, such as a flashing data block on the radar display or special symbology added to the data block. This alerts the controller to check the ETIS display (TIPS), where it is proposed that the specific message and aircraft ID preempt a portion of the normal display. After giving the message by voice, use of the quick action keys allows the controller to return the display to its normal state.

An audible alert as a general indication to the controller of the problem may be more suitable than adding to the clutter of the radar screen. This is also preferable in the tower where the controller is not usually watching a radar display. The audible alert could be accompanied by flashing the appropriate portion of the TIPS display. Or, the alert itself could be a stored voice message such as "Check ETIS."

3.6.4 Other Controller Display Considerations

Several other controller display design considerations of a more general nature are summarized below. These apply primarily to data link services other than ETIS, but it is useful to mention them here.

1. Some type of character or symbol should be included in the data block of all aircraft that are data link equipped. Two or more characters may be required to differentiate between levels of avionics capability. Alternatively, this information could be included in tabular form in a designated area of the radar screen.

2. Messages which must be reviewed, approved, and/or actively dispatched by the controller must be displayed to him in some form, probably on the radar screen. (ETIS as currently conceived does not include messages of this type.) An indication that the message was received and properly acknowledged must also be provided, perhaps with the addition of a symbol for a fixed time period and then deletion of the message. In the event of a problem in delivering these messages, a suitable means for alerting the controller must be implemented. (See Section 3.6.3.)

3. If a pilot cannot comply with a message he has received by data link, or has some question regarding it, some type of response on his part to so indicate is required. This may simply be picking up the microphone and establishing voice contact with the controller. Or, particularly as more communications are handled by data link, an "Unable" type response (as opposed to WILCO) may be utilized over the data link under these circumstances. If this is the case, an indication of the Unable response must be given to the controller so that he may take the appropriate action. The addition of a specific symbol to the data block or to the message receiving the Unable response, and perhaps flashing of the data block or the message to quickly get the controller's attention, is one possible method of handling this situation.

4. TYPICAL ETIS SCENARIOS

The following paragraphs describe several typical scenarios involving the use of ETIS by pilots conducting IFR and VFR flights with different levels of avionics capability. While all possible combinations of circumstances and events can not be included, a representative sample should be sufficient to help in fully understanding the DABS ETIS concept.

Note that in the following scenarios, other data link services will be available and in use by these aircraft. Only the ETIS services will be described, however, as the others are beyond the scope of this study, and are not fully documented at this time.

4.1 FULL CAPABILITY AVIONICS, IFR

This example is representative of the commercial airline installation as well as the business jet and perhaps some of the larger commuter airline twins. The flight is under instrument flight rules, there are two or more crew members on board, and the data link avionics and DABS transponder include ELM capability, printer, CRT, and extensive function button/pilot input capability.

Departure is from a major airport with a co-located DABS sensor and coverage is available over the airport surface. Early in the pre-flight preparation, the DABS avionics is turned on and is acquired by the DABS sensor. A crew member presses a single function button marked "ETIS," then a send button. The following message appears on the CRT:[1]

ETIS BOS 1413

SKY 55S/85S

VSB 6

WND 18/7/0

[1] Since the aircraft is on the ground, it is understood departure ETIS is desired, and no LOC ID is necessary.

TMP 58/42

ALT 2999

DEP 27

APR 22L/22R

CLNC DELY 119.0

CAUTN BIRDS RPTD OFF R27.

The crew member notes that the message has been automatically printed, as are all messages under company policy for this particular airline. The flight receives its clearance and starts taxiing out when a data link message appears on the CRT:

BOS ALT 2998.

The crew sets in the new reading and the flight departs routinely.

The flight proceeds with no further ETIS messages until it nears its destination, where conditions are poor, and RVR is near minimums. About 40 miles out from the airport, shortly before being handed off to approach control, the following message is automatically sent to the aircraft:

ETIS MIA 1747

SKY 04B

VSB 1/2+R

WND 04/3/0

TMP 81/81

ALT 2980

APR ILS 6/RVR 20

DEP 32.

The crew reviews the ILS runway 6 approach procedures, and the flight is handed off to approach. Upon contacting approach control, the pilot indicates he has data link ETIS.

While the flight is being vectored for the approach, the following message is received:

MIA 1802

R6 RVR 19/19/18.

Because this is below minimums for the approach, the pilot is instructed by the controller to proceed to the outer marker and hold. Before reaching the outer marker, the pilot wishes to verify that the RVR is still below minimums. He presses a function button labeled "RVR" and the send button, and receives the following:

MIA 1809

R6 RVR 19/18/18.

The pilot enters the holding pattern at the outer marker and receives periodic RVR updates automatically. The conditions begin to improve and when RVR reaches minimums, the flight is cleared for the approach. After departing the holding pattern and while passing the outer marker inbound, the following message is received by the aircraft:

CF WND 08/5/0

R6 WND 07/7/0

RVR 21/21/20.

The flight makes a routine landing and taxies to the gate.

4.2 MODERATE CAPABILITY AVIONICS, IFR

This second example is representative of a well-equipped light twin, perhaps for business or small commuter airline use. The flight is IFR and the aircraft is equipped with an ELM capability DABS transponder, display integrated with the weather radar CRT, and a full alphanumeric keyboard with some dedicated function buttons.

The airport of departure is ETIS equipped but is remote from the DABS sensor so that no coverage exists at the surface.

The pilot tunes to the appropriate VHF frequency (formerly used for ATIS at this airport) and receives the following broadcast from the local VRS:

> "Springfield Municipal automated ETIS information at one four two two Greenwich. Sky: three two hundred scattered, four eight hundred broken. Visibility: four miles in light snow. Wind: two five zero degrees at one one. Temperature: four eight. Dewpoint: three seven. Altimeter: two niner niner one. Localizer two eight approach in use. Departures on runway two eight. Glide-slope runway two eight out of service. Advise you have ETIS information one four two two."

He receives his clearance, taxies out, and departs the airport on his IFR flight plan.

While still a hundred miles or so from his destination, the pilot decides to take advantage of the relatively low workload during that time and begins to plan his arrival. He requests ETIS for his destination, pressing a function button labeled "Pilot Request," a menu list of downlink request messages appears on the CRT. The pilot selects #3, which corresponds to ETIS, by pressing the #3 numeric input button, and then presses the "Send" button. The request is received on the ground, understood to be an ETIS request for the destination airport, and the appropriate arrival ETIS is transmitted to the aircraft similar to the previous example.

As the aircraft nears the terminal area and is handed off to approach control, no repeat of the ETIS will be sent to it. However, any change messages will be sent as conditions dictate after the time the initial ETIS was sent. Shortly after handoff to approach, the following message is received by the aircraft:

STL 2415

ALERT-THDRSTM

14W/E/8.

After a few minutes, another message is received by the aircraft:

STL 2418

ALERT-WND SHR

R14L WIND 20/4/0

CF WND 15/24/30

DIFF 14/21.

Prior to beginning his final approach, the following message is sent:

STL 2427

ALERT-THDRSTM

12W/E/9.

The pilot elects to continue the approach, since he estimates he will be on the ground well before the storm reaches the airport, based on the data he has received. The wind shear alert is of some concern, but he does not expect it to be a problem. As the aircraft passes the outer marker, the following message is received:

CF WND 16/20/30

R14L WND 19/8/0.

He continues the approach and makes an uneventful landing.

4.3 MINIMUM CAPABILITY AVIONICS, VFR

The final example represents the pilot flying a small single-engine aircraft with limited avionics. He is flying VFR, the DABS transponder on board has Comm-A/B/C capability and the aircraft is equipped with minimum data link avionics. The latter consists of a sixteen character solid-state display and a very limited keyset with touch-tone style alphanumerics and no function buttons.

The aircraft departs from a small, uncontrolled airport that has no ETIS, and heads for a busy general aviation field several hours away. No flight plan is filed. As the flight nears its destination, the pilot requests ETIS in the following manner: He pushes the alphanumeric keys which correspond to the letters E and T, which is the abbreviation for ETIS utilized by the avionics, following each one with the left, center, or right key to select the letter. The sequence is 3(DEF), Center, 8(TUV), and Left, a total of four keystrokes. The letters "ET" appear in the data link display. The pilot follows this by keying in the LOC ID of his destination, HPN, in a similar fashion. The sequence is 4(GHI) Center, 7(PRS), Left, 6(MNO), and Center. The final selection is the number 1, which the pilot remembers as the Code to select a full ETIS report. A total of twelve keystrokes are required, including the final "Send" button.

The complete ETIS message is sent to the aircraft and stored in the avionics. Since the display is limited to 16 characters, only a portion of the message is displayed at one time. An indicator on the display tells the pilot there is more of the message in storage which he accesses by pushing a button labeled "MSG ADV" (message advance). The message is displayed in the following sequence:

ETIS HPN 1114

(MSG ADV)

SKY 45S/850C

(MSG ADV)

VSB 3

(MSG ADV)

WND 11/09/0

(MSG ADV)

TEMP 39/27

(MSG ADV)

ALT 2986

(MSG ADV)

APR IL09R

(MSG ADV)

DEP 09R

(MSG ADV)

ICE RWYS TXWYS

(MSG ADV)

SNW BNKS R09R

(MSG ADV)

VFR AC CTC APRCH

(MSG ADV)

124.35.

Thus, the message has been presented in 12 segments, each one reviewed by the pilot prior to advancing to the next. These avionics allow the pilot to store up to ten message segments by simply pressing a "STORE" button before advancing to the next segment.

The pilot contacts approach on the frequency indicated and is sequenced into the arrival flow. About six miles out, the following message appears on the aircraft display:

HPN 1130 BLO VFR

(MSG ADV)

VSB 2.5 CLG 85.

The pilot, not instrument rated, obtains special VFR clearance from ATC and continues his visual approach. Near the outer marker of runway 09R, he receives the following message:

CF WND 11/07/0

(MSG ADV)

R09R WND 10/06/0.

The pilot continues his approach and lands at the airport.

5. BIBLIOGRAPHY

Canniff, J. and Golab, J., "Functional Utilization of DABS Data Link Discrete Address Beacon System," DOT-TSC-FAA-78-16, U.S. Department of Transportation, Research and Special Programs Administration, Transportation Systems Center, Cambridge MA, October 1978.

FAA, "U.S. National Aviation Standard for the Discrete Address Beacon System - Draft," U.S. Department of Transportation, Federal Aviation Administration, Washington DC, March 7, 1978, available upon request.

FAA, "Airman's Information Manual, Part 1, Basic Flight Information and ATC Procedures," U.S. Department of Transportation, Federal Aviation Administration, Washington DC, July 1978.

FAA, "Terminal Information Processing System (TIPS) - Engineering Requirement," FAA-ER-D-120-006, U.S. Department of Transportation, Federal Aviation Administration, Washington DC, undated

FAA, "Program Development Plan - Automated Low-Cost Weather Observation System (ALWOS)," U.S. Department of Transportation, Federal Aviation Administration, Washington DC, available upon request.

FAA, "Systems Research and Development Service Progress Report, 1978," FAA-RD-78-90, U.S. Department of Transportation, Federal Aviation Administration, Washington DC, 1978.

FAA, "Consultative Planning Conference, New Engineering and Development Initiatives - Policy and Technology Choices, Progress Report," U.S. Department of Transportation, Federal Aviation Administration, Washington DC, September 6, 1978.

FAA, "Specification for Aviation - Automated Weather Observation System (AV-AWOS) - Draft," FAA-ER-450, U.S. Department of Transportation, Federal Aviation Administration, Washington DC, December 12, 1978.

FAA, "Air Traffic Control," 7110.65A, U.S. Department of Transportation, Federal Aviation Administration, Air Traffic Service, Washington DC, January, 1978.

Goff, Craig R., "Low-Level Wind Shear Alert System (LLWSAS)," NA-78-63-LR, U.S. Department of Transportation, Federal Aviation Administration, National Aviation Facilities Experimental Center, Atlantic City NJ, October 1978.

Mandel, E., "Automation of Aviation Surface Observations Is Practical," ICAO Bulletin, Vol. 33, No. 7, pp. 31-33, July 1978.

Talink, W. R., and Lynch, R. H., "The Development of a Fixed Base Automated Weather Sensing and Display System, "AFGL-TR-78-0009, Air Force Geophysics Laboratory (LYO), Hanscom AFB, Massachusetts, December 1977.

U.S. Department of Commerce, "Federal Meteorological Handbook No. 1, Surface Observations," Second Edition, U.S. Department of Commerce, Washington DC, January 1, 1979.

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