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Function Key and Shortcut Key Use in Airway Facilities

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16. Abstract

This document provides information on the function keys and shortcut keys used by systems in the Federal Aviation Administration Airway Facilities (AF) work environment. It includes a catalog of the function keys and shortcut keys used by each system and the associated functionality. Researchers collected these data through analysis of software specifications, computer-based instruction manuals, and field site visits. They extracted human factor guidelines relevant to function key and shortcut key use from human factors guidelines and the research literature. Researchers also collected information on function key and shortcut key use by commercial applications to extract what amounts to de facto industry standards for function key and shortcut key use. The researchers compared current function key and shortcut key use across systems in the AF operational environment. They also compared current AF use of function keys and shortcut keys against human factors guidelines and de facto industry standards. Based on this evaluation, the researchers found little consistency in the assignment of functions to function keys and shortcut keys among different AF systems. The researchers make recommendations toward improving consistency and usability of function keys and shortcut keys in the AF environment.

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Executive Summary

This study is part of a line of research evaluating computer human interfaces in the Airway Facilities (AF) domain (Ahlstrom & Muldoon, 2002). As part of a larger effort, this study supports the evolution toward standardized interfaces in the AF environment. This document focuses on the use of function keys and shortcut keys in AF systems and equipment.

Function keys and shortcut keys are often used as a redundant means of performing functions that are represented in menus or graphically. For example, 'Help' can be found as a pull-down menu option in many software programs; those same systems will sometimes use the 'F1' key as redundant (and presumably faster) means to access the same 'Help' options. Consistent with the name shortcut, the shortcut keys (and function keys) provide a more direct means of activating system commands or attributes usually as an alternative to time consuming navigation through a menu. An example is using shortcut Ctrl + C to copy an item instead of using the pointing device to navigate to the Edit menu bar option then moving down to the Copy option and selecting Copy. The use of specially designated keys to enable system commands/attributes can occur in conjunction with other interaction styles, such as command line interaction or graphical user interface interaction. The meanings of most function keys and shortcut keys are not presented visually and thus rely on the user to learn and recall their meaning. As AF specialists work on multiple, different systems, if these systems are not standardized, the number of unique keys that must be learned and recalled can quickly become unmanageable.

Much of the software with which the AF specialists currently interact was designed independently without consideration of other software that is currently in use in that environment. The result can be a lack of consistency in how the specialists must interact with different systems.

A research team from the William J. Hughes Technical Center Research Development and Human Factors Lab examined computer-based instruction manuals and visited 12 AF field sites to determine how AF specialists currently use function keys and shortcut keys in AF systems. They cataloged the function keys used by AF systems currently in the field.

The research team also examined the functions assigned to dedicated function keys on specialized keyboards used for AF systems. They identified functions that were in common with non-dedicated function keys and shortcut keys used for other systems.

By adhering to good human factors practices and standardizing some common functions across systems, it will be possible to increase efficiency and decrease errors in interacting with AF systems. The catalog of function keys and shortcut keys contained in this document highlights the inconsistency in the assignment of meanings across AF systems. The analysis of commonalities in functions across the systems allows future programs to take an integrated approach to developing future systems. By taking an integrated approach and standardizing common functions across systems as suggested in this document, it is possible to reduce user confusion and the potential for human errors, reduce costs of human factors studies for individual programs by providing standards, reduce the need for training by making the systems more usable and building on existing knowledge, and reduce development and deployment time for new systems.

1. Introduction

This study is part of a series examining interaction with computer systems in Airway Facilities (AF). The systems with which AF specialists interact change over time as the National Airspace System (NAS) modernizes. Modernization of the NAS introduces new systems to the AF environment and updates existing systems. Designers have developed many systems that currently exist in isolation of one another, leading to inconsistencies between how specialists interact with the different systems in the same environment. This series of studies takes an integrated approach looking not at a single system, but at all of the systems and providing information on how to improve and standardize the interaction with these systems. By providing information on how to improve existing interfaces, designers can insert good human factors into this modernization process.

1.1 Background

1.1.1 Airway Facilities Roles and Responsibilities

AF is the portion of the Federal Aviation Administration (FAA) that is responsible for maintaining, monitoring, and controlling the systems and equipment necessary for airplanes to safely and efficiently get from one location to another. AF is not a homogenous entity, but rather is organized into different domains, each with unique responsibilities. Because of their unique responsibilities, each domain has a unique configuration of systems and equipment.

At the highest level of the AF hierarchy are the three Operations Control Centers (OCCs). They coordinate and prioritize infrastructure management actions within a domain, serve as point of contact for trouble reports, and remotely manage NAS infrastructure services/systems. Systems at the OCC include Event Manager (EM), Maintenance Automation Software System (MASS), Interim Monitor and Control Software (IMCS), and the Weather and Radar Processor (WARP) or some other weather presentation system. In addition, there is software that will permit rapid dialing to other facilities, and technicians and software that will log and list events. Together, these systems combine to permit logging and communication of event information.

AF personnel at a Terminal Radar Approach Control (TRACON) facility are responsible for all the equipment necessary to monitor and control all airport related systems, from runway landing light operation and Windshear warning systems to Instrument Landing System (ILS) equipment and terminal radar systems. AF specialists and technicians at TRACON facilities interact with the same systems available at the OCC plus up to 10 other systems that are terminal related.

AF personnel at an Air Route Traffic Control Center (ARTCC) are responsible for all the equipment that handles aircraft while en route between airports. Personnel at these facilities use EM, MASS, IMCS, and WARP in a similar manner to communicate and log events as AF personnel at OCCs and TRACONs. However, whereas TRACON specialists will interact with up to 14 systems on a daily basis, AF specialists at an ARTCC will monitor and control up to a total of 25 total systems (including several of the same systems as at the TRACON).

1.1.2 Function Keys and Shortcut Keys

Users can interact with AF systems in many ways. Direct manipulation of visual symbols or icons, command line interaction, menus, form filling, or special command keys are all different ways of interacting with AF computer systems. The use of specially designated keys such as function keys or key combinations called shortcut keys to enable system commands can occur in conjunction with other interaction styles, such as command line interaction or menu interaction.

Just as their name implies, function keys are keys that are assigned a given function. There are two types of function keys. **Dedicated function keys**, (i.e., Home, End, and Delete), have their names on the keycap to convey their functions. **Non-dedicated function keys** (also known as F keys) are keys generally located across the top of the keyboard. They are assigned a number preceded by the capital letter F (e.g., F1, F2, F3). Both dedicated and non-dedicated function keys serve as keyboard shortcuts by combining, in one key, the actions of a sequence of several individual keys, keystrokes, or commands. Function keys allow users to quickly and accurately access frequently used commands. This report focuses partially on the non-dedicated function keys, whose functions are usually definable by the user.

The use of function keys is often extended through the use of modifier keys. Common modifier keys (Shift, Ctrl, and Alt), when used simultaneously with an 'F' key, provide the user more options.

Shortcut keys are a combination of a modifier key such as Ctrl, Shift, or Alt and another key from the keyboard. AF specialists use these keys together to perform basic application functions or actions with a minimal number of key presses and without necessitating the use of a pointing device. They often use shortcut keys as alternatives to actions available from a menu. Experienced users often use these shortcut key combinations as a way to accomplish tasks more quickly and accurately than alternative means.

1.1.3 General Pros and Cons of Function Keys and Shortcut Keys

Function and shortcut keys provide a redundant means of performing functions that menus represented. They can reduce user effort by minimizing the transitions needed between keyboard and mouse. They can provide quicker access to commands that are sometimes buried in submenus by eliminating the need to navigate through the menu structure to access the command. One (function key) or two (shortcut key) keystrokes can access commands/attributes that may take several mouse clicks. By providing an alternative to the use of a pointing device, shortcut keys and function keys also provide a means of access to commands and attributes even if the mouse becomes unavailable or if users have difficulty using the mouse (i.e., due to repetitive stress injuries).

One problem with using this type of keyboard interaction, however, is that function keys and shortcut keys require the user to remember what key presses are used for which actions. Therefore, the user must learn and remember what the keystrokes are and how to use them. This can be a greater problem for function keys than shortcut keys as the combination of keystrokes used for shortcuts usually has at least one letter that gives a hint as to what the function is (e.g., Ctrl + C for the function Copy). Because they must be learned, experienced operators use function keys and shortcut keys more often by of the system (Ahlstrom & Longo, 2001).

1.1.4 AF-Specific Concerns

There are currently more than 25 different systems monitored and controlled by AF specialists across different domains. Most of the software with which the AF specialists currently interact has been designed independently without consideration of other software that is currently in use in AF environments. Some software packages have been specifically designed for the FAA by

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acquisition contracts or are Commercial-Off-the-Shelf (COTS)[1] software that has been customized for FAA use. The result can be a lack of consistency in how the specialists must interact with different systems. Adding to the problem is that some of the systems date before consideration of human factors was common in the design of software.

With the standard 12 non-dedicated function keys, 22 dedicated function keys, 47 different character keys, and 3 modifiers (Shift, Ctrl, and Alt) on most standard keyboards, there are more than 486 potential function and shortcut key combinations. The combination of unique meanings that must be remembered by the specialists for 25 systems quickly reaches unmanageable proportions. As the meanings of most function keys and shortcut keys are not presented visually, the users must learn and memorize the meanings of these keys. Having too many unique items to remember can tax user memory. This increases potential for interference between items because of the similarity between items remembered, potentially resulting in errors (Reason, 1990; Wickens, 1984). In other words, if the user learns that F1 is used to access the Help function in System A, and F1 is used to access the Print function with System B, the user has to learn the different meanings for the function keys in these two systems. Subsequently, when the user is interacting with System B and trying to remember the meaning for F1, the meaning of F1 for System A may interfere, and the user may think that he will activate the Help function when he presses F1 rather than the Print function. In a previous study of human error in the AF environment (Ahlstrom & Hartman, 2001), 6% of the errors committed by AF personnel that were severe enough to lead to an outage were attributable to keyboard and data entry errors such as these. According to Reason, this type of error is a result of a latent failure of the overall design process.

Most commercial software is designed for office environments, where a single user interacts with a program or suite of programs located on a single computer system. The AF environment is unique in that the specialists interact with multiple different programs, often located on different systems in order to complete a single task. The multiplicity of different systems causes unique problems for the users, particularly in the area of standardization. The purpose of function keys is to allow the user quick and easy access to frequently used commands. As the frequently used commands are often different for different applications, F keys allow the user to define the function assigned to the shortcut keys. Although this works well if a user is interacting with only one system, this can be problematic for users who have to interact with multiple different systems. A delicate balance must be reached between the flexibility of allowing user-defined function keys and shortcut keys (consistent with the original intent of providing quick access to frequently used commands) and the need for consistency across systems to minimize confusion and likelihood of errors.

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[1]Commercial-Off-the-Shelf (COTS) is a term widely used in the government for systems and programs that are not developed by the government, but rather are a pre-developed product that the government purchases. These products are generally modified to some extent to meet the needs of the program.

This study is part of a line of research on computer human interfaces in the AF domain (Ahlstrom & Muldoon, 2002). As part of a larger effort, this study supports the evolution toward standardized interfaces in the AF environment. Standardization of interfaces can reduce confusion and the potential for human errors, reduce task performance time, reduce costs, reduce the need for training, and reduce development and deployment time (Ahlstrom & Longo, 2001; CTA, Inc., 1996; Department of Defense, 1995; 1999; FAA, 1996; Galitz, 1993; Teitelbaum & Granda, 1983).

2. Method

2.1 Site Visits

Within AF, there are several different working environments, including Systems Operation Centers (SOCs) at en route and terminal facilities and OCCs. Facilities across the regions vary to some extent in the systems that are present in the facility. We can classify no single AF site as "typical." Thus, in order to maximize the applicability of the results by capturing some of the diversity in AF environments, we have targeted sites from six of the nine regions. To minimize the time needed for data collection at each site visit, researchers used computer-based instruction manuals and available software documentation to gather information on command conventions and command interaction for each system prior to conducting the site visits. The researchers verified and expanded upon this information at the site visits.

Researchers targeted 12 sites for their location and diversity and for their ability to visit more than one type of facility per location (i.e., SOC and an OCC in one city). These sites are: Chicago TRACON and ARTCC; Seattle TRACON and ARTCC; Atlanta OCC, TRACON, and ARTCC; Dallas Fort Worth TRACON and ARTCC; and San Diego TRACON, ARTCC, and OCC. Visits to these sites were contingent on the time and staffing constraints inherent to any busy operation and on approval by union and management.

2.2 Procedure

At each site, the researchers met the points of contact (POCs) and thanked them for their time. They then explained the purpose of the study.

The POCs and others available and interested in participating in this study received a brief, written description explaining its purpose and containing project contact information. Other pertinent coordination information was available upon request, including the names of management and union personnel with whom they coordinated prior to the study. The research team distributed a written statement of confidentiality and asked study participants to sign it. They assured the participants that they would keep any responses to questions confidential and only participant number would identify data.

2.2.1 Observation

At each site, the research team spent time observing interaction with each system. They observed the systems that were in use and whether the primary method of interaction was through command line interaction, function keys or shortcut keys, or a graphical user interface. They also observed whether the users appeared to have difficulty in remembering the correct commands, whether they needed to consult on-line help or a reference manual, or had to enter commands more than one time. For any system that had non-standard keyboards, the research team took digital photographs or sketched the unique keyboards.

2.2.2 Structured Interviews

At the site, the research team sought verification for information obtained from FAA computer-based instruction manuals and software documentation for these systems. They then paired with an individual and went through a system in detail. Which system the specialist felt most knowledgeable about and comfortable discussing determined the system discussed. Finally, the research team documented the participant concerns and problems with the current systems and any suggestions they had for improvements. This final step can highlight potential problems that someone might otherwise miss.

2.3 Data Collection and Analysis

Following the site visits, the research team identified commonalities in functions across systems. Using information from the Human Factors Design Guide (Ahlstrom & Longo, 2001; FAA, 1996) and other sources, the research team evaluated the current use of function keys and shortcut keys against human factors recommendations. They also surveyed commonly available commercial software to identify the use of function keys and shortcut keys in commercial products. They then compared the assignment of functions and commands to AF shortcut keys and function keys against common commercial products.

3. Results

Based on observation and information provided by the users at the field sites visited, Table 1 lists the primary and secondary means of system interaction.

3.1 Function Keys

Function keys are programmable in many commercial application programs. Although there is no published standard restricting function keys to a particular meaning, over time, particular meanings have become associated with certain function keys. As more and more people grow increasingly familiar with the programs on their home computers, users begin to associate particular meanings to specific function keys. It is important to keep these meanings in mind when examining function key use for AF systems. Research has shown that the integration of sensory and motor codes such as those used to activate function keys on a keyboard increases the users ability to retain them in memory (Stein & Garland, 1993). The impact of this finding is that if the AF specialists are accustomed to reaching for a particular function key on their home computer to activate a particular function, it is likely that this relationship will transfer to the systems at their work environment. If the systems at their work environment violate these relationships, the likelihood of error increases.

Table 2 summarizes the use of function keys in commercial personal computer (PC) applications. The researchers compiled these data by conducting an informal survey of software programs and by consulting with system experts and computer system documentation. For most PC software, the function key, F1, generally initiates help menus. Specialists often use F5 as a Refresh, Go To, or Restore function and F7 for Spell Checking. They often use F10 to access a menu bar and F12 as a Save function. Unix systems do not use predefined function keys. Macintosh keyboards have 15 function keys, none of which is predefined. On PC keyboards, the three rightmost keys (correlated to the Macintosh function keys 13-15) in the same row as the function keys provide the functions PrtScn/SysRq, ScrLk or Scroll Lock, and Pause Break (Apple Computer, Inc, 1996).

Table 1. Means of Interacting With Systems at AF Operational Sites

System	Primary Access	Secondary Access
Automated Radar Terminal System (ARTS)	Pull down menus with mouse	Command line
Codex	Unique three button mouse, Icons	Dedicated Function keys from unique keyboard
Center TRACON Automation System (CTAS) Traffic Management Advisory (TMA)	Pull down menus with mouse	Keyboard
Data Acquisition Subsystem Real-time Status Display (DAS/RSD)	Point and Click with Mouse	Keyboard
Direct Access Radar Channel (DARC)	Pull down menus with mouse	Command line
Display System Replacement (DSR)	Point and click with Trackball, three button options and dedicated function keys from unique keyboard	
Digital Voice Recording System (DVRS)	Pull down menus with mouse	
Enhanced Traffic Management System (ETMS)	Pull down menus with mouse	Command line
Event Manager (EM)	Mouse clicks and standard keyboard entries.	
Host	Command line	
Host Interface Device (HID) National Airspace System (NAS) Local Area Network (LAN)	Pull down menus with mouse	
Host and Oceanic Computer System Replacement (HOCSR)	Pull down menus with mouse	
Interim Monitor and Control Software (IMCS)	Command lines and mouse click on pictograph Icons used in conjunction	Function keys and Function keys with Shift as a modifier
Low Density Radio Communications Link (LDRCL)	Mouse point and click	
Maintenance Automation Software System (MASS)	Pull down menus with mouse in conjunction with scrollable lists with mouse	Provides mnemonics, but never saw them used
Mode-S	Pull down menus and clickable text Icons with mouse	
Oceanic Display and Planning System (ODAPS)		
Random Access Plan Position Indicator (RAPPI)	Equal use of mouse and menus and Keyboard dedicated number keys	
Radio Communications Link (RCL)	Command line with 8 mouse clickable options	Function Keys for the same 8 options
Rapid Deployment Voice Switch (RDVS)	Pull down menus with mouse	
Standard Terminal Automation Replacement System (STARS)	Point and click on Text Icons with Mouse	
Very High Frequency Omnidirectional Range/Tactical Air Co-located (VORTAC)	Command line	
Voice Switching and Control System Maintenance Position Equipment Subsystem (VSCS [MPES])	Mouse clicks from pull down menu bar	
VSCS Training and Backup System (VTABS)	Pull down menus with mouse	
Weather and Radar Processor (WARP)		Pull down menus with mouse

Table 2. Function Key Use in Commercial Personal Computer Software Applications

Action	Function Key
Help	F1
Refresh, Go to, or Restore	F5
Spell check	F7
Menu Bar access	F10
Save	F12
Exit program	Alt +F4
Close	Ctrl + F4

Surprisingly, in many of the AF systems, the function keys have no function at all. Out of 25 systems examined, 14 use function keys to access system commands. Table 3 presents the AF systems examined. Appendix A presents a catalog of the function keys used by each system.

Table 3. AF Systems Examined at Site Visits

System	Facility Type
ARTS	TRACON
Codex	ARTCC
CTAS TMA	(Future) ARTCC, TRACON
DARC	ARTCC
DAS/RSD	ARTCC
DSR	ARTCC
DVRS	ARTCC
EM	ARTCC, OCC, TRACON
ETMS	TMU, TRACON
HNL	ARTCC
HOCSR	ARTCC
Host	ARTCC
IMCS	ARTCC, OCC, TRACON
LDRCL	ARTCC, TRACON
LLWAS	TRACON
MASS	ARTCC, OCC, TRACON
ODAPS	ARTCC
RAPPI	ARTCC
RCL	ARTCC
RDVS	TRACON
STARS	(Future) TRACON
VORTAC	ARTCC
VSCS[MPES]	ARTCC
VTABS	ARTCC
WARP	ARTCC, OCC, TRACON

Although many of the actions assigned to function keys were unique to the individual systems, the researchers identified some commonalities across systems. Table 4 summarizes these commonalities.

Table 4. Common Function Key Usage in AF Systems

Action	Function Ke	System
Help	F1	ETMS, RAPPI, RDVS
	F2	IMCS, MMS
	F8	RCL
	F9	DAS/RSD
	F16	VSCS[MPES]
Refresh	F1	DAS/RSD
Go to	F1	IMCS, MMS
	F7	DAS/RSD
Menu bar access	F3	IMCS, MMS
	F10	MASS, RDVS
Save	F2	RCL
	F6	DAS/RSD
	F15	MMS
Print	F9	Codex
	F10	ARTS, RDVS
View logs; Reports; Status	F3	RCL
	F6	DARC
	F10	MMS
	F15	IMCS
Alarm acknowledge	F2	RDVS
	F5	IMCS, MMS, RCL
Log off	F6	IMCS
	F12	MASS

The researchers compared the functions assigned to the function keys for AF systems against the conventions identified in Table 2. Three of the systems use the F1 key for access to help screens. Other systems use F2, F8, F9, and F16 to access help.

The main tenet for assigning functions to the function keys is to try to maintain consistency across systems. One method is to try to follow conventions that are present in commercial software applications. There are several reasons for taking this approach. If AF systems follow commercial conventions/personal use, future procurements of COTS software are more likely to be consistent with the AF systems in that environment. Following commercial conventions is also important in that many users become familiar with certain conventions through interactions with their home computers or if they use computers for general office work.

The question then becomes which function to assign to which key in an effort to provide consistency between applications. As the Help function is assigned to the F1 key in commercial applications and is assigned to the F1 key in several AF applications, we recommend that the F1 key always be reserved for the help function.

Although function keys are assigned to spell check and refresh functions in many commercial applications, none of the AF systems use the function keys for a Spell Check function and only one system used the function keys for a refresh function. Commercial applications use F10 for Menu Bar access and F12 for Save. In AF applications, Menu Bar access is currently either F3 or F10, and the Save function is F6, F2, or F15, depending on the system. We recommend using the commercial conventions when practical when a system has a similar function that is worthy of making accessible through a function key. For example, when a system has the Menu Bar function assigned to the function keys, it could be assigned to F10. Therefore, if a system has the Save function, but it is not used frequently, it most likely does not need to be assigned to any function key (See Table 5, first item). Table 5 provides human factors information related to function keys (Ahlstrom & Longo, 2001).

Table 5. Human Factor Guidelines for Function Keys

1. When the same function is used in related applications, it shall be assigned to the same in all applications.
2. Function keys should be used for frequently performed tasks requiring only a limited number of control entries or for use in conjunction with other dialogue types as a ready means of accomplishing critical entries that must be made quickly without syntax error.
3. When the same function is used in different operational modes within an application, it shall be assigned the same key for all modes. For example, if F1 is assigned to help in the normal operating mode, it should be assigned to help in the emergency operating mode.
4. A function key shall perform its function with a single press of the function key.
5. Function keys that have potentially disruptive consequences shall be safeguarded. Safeguarding may take the form of physical protection, software disabling, interlocks or multiple key combinations. Any control entry, whether through function key, shortcut key or other means, that results in potentially disruptive actions such as loss of data, shall inform the user of the consequences of the action and require confirmation before implementing the action.

Other functions are not present in commercial systems but are common across some AF systems, possibly warranting an assigned function key or shortcut key combination. These functions that are assigned to AF function keys are not standardized across AF systems. Examples include Alarm Acknowledge, Print or Produce Report, and Log Off. There are two principles for assigning the function to one key over another for these cases: 1) consistency across systems and 2) frequency of use. In the case of the F5 key, which is sometimes used for the Go To function in commercial applications and frequently used for Alarm Acknowledge in AF systems, users should be involved in deciding whether to assign F5 the Go To function or the Alarm Acknowledge function.

The first thing that is noticeable about function key use across AF systems is that there is no consistency to the way the functions are assigned to the keys within or between systems. This violates human factors guideline number one from Table 5. Because of a lack of consistency, the specialist must think about the system with which he or she is interacting before using the function keys, with the prospect of decreased efficiency or the introduction of errors. With so many different function keys to learn and so little overlap, it is easy for the specialist to make an incorrect decision as to what the function key means for a particular system and press the wrong key.

The purpose of function keys is to provide quick, accurate access to frequently used commands (see item two, Table 5). Not all of the AF systems have the same functions assigned to function keys as those in commercial applications because the AF systems have unique functions. However, there is some commonality with commercial systems. Of the systems that do have one or more functions in common with commercial software or systems, very few of the functions assigned were consistent with commercial conventions or with other AF systems.

For the AF systems on which we collected data, we did not note any case where specialists used the same function in modes of operation that were assigned to different keys. Additionally, we did not note any case where the function key did not perform its function with a single press of this function key.

It is important to adequately safeguard function keys with potentially disruptive consequences. We noted the assignment of the Log Off function to a function key for some systems. Accidental activation of this function could have potentially disruptive consequences (see item five, Table 5). We recommend that a safeguard be associated with this function. Some possibilities are the presence of a pop-up dialog asking the user to confirm the action before initiating it or relegating the Log Off function to a multiple key combination.

3.1.1 Function Keys Used Together With Modifier Keys

Not all AF systems that use function keys use them together with modifier keys. The systems that do are ARTS, VSCS, Mode-S, RAPPI, RDVS, Codex, and MASS. There is no consistency between the uses of function keys together with modifier keys across AF systems. Table 6 shows examples of the relationships between the use of the function keys and the function keys plus the modifier keys. For all of the function keys used together with modifier keys, see Appendix B.

Table 6. Function Keys Used Together With Modifier Keys

F Key	Meaning	F Key + Shift Meaning	F Key + Alt Meaning	F Key + Ctrl Meaning
F1	Help (ARTS, RAPPI) Default VSCS (VSCS)	Additional information for a particular screen or utility (ARTS) Default CSS startup (VSCS)	BOMARC Beacon (RAPPI)	N/A
F2	Custom VSCS (VSCS) IOP Select (RAPPI)	Custom CSS (VSCS)	Beacon Mode 2 Radars (RAPPI)	Channel A (Mode-S)
F3	Halt VSCS (VSCS) Status (RAPPI)	Shutdown CSS (VSCS)	Strobe sites (RAPPI)	Channel B (Mode-S)
F4	Alter default on-line database (VSCS) Display Search Information (RAPPI) Fault isolation (RDVS) IMCS Menu (MASS)	Rebuild online database (VSCS)	File close (MASS)	ATCBI Channel A (Mode S) Fault description (RDVS)

There are very few commercial conventions for shortcut keys across systems. One exception is that AF specialists often use the function key, F4, together with the Alt key to activate the Close command, and they often use F4 together with the Ctrl key to activate the Exit command. MASS reflects this convention in the use of F4.

We recommend that when two or more sets of functions are assigned to a single function key (e.g., when a secondary function is accessed by simultaneously pressing a function key and another key), the logical relationship from one set of functions to another should be clear and consistent (Ahlstrom & Longo, 2001). For example, if the function key, F5, is used as a means of acknowledging a single alarm, Ctrl + F5 might be used to acknowledge all alarms. As is seen in Table 6, there is often no clear relationship between the meaning assigned to a function key and the meaning assigned to the same function key together with a modifier key. For example, RAPPI has F1 assigned to the Help function and Alt + F1 assigned to BOMARC Beacon. By having a logical relationship between the function key and the function key used together with the modifier, the user is able to use categorical information to help reduce the memory load.

3.2 Unique Keyboards

Some of the AF systems did not use standardized keyboards. Instead of assigning function keys to the F1- F12 keys located across the top of a keyboard, these systems often have functions assigned to dedicated keys on the keyboard. The systems with specialized keyboards are Codex, DSR, Host (KVDT), and RCL. Appendix C provides diagrams of these keyboards with the specialized keys labeled.

3.2.1 Dedicated Function Keys

A standard keyboard has at least 21 dedicated function keys. Table 7 lists these keys along with their associated functions. The average PC user rarely uses some of these keys and may not even be sure what the key does, whereas, others may be used on a regular basis. Although there is anecdotal evidence indicating which of these keys are highly familiar and used frequently, empirical data on familiarity and frequency of use are decidedly lacking.

Appendix C contains the dedicated function keys and the unique AF keyboards, along with the associated meanings, where known. The AF specialists did not know the meanings for some of the dedicated function keys. From their reports, these options were of little importance and rarely used. Importance and frequency of use are the underlying justification for a keyboard having dedicated function keys. Functions that have low importance or that specialists use infrequently should not require a dedicated designation on the keyboard.

The advantage to having dedicated function keys is that they provide quick access to commands. The disadvantage is that it can be contrary to the motor memory that users may have developed over an extended period using other systems and PCs. This same type of motor memory is how touch typists learn where the keys are located. Their fingers "automatically" go to the correct key without having to look at where the letter is or devoting much conscious effort to finding the key. Another disadvantage of such specialized keyboards is that the cost of purchasing and replacing unique keyboards tends to be significantly higher than for standard QWERTY keyboards. Additionally, there is often a wait involved in obtaining unique keyboards or replacement parts for unique keyboards, as supplies for unique items are not as readily available as standard items.

Table 7. Dedicated Function Keys on Standard QWERTY Keyboards

Label On Key	Function Performed
Esc	Terminate a function in progress
PrtScn/SysRq	Capture and print a screen image
Pause/Break	Pause or stop the memory dump to the screen
Navigation keys	Can often be modified by using one of the modifier keys in conjunction with the navigation key
Home	Move scroll boxes to the top of the vertical and left end of the horizontal scroll bar without changing location of insertion point
End	Opposite effect of home, move scroll bars to bottom and far right.
PageUp	Move up one page or screen
PageDown	Move down one page or screen
Tab	Move cursor to next field
Left Arrow	Move left one unit
Right Arrow	Move right one unit
Up Arrow	Move up one unit
Down Arrow	Move down one unit
Editing keys	
Backspace	Remove selected text or removes character to the left of insertion point
Delete	Remove the character following the insertion point or removes selected text
Modifier keys	
Shift	Causes simultaneously presses alphabetic character to appear in uppercase or produces character on upper half of key; as a modifier key together with mouse extends selection; together with function or shortcut keys, can alter resultant action
Ctrl	Together with mouse –allows non contiguous selection of items, used together with alphanumeric keys to create shortcuts for commands, used with navigation keys to increase the amount of cursor movement
Alt	Use to enact a mnemonic used together with an alphanumeric key
Toggle keys	
Num Lock	Toggle between numbers and directional arrows –allows arrows on numeric keypad to yield numbers rather than direction
Caps Lock	Toggles on/off. When on, changes typed alphabetic characters to uppercase
Insert	Toggles between insert (new characters are inserted pushing other characters to the right) and overtype (new characters replace old characters)
ScrLk	Scroll lock- allows scrolling through data using navigation keys without moving insertion point

If systems with unique keyboards such as Codex and RCL were converted to standard QWERTY keyboards in the future (as systems are replaced by newer systems), some of the functions that are now assigned to dedicated function keys could be reassigned to function keys or shortcut key combinations. This is because the specialists appear to underutilize the function keys on these systems. This would be more difficult to accomplish for the DSR system, which has over 23 unique dedicated function keys with very little overlap in functionality with other systems. This is probably because the DSR keyboard is mainly designed for Air Traffic Control functions rather than monitor and control or maintenance functions.

3.3 Shortcut Keys

Shortcut keys are a way for users to quickly and efficiently interact with a computer system. As with function keys, there are shortcut keys that have become associated with particular meanings in commercial applications. The benefit of providing shortcut keys is that they permit the user to

perform frequently accessed functions in a shorter time than it would take to accomplish the same function by going through the menu structure. Table 8 for PCs and Table 9 for Unix systems summarize these key combinations.

It is clear when comparing Table 8 and Table 9, that there is little consistency between Unix and PC-based systems on the assignment of functions to the shortcut keys. Furthermore, Table 10 shows that AF systems are not consistent in their assignment of functions to shortcut keys among AF systems or between AF systems and commercial applications. As more people have PC systems than Unix systems for home use and are therefore more likely to be familiar with conventions used by PC systems, we placed a greater emphasis on PC systems when considering recommendations.

Table 8. Shortcut Key Use in Commercial Applications for PCs

Shortcut Key	Function
Ctrl + A	Select All
Ctrl + C	Copy
Ctrl + F	Find
Ctrl + G	Go to
Ctrl + N	New
Ctrl + O	Open
Ctrl + P	Print
Ctrl + S	Save
Ctrl + V	Paste
Ctrl + X	Cut
Ctrl + Z	Undo
Shift + Ctrl +Z	Redo

Table 9. Shortcut Keys Used in Unix Systems

Shortcut Key	Function
Ctrl + C	Interrupt processes
Ctrl + O	Flush/Discard Output
Ctrl + Q	Resume
Ctrl + S	Stop
Ctrl + D	End of file
Ctrl + W	Word Erase
Ctrl + Z	Suspend Current Process/Program
Ctrl + \	Quit

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Table 10. Shortcut Keys for AF Systems

Shortcut Key	Function (system)
Ctrl + A	Choose object by Attributes (HNL); Make manual input to system (DARC); Find an object Attribute (CTAS TMA); Return to the beginning of a line (ARTS)
Ctrl + F	Move cursor forward one character (ARTS); Find (CTAS)
Ctrl + H	Highlight (CTAS; HNL)
Ctrl + N	Next (ARTS); Choose object by Name (HNL)
Ctrl + P	Previous (ARTS); Print window (CTAS TMA)
Ctrl + S	Save As (CTAS TMA)

Nine of the 25 AF systems evaluated (36%) used shortcut keys. Among these systems, there was little consistency in the assignment of shortcut keys. For example, the shortcut key combination Ctrl + A was assigned four different meanings by four different systems (see Table 10). DAS/RSD did not use modifier keys for keyboard shortcuts, rather incorporating single or two letter combinations to access different data screens and access appropriate systems. DAS/RSD, DSR (with more than 40 dedicated keys on a unique keyboard), and RAPPI (incorporating single number key hits) provided the only real divergence in the method for shortcuts among the systems using them. DAS/RSD makes use of a lengthy list of single and double letter key combinations to access different screens and subsystem information (See Appendix D). As a stand-alone system, this approach may be worthwhile, but, in a multiple-system environment, where this approach is inconsistent with other systems, this method could increase the potential for error.

The DAS/RSD shortcuts were unusual in that they were alphanumeric characters used to enable commands without the use of a modifier key. Users said interacting with the system this way was done so infrequently that the user must look up the code in the system manual before using it. This can increase the time necessary to deal with a problem and increase stress for the system user. RAPPI makes similar use of the number keys on the QWERTY keyboard. A single key press here will enact a command or change screen information. Where possible, users should avoid unique shortcuts such as these.

The meanings assigned to shortcut keys should be consistent among systems and within systems (Ahlstrom & Longo, 2001). This is particularly important in the AF environment where specialists interact with multiple systems. A specialist who often uses the shortcut Ctrl + A for one system may mistakenly use the same shortcut combination on another system, particularly if under time pressure or high workload. This might have unintended results. Standardizing the meanings of the shortcut keys not only would decrease the learning curve, but it would allow safer and more efficient system interactions.

Because shortcut keys can be beneficial to experienced users, we recommend that methods such as the use of shortcut keys (also known as hot keys) should be provided where feasible to allow experienced users to bypass the menu structure for frequently accessed options (Ahlstrom & Longo, 2001).

Where users are familiar with the shortcut keys used by commercial applications, we recommend retaining the meaning used by the commercial applications, where possible. For example, many experienced computer users are familiar with the shortcut combination of Ctrl + C to copy an item. In general, AF systems did not use the shortcut key combinations that are most commonly associated with shortcut keys used in PC systems for the same meanings (see Tables 8 and 10), with the exception of CTAS TMA. However, many AF systems have the same options as commercial applications in their system menus without the shortcut keys to access these functions.

If AF specialists do not use these functions frequently in the AF systems, there may be no reason to provide shortcut keys as a means of accessing these functions. However, eight AF systems have the Print function in their menu system, four systems have the Save function, two systems have the Copy function, and so on. If these functions are commonly used by either providing shortcut keys or assigning these functions to function keys (as is done with some AF systems), more experienced users have a quicker means of accessing the frequently used functions. If possible, the combination of keystrokes associated with familiar meanings should be reserved to have the same meaning in AF systems shortcut keys, such as Ctrl + C to copy an item.

Shortcut key combinations are often used redundantly with mnemonics (Ahlstrom & Muldoon, in press). In these cases, it is recommended that the shortcut key combination use the same letter as the letter used for the mnemonic, unless that shortcut key combination is already used or has a very familiar alternate meaning (Ahlstrom & Longo, 2001). For example, CTAS TMA uses the shortcut key combination Ctrl + F and the mnemonic (underlined letter) 'F' for the menu item, Find. AF specialists can activate the Find option through either method. When shortcut key combinations are used as a means of activating a menu item, the shortcut key combination should appear right justified on the same line as the option in the menu, separated by enough space to appear visually distinct (Ahlstrom & Longo) (See Figure 1).

File

New…   Ctrl+N
Open…   Ctrl+O
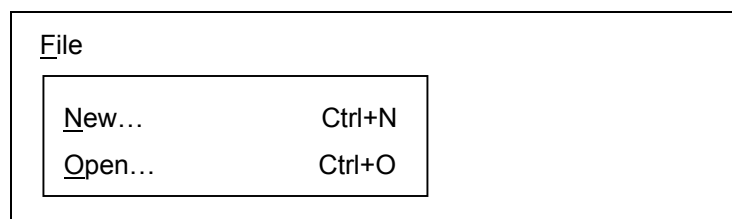
Figure 1. Shortcut key combinations indicated in a menu.

3.3.1 Observations and Structured Interviews

In the visits to field sites, the research team found that AF personnel did not use function keys and shortcut keys very frequently. Of the 30 plus personnel who discussed various systems, none used the keyboard to enter commands except for limited keyboard entries with the RAPPI. Most personnel did not even know that keyboard entries could be made with particular systems in order to accomplish tasks and had to use training or software manuals to lookup the meaning of the shortcut keys and function keys when asked.

With a few exceptions, memory aids such as keyboard overlays were absent, and thus, the specialists who did use function keys and shortcut keys had to memorize the meanings of the keys. Norman (1988) recommends reducing memory load as a means of preventing errors. One means of reducing memory load for function keys is using labeled key overlays indicating the actions associated with function keys; another, of course, is through standardization. These two options are not mutually exclusive.

When users had questions or were unsure of a command, system interaction, or what action should be taken next, almost exclusively the first action they took was to ask a coworker. The users were usually able to determine the action or command through this method. When the coworker did not have the answer to the question, they consulted one of the many manuals and system documents located nearby. If the answer was not forthcoming from these two steps, the users consulted an outside source such as an AF technician at a different location (e.g., the equipment room).

4. Conclusions

It is an interesting paradox that the function keys and shortcut keys are supposed to make interaction with the system more efficient but, if used incorrectly, can increase interaction inefficiency. Function keys and shortcut keys are designed to give the user a faster, more precise method for completing frequently repeated tasks. Used correctly, function keys and shortcut keys can increase interaction efficiency. They also can provide the redundancy needed for data input so that the same function can be accomplished with either the keyboard or mouse. Through this redundancy, function keys and shortcut keys allow a better means for accommodating disabled users. Function keys and shortcut keys can usually be customized in commercial PC programs; thus, it should not be difficult to take advantage of the recommendations provided in this document in future AF systems, even if those systems are COTS.

To improve efficiency in an environment like AF, shortcut keys and function keys should be standardized to the extent possible across systems. This standardization should take into account familiarity effects that may be present due to home computer use and capitalize on the preexisting knowledge that familiarity effects provide. (Due to the proliferation of home computers, it is reasonable to assume that, in the future, most AF specialists will have a computer at home with which they interact.)

Across AF, there are more than 25 different systems. Of 14 systems that used function keys and 9 systems that used shortcut keys, there was very little consistency across systems. One might speculate that the lack of consistency is due to the uniqueness of the different systems present in the AF environment. However, we found many common functions across different systems. These commonalities are key areas where standardization efforts can be focused.

Of the 14 systems that used non-dedicated function keys, we identified 157 different functions,[2] 22 functions assigned to a function key plus a modifier key, and 59 different functions assigned to shortcut keys. This adds up to 238 different items to remember.[3] Standardization of common functions assigned to particular function keys and shortcut keys can decrease the memory load for the specialist. In addition, there is a high probability for the learned meanings of one system to interfere with the learned meanings for the other system when common functions are present between the systems but the assignment of functions is not standardized. The large number of possible combinations causes a high potential for confusion. This could result in the specialist choosing the wrong key and increasing restoration time. Although only 14 systems used shortcut keys, the researchers found little consistency in the assignment of functions to these keys; for example, 50% of the systems using Ctrl + A assign different meanings to the same shortcut key combination.

Standardization of function keys and shortcut keys in alignment with human factors best practices set forth in the FAA guidelines (Ahlstrom & Longo, 2001; FAA, 1996) and elsewhere can make the job of future software developers and systems acquisition easier and less costly because they can build on existing knowledge. By building on existing knowledge, training time can also potentially be decreased, saving time and money for the FAA.

For functions that are not frequently used, there may not be justification to provide function keys or shortcut keys for those functions. However, a review of the commands used by menus (Ahlstrom & Muldoon, in press), shortcut keys and function keys showed commonalities across the systems. Many of the AF systems had a means of acknowledging alarms, a close command, a Delete command, a Help command, a Log off command, a Print command, a Save command, an Exit command, a Clear or a Delete command, and a Report or Produce Reports command. Some of these commands are good candidates for assignment to function keys. For example, the Help command is often assigned to F1 in commercial applications. The Delete or Clear command is usually assigned to a dedicated function key on most commercial keyboards, labeled Del or Delete. We recommend using the dedicated function key for this purpose rather than assigning this function to a function key.

Other keys, due to their potentially destructive or disruptive nature, may not be good candidates for function keys because of the risk for accidental activation. Commands that have potentially disruptive consequences should be safeguarded (Ahlstrom & Longo, 2001). These commands include Log off, Exit, or Close. This does not mean that these could not be assigned to shortcut keys. Shortcut keys require two simultaneous key presses to activate rather than one, reducing the likelihood of accidental activation. We recommend that Close be assigned to the shortcut key combination Ctrl + F4 and Exit be assigned to the shortcut combination Alt + F4 (these assignments are based on commercial conventions). Any function key or shortcut key combination that could result in potentially destructive consequences should inform the user of the consequences of the action and require user confirmation prior to implementing the action.

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[2]This number varied by location as the Host and HOCSR both have 24 function keys whose functions can be determined by the site.

[3]The actual number is likely to be less as not all of the systems will be located at the same location. Even if only half the number of items need to be remembered, however, it is still a great burden on the user memory.

Meanings assigned to modifier keys used in conjunction with function keys should be logically related to the meanings of the function key alone. For example, if F1 is assigned to the function help, Shift + F1 should provide some function related to Help, such as context sensitive help.

Although there is no requirement that one must provide function keys and shortcut keys to the users, doing so can minimize the keystrokes needed to execute a command or accomplish a task for expert users, thus ostensibly increasing efficiency. Because shortcut keys can be beneficial to experienced users in this way, we recommend that shortcut keys should be provided for frequently used commands, where feasible, to allow experienced users the ability to bypass the menu structure. The meanings assigned to the function key and shortcut key combinations should be consistent among and within systems (Ahlstrom & Longo, 2001) and should follow conventionally associated meanings for those key combinations, where possible. We recommend that shortcut keys that are used together with mnemonics use the same letter as the mnemonic unless that shortcut already is reserved for another purpose.

Function keys and shortcut keys should be used to provide quick and efficient access to frequently performed tasks without syntax error (Ahlstrom & Longo, 2001). This being said, there needs to be a balance achieved between the flexibility of assigning functions to keys and consistency across systems so that when the same function is used in related tasks, it should be assigned to the same key or set of keys (Ahlstrom & Longo). This is particularly important in a work environment such as AF where the users must interact with multiple systems.

The researchers used the cataloged set of functions collected from field sites, software manuals, and other sources to examine common functions assigned to function keys and shortcut keys across AF systems. They also compared functions of AF shortcut keys and function keys to those used in commercial systems.

Based on commonalities identified across systems, the research team recommends that certain function keys and shortcut key combinations be reserved in future systems. Overall, the research team recommends assigning meanings to shortcut key combinations that are consistent with common commercial standards as described in this document. To promote consistency across systems, we recommend that the F1 key be reserved to invoke Help for all systems. For systems that have Menu bar access assigned to a function key, we recommend that F10 be reserved for Menu Bar access if possible. We recommend that Ctrl + P be reserved for the Print function and Ctrl + S be reserved for the Save function. This does not mean that every system needs to have a print function, but that the Ctrl + P key combination should only be used to activate a print function for systems that have this as an option. We recommend that the Delete or Clear command be assigned to the dedicated function key "Delete" on a standard keyboard. Extensions of this command, when appropriate, (e.g., Delete All) should be achieved by using modifier keys in addition to the Delete key (e.g., Shift + Delete).

There are some functions unique to AF systems, such as the Alarm Acknowledge function. We recommend that if this function is assigned to a function key, this function be assigned to a common F key such as F5, if possible. Here, we deviate from the commercial conventions assigned to this function. This is not particularly problematic in that there is no single function established for this function key across commercial systems, but rather three main functions. Thus, the users are not likely to have a single expectation associated with this key through use of home computers.

By adhering to good human factors practices and standardizing common functions across systems, there is potential to increase efficiency and decrease errors in interacting with AF systems. The catalog of function keys and shortcut keys contained in this document highlights the inconsistency in the assignment of meanings across AF systems. The analysis of commonalities in functions across the systems allows future programs to take an integrated approach to developing future systems. By taking an integrated approach and standardizing common functions across systems, it is possible to reduce user confusion and the potential for human errors, reduce costs of human factors studies for individual programs by providing standards, reduce the need for training by making the systems more usable and building on existing knowledge, and reduce development and deployment time for new systems.

5. Recommendations

Based on this study, we recommend

- that systems use function keys and shortcut keys for frequently used commands, where feasible, to allow experienced users to bypass the menu structure for frequently accessed options.
- that the assignment of functions to keys be standardized across systems, where feasible.
- that, in the cases where users are familiar with the shortcut keys used by commercial applications, the meaning used by the commercial applications be retained, where possible.
- that the F1 key be reserved for the help function.
- moving toward the commercial conventions, when practical, when a system has a similar function that is worthy of making accessible through a function key.
- that function keys with potentially disruptive consequences be adequately safeguarded.
- that meanings assigned to modifier keys used in conjunction with function keys be logically related to the meanings of the function key used without the modifier.
- that the shortcut key combination use the same letter as the letter used for the mnemonic.
- using the dedicated function key for the Delete or Clear command rather than assigning this function to a non-dedicated function key (F key).
- that Close be assigned to the shortcut key combination Ctrl + F4 and Exit be assigned to the shortcut combination Alt + F4 (these assignments are based on commercial conventions).
- that, in most cases, Log Off, Exit, and Close not be assigned to function keys.
- that Ctrl + P be reserved for the Print function and Ctrl + S be reserved for the Save function.
- that when "alarm acknowledge" is assigned to a function key, it be assigned to the F5 key, where feasible.
- that the users be provided with keyboard overlays identifying the meanings for the top row of function keys.

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Acronyms

AF	Airway Facilities
AOCC	Atlantic Operational Control Center
ARTCC	Air Route Traffic Control Center
ARTS	Automated Radar Terminal System
CSS	Central Software Support
CTAS	Center TRACON Automation System
DARC	Direct Access Radar Channel
DAS	Data Acquisition Subsystem
DAS/RSD	Data Acquisition Subsystem Real-time Status Display
DFW	Dallas Fort Worth
DSR	Display System Replacement
DVRS	Digital Voice Recording System
EM	Event Manager
ETMS	Enhanced Traffic Management System
FAA	Federal Aviation Administration
HID	Host Interface Device
HNL	HID/NAS/LAN
HOCSR	Host and Oceanic Computer System Replacement
ILS	Instrument Landing System
IMCS	Interim Monitor and Control Software
LAN	Local Area Network
LDRCL	Low Density Radio Communications Link
LLWAS	Low Level Windshear Alert System
MASS	Maintenance Automation Software System
MMS	Maintenance Monitoring System
MOCC	Mid states Operational Control Center
MPES	Maintenance Position Equipment Subsystem
NAS	National Airspace System
OCC	Operational Control Center
ODAPS	Oceanic Display and Planning System
PC	Personal Computer
POCC	Pacific Operational Control Center
RAPPI	Random Access Plan Position Indicator
RCL	Radio Communications Link
RDHFL	Research Development and Human Factors Laboratory
RDVS	Rapid Deployment Voice Switch
RSD	Real-time Status Display

SOC   Systems Operation Center
STARS   Standard Terminal Automation Replacement System
TMA   Traffic Management Advisory
TMU   Traffic Management Unit
TRACON   Terminal Radar Approach Control Facility
VORTAC   Very High Frequency Omnidirectional Range/Tactical Air Co-located
VSCS   Voice Switching and Control System
VSCS/MPES   Voice Switching and Control System/Maintenance Position Equipment
                Subsystem
VTABS   VSCS Training and Backup System
WARP   Weather and Radar Processor
WJHTC   William J. Hughes Technical Center

Appendix A

Function Keys Used With AF Systems

	ARTS	Codex	CTAS	DARC
F0	N/A	Same function as the Codex left 'Mouse' button	N/A	N/A
F1	Initiate Control	Same function as the Codex Center 'Mouse' button	Opens the Airport Status Window from the CM Watch Window TMU position only	Not Used
F2	Track Reposition	Same function as the Codex right 'Mouse' button	Opens Graphs TMU only	Not Used
F3	Track Suspend	Inventory a Device	Map options TMU Only	Not Used
F4	Terminate Control	Configure a Device	Departure List TMU Only	Not Used
F5	Track Handoff	Display Events Windows	Traffic Count TMU Only	View Files
F6	Flight Data Entry	Open Trouble Tickets	Delays TMU Only	View Logs
F7	Automated Terminal Information System (ATIS)	Alternate Configurations window (not used by FAA)	Airport Configuration TMU Only	DARC Mode (EP Mode)
F8	Digital Display - Full Digital ARTS Display (FDAD) only	Opens Scheduled Jobs Status window	Not Used	To select 'All' under AR on the A/T Com. Pull down
F9	VFR Flight Plan	Send Display on screen to Printer	Time Lines TMU Only	Examine Parameters (EP UCON)
F10	Interfacility (IF) Print	Not Used	Not Used	Radar Coverage Control Site (RCCS) Status same as YR command
F11	Conflict Alerts	Not Used	Not Used	Not Used
F12	Altitude Restriction	Not Used	Not Used	Line Feed
F13	Run Down List	N/A	N/A	N/A
F14	Interfacility (IF)	N/A	N/A	N/A
F15	Target Generator	N/A	N/A	N/A
F16	F16 Multifunction	N/A	N/A	N/A

	DAS/RSD	DSR	DVRS	ETMS
F0	N/A	N/A	N/A	N/A
F1	REFRESH MDT Data. EDIT DIB Mask	Not Used	Not Used	Help Screen
F2	Filter LUIDs, Upload DAS (P10 table), and Set AMCC Date/Time, Used to Toggle between screens	Not Used	Not Used	Not Used
F3	Clear Status History from that screen and Toggle LUID	Not Used	Not Used	Not Used
F4	Edit Data, Edit DIB Mask settings	Not Used	Not Used	Not Used
F5	Load File	Not Used	Not Used	Not Used
F6	Save File, Save current P10 settings, Save DIB setting	Not Used	Not Used	Not Used
F7	Write Text File, and Go To Page (Search the CDC/DCC)	Not Used	Not Used	Not Used
F8	Dump Screen/File (saves a page of status information)	Not Used	Not Used	Not Used
F9	Help	Not Used	Not Used	Not Used
F10	Exit to DOS, Exit from any status screen	Not Used	Not Used	Not Used
F11	Get MDT Date/Time	Not Used	Not Used	Not Used
F12	Set MDT Date/Time	Not Used	Not Used	Not Used
F13	N/A	N/A	N/A	N/A
F14	N/A	N/A	N/A	N/A
F15	N/A	N/A	N/A	N/A
F16	N/A	N/A	N/A	N/A

	Event Manager	HNL	HOCSR	Host
F0	N/A	N/A	N/A	N/A
F1	Not Used	Not Used	Customizable	Provides 24 function keys, customized by facility
F2	Not Used	Not Used	Customizable	Customizable by facility
F3	Not Used	Not Used	Customizable	Customizable by facility
F4	Not Used	Not Used	Customizable	Customizable by facility
F5	Not Used	Not Used	Customizable	Customizable by facility
F6	Not Used	Not Used	Customizable	Customizable by facility
F7	Not Used	Not Used	Customizable	Customizable by facility
F8	Used to close a Log Interrupt Report (LIR)	Not Used	Customizable	Customizable by facility
F9	Not Used	Not Used	Customizable	Customizable by facility
F10	Not Used	Not Used	Customizable	Customizable by facility
F11	Not Used	Not Used	Customizable	Customizable by facility
F12	Not Used	Not Used	Customizable	Customizable by facility
F13	N/A	N/A	N/A	Customizable by facility
F14	N/A	N/A	N/A	Customizable by facility
F15	N/A	N/A	N/A	Customizable by facility
F16	N/A	N/A	N/A	Customizable by facility

	IMCS	**LDRCL**	**MASS**	**MMS**
F0	N/A	N/A	N/A	N/A
F1	Go To, Site Entry Status, Enter Selection	Not Used	Help	Go To
F2	Help	Not Used	Monitor	Help
F3	(sub) Menu, Site Information	Not Used	Subsystem 1	(sub) Menu
F4	View Active Alarms	Not Used	Subsystem 2	IMCS Menu
F5	Alarm Acknowledge, Ack. Terminal Messages	Not Used	Not Used	ALARM
F6	MCS Menu includes LogOff	Not Used	Not Used	LogOff
F7	Retrieve (RETVR), Read/Send	Not Used	Not Used	Retrieve (RETVR)
F8	ADD/Create	Not Used	Not Used	ADD
F9	Site Directory (full view)	Not Used	Not Used	Modify (mod)
F10	Produce Report Terminal Messages	Not Used	Enable Menu Bar	Produce Report
F11	Fold Selection	Not Used	Not Used	Initiate Archiving
F12	Create Data Set, Produce, Begin	Not Used	Logoff	Create Data Set
F13	Sequential Retrieval	N/A	N/A	Sequential Retrieval
F14	Utilities	N/A	N/A	Change Key
F15	Reports	N/A	N/A	Save Screen
F16	Return to CM	N/A	N/A	N/A

	Mode-S	**RAPPI**	**RCL**	**RDVS**
F0	N/A	N/A	N/A	N/A
F1	Not Used	Help	Cancel	Help
F2	Not Used	IOP Select	Save IWA	Alarm Reset
F3	Not Used	Status	Restore IWA	Not Used
F4	Not Used	Display Search Information (Errorlog)	Command Status	Fault Isolation
F5	Not Used	Display Light Weather Information	Alarm Mode	QCT Raw Status screen
F6	Not Used	Display Heavy Weather Information	Previous Page	Clear or Ignore
F7	Not Used	Display BEACON MODE-3A Radar Information	Next Page	Log Archives
F8	Not Used	Display BEACON VFR Radar Information	Help	Equipment Ids
F9	Not Used	Displays BEACON Searched Radar Equipment	Not Used	Not Used
F10	Not Used	Displays All BEACON Sites	Not Used	Enable Printout
F11	Not Used	Displays BEACON Target 'Dots'	Not Used	Not Used
F12	Not Used	Displays BEACON MODE-C Radars	Not Used	Not Used
F13	N/A	N/A	N/A	N/A
F14	N/A	N/A	N/A	N/A
F15	N/A	N/A	N/A	N/A
F16	N/A	N/A	N/A	N/A

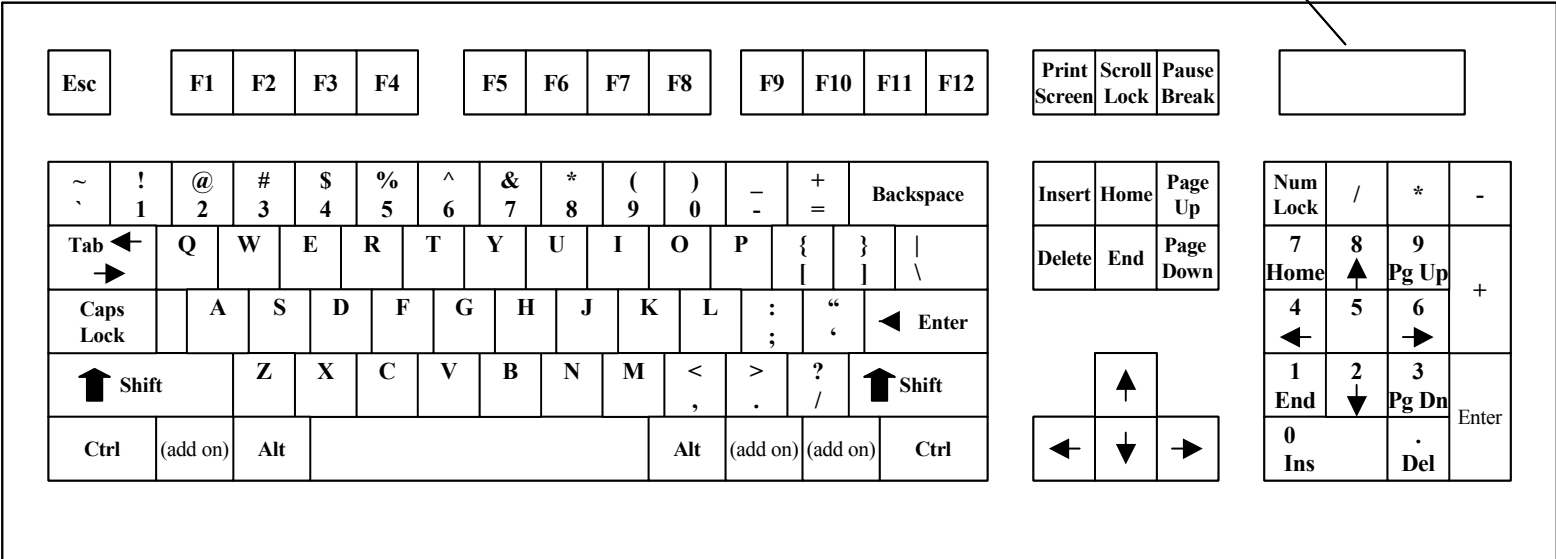|	STARS	VORTAC-DME	VSCS (MPES)	VTABS	WARP
F0	N/A	N/A	N/A	N/A	N/A
F1	Not used	Not used	Default VSCS System Startup	Not Used	M&C for WARP is currently under contract with Harris
F2	Not used	Not used	Custom VSCS System Startup	Not Used	N/A
F3	Not used	Not used	Halt VSCS	Not Used	N/A
F4	Not used	Not used	Alter Default On-Line Database	Not Used	N/A
F5	Not used	Not used	N/A	Not Used	N/A
F6	Not used	Not used	N/A	Not Used	N/A
F7	Not used	Not used	Display Database Selections	Not Used	N/A
F8	Not used	Not used	Not Used	Not Used	N/A
F9	Not used	Not used	Not Used	Not Used	N/A
F10	Not used	Not used	Not Used	Not Used	N/A
F11	Not used	Not used	Not Used	Not Used	N/A
F12	Not used	Not used	Not Used	Not Used	N/A
F13	N/A	Not used	N/A	N/A	N/A
F14	N/A	Not used	N/A	N/A	N/A
F15	N/A	Not used	N/A	N/A	N/A
F16	N/A	Not used	TACL Help (Invokes Tandem Help Display)	N/A	N/A

Appendix B

Function Keys Plus Modifiers

Function Keys Plus Modifiers

	ARTS	VSCS	Mode-S	RAPPI	RDVS	Codex	MASS
F Key	F1=HELP from several of the screens	F1=Default VSCS F2=Custom VSCS F3=Halt VSCS F4=Alter default on-line database F8=N/A F16=TACL Help	F2=N/A F3=N/A F4=N/A F5=N/A F6=N/A F7=N/A F8=N/A F9=N/A	F1= Help F2=IOP Select F3=Status F4=Display Search Information	F4=Fault isolation	F5 = Displays Event Windows F9=Send display to printer	F4= IMCS Menu
F Key + Modifier	Shift + F1= Additional information for a particular screen or utility	Shift + F1=Default Central Software Support (CSS) Startup Shift + F2= Custom CSS Shift + F3= Shutdown CSS Shift + F4= Rebuild online database Shift + F8= Log Off Shift + F16= Display Tandem VSCS menu screen	Ctrl +F2= Mode-S Channel A Ctrl +F3= Mode-S Channel B Ctrl +F4= ATCBI Channel A Ctrl +F5= ATCBI Channel B Ctrl +F6= Request Control Ctrl +F7= Release control Ctrl +F8= Audible alarm toggle Ctrl +F9= Audible alarm toggle off on multiple windows remote terminal	Alt + F1= BOMARC beacon Alt + F2= Beacon Mode 2 Radars Alt + F3= Strobe sites Alt + F4= All beacon sites	Alt+F4= Fault description	Shift+F5= Displays Outstanding events window only Shift + F9= Send display to printer	Ctrl + F4= File close

Appendix C

Keyboards and Dedicated Function Keys

Num Lock, Caps Lock, and Scroll Lock LED Indicators

Esc

F1 F2 F3 F4   F5 F6 F7 F8   F9 F10 F11 F12

Print Screen | Scroll Lock | Pause Break

~ `   ! 1   @ 2   # 3 $ 4   % 5   ^ 6   & 7   * 8   (9   ) 0   _ -   + =   Backspace

Tab   Q   W   E   R   T   Y   U   I   O   P   { [}] | \

Caps Lock   A   S   D   F   G   H   J   K   L   : ;   " '   Enter

Shift   Z   X   C   V   B   N   M   < ,   > .   ? /   Shift

Ctrl   (add on)   Alt   Alt   (add on)   (add on)   Ctrl

Insert | Home | Page Up
Delete | End | Page Down

↑
← ↓ →

Num Lock   /   *   -

7 Home   8 ↑   9 Pg Up   +

4 ←   5   6 →

1 End   2 ↓   3 Pg Dn   Enter

0 Ins   . Del

Standard QWERTY Keyboard layout (Some variations manufacturer-dependent)

C-1
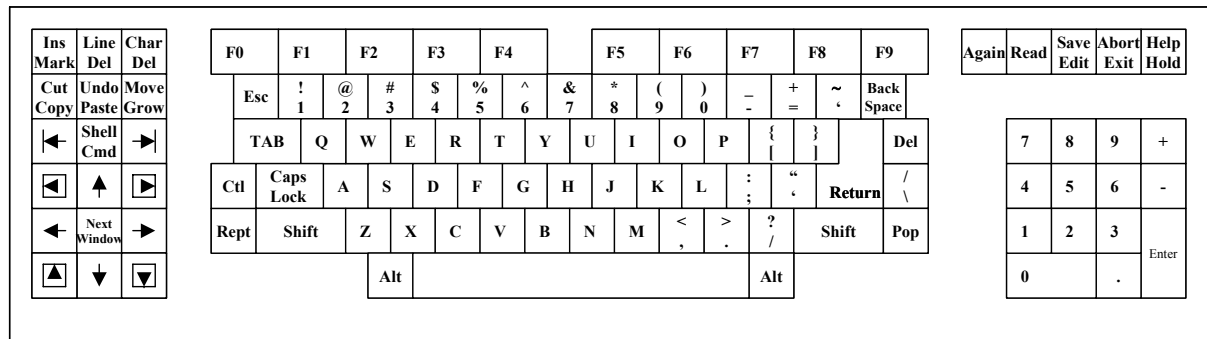
Codex Keyboard

Functions associated with dedicated function keys on the Codex keyboard	
Shift + Shell/Cmnd Key	Creates a process shell
Next Window	Used to exit the terminal emulation session
Shell/Cmnd	Moves the cursor to be used for commands in the display windows
Bounded Arrow Keys	Permits the user to scroll through a layout in the Network window
Arrow Keys	Same as using the mouse to move the cursor
Again	
Read	Causes the 'Command' prompt at the bottom of the screen to be replaced by the 'Read File' prompt
Save/Edit	Replaces the 'Command' prompt with the 'Edit File' prompt at the bottom of the screen
Abort/Exit	Closes the active process shell
Help/Hold	

RNG BRG | RSB | SIM
INT | PVD | ALT

F1 | F2 | F3 | F4 | F5 | F6
F7 | F8 | F9 | F10 | F11 | F12

RS | CST | CRD | DROP TRK | CODE | CA
VP | HOLD | SG | RPT | TRK | HALO

LOOK | RTE | FR
INT | PVD | ALT

CLEAR | ◯ | ⊕ | ↑ | ↓ | RE-CALL | HOME | MAN MAP | PSET MAP | AUTO | SISO | * | ▲ | − + | BACK SPACE

NEXT LINE | TAB | Q | W | E | R | T | Y | U | I | O | P | ◄ | ► | INSERT | DEL CHAR

MULTI FUNC | − = | A | S | D | F | G | H | J | K | L | : ; | ▼ | EDARC

SHIFT | Z | X | C | V | B | N | M | , | . | ? / | SHIFT | ENTER

SPACE | SPACE
1 | 2 | 3
4 | 5 | 6
7 | 8 | 9
0 | CUR LOCK
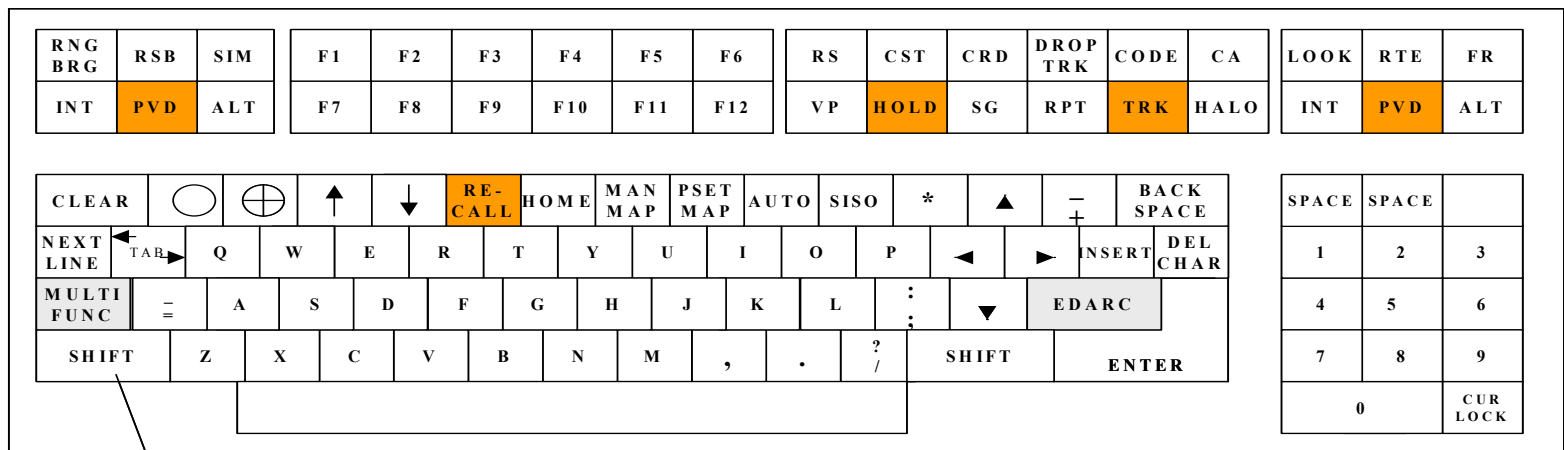
For D-Side controllers this is the MSG ACK key
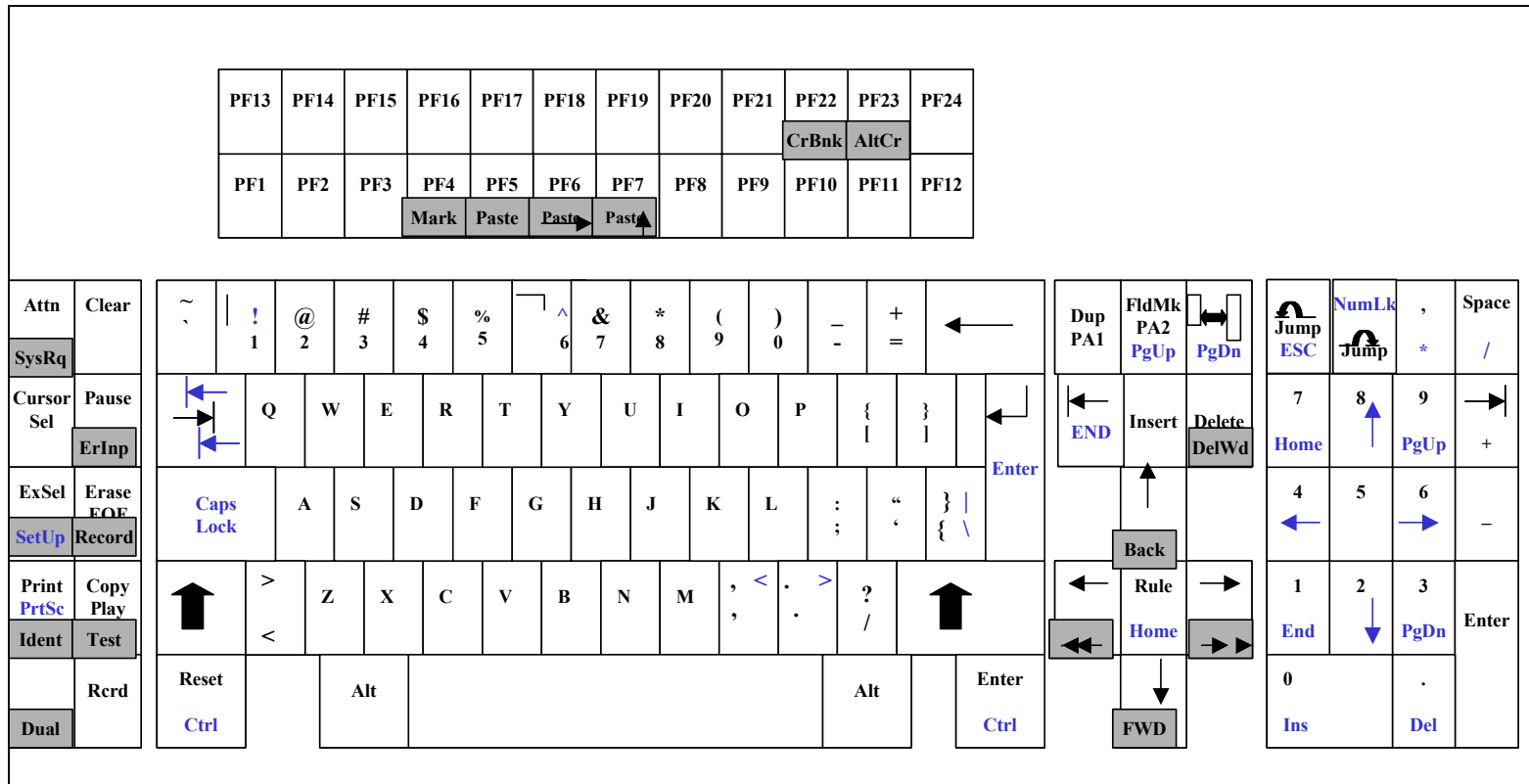
DSR Keyboard

C-3

Functions associated with dedicated function keys on the DSR keyboard	
RNG BRG	Brings up a menu allowing the acquisition of a bearing from a point in space to an aircraft or fix. Necessary for estimating flight times. This key enables and is used in conjunction with the F1, F2, and F3 function keys.
RSB	From 'Radar Sort Box' – flight information coordinates (latitude and longitude), where radar information is coming from, and which radar site is preferred.
SIM	Used for dynamic Simulation commands, change speed and heading of aircraft. Run by ATs in DYSIM lab. Not a stand-alone system.
INT	The Interim Altitude button – for entering altitudes that will not forward changes to the NAS flight plans.
ALT	Updating Altitudes in aircraft's flight plan.
PVD (orange)	Allows controllers to force a data block onto another controller's scope.
RS	Remove Strip – to remove flight plans from the system.
CST	COAST – manually places a target in the coast mode. This is the computer's method for tracking an aircraft when real-time updates are unavailable.
CRD	CRD (referred to as crud)– A display area of the DSR presenting altitude limits and alternate settings. Originally from the term Cathode Ray Display.
DROP TRK	Drops a track off the screen without suppressing the NAS data block. Tells the NAS system 'not to worry' about the particular flight plan.
CODE	To select Beacon Codes for assignment to aircraft or to change the Beacon Code for existing aircraft.
CA	Conflict Alert – temporarily suppresses the flashing display of a CA.
VP	Used to input VFR flight plans quickly.
HOLD (orange)	Holds a flight plan at its current location and discontinues updates to the NAS.
SG	Suppress Group – tells the computer to pay no attention to selected aircraft if they are in CA.
RPT	REPORT – to report an aircraft at a specific altitude of the MODE C field
TRK (orange)	TRACK – to start or update track positions of aircraft.
HALO	Places a circle around the aircraft target in order to gauge aircraft separation.
LOOK	Pulls up traffic that another position is working. Frequently used so a position can see what is coming into its sector, for example.

RTE	ROUTE – the function (QU) to input aircraft direct to a fix, amending NAS flight plans. Also can display a graphical line of the aircraft's route through a sector.
FR	Flight plan Readout – accesses actual full flight plans for particular aircraft.
CLEAR	Clears out information typed into the CRD display area. Effective only before information is entered into the system.
◯	Acts as a classifier. Past use as the 'clear weather' identifier. Currently used to classify remarks entered in field 11 of the flight plan. In addition, to classify General Information (GI) messages. These messages will be sent to all facilities along the particular aircraft's flight plan.
⊕	Past use to signify 'overcast weather.' Currently used to classify remarks that will be sent throughout a particular center only.
↑	This is a character input; it does not move the cursor. It classifies certain parts of messages. It may be used to indicated the departure airport, for example.
↓	This classifier may be included to indicate the arrival airport among other uses.
RE-CALL (orange)	Brings back input made on a previous command. Controllers use this command to save time when several aircraft will be given like flight plan data.
HOME	Return cursor to center of display. Data may become very involved on a sector map and this allows even experienced controllers the ability to relocate their cursor.
MAN MAP	Used simultaneously with the Multi Func key. Will recenter/realign a sector map in relation to the location of the cursor on the screen.
MULTI FUNC (gray)	Similar to the use of a 'Shift' key. It is used as a qualifier for a controller action. It will keep a controller from committing to an action that would better be avoided on second thought.
PSET MAP	Will center the sector map to a preset location rather than on the location of the cursor.
AUTO	Used as a toggle. Can inhibit the presentation of all or any number of sectors. It changes the status of the automatic handoff mode.
SISO	Sign In/Sign Out – used along with controller's initials to access a position. It automatically logs start times and adjusts the display for that controller's settings. When used simultaneously with the Multi Func key, the controller is signed out.
*	A character that qualifies elements in a flight plan or highlights amendments to a flight plan.

Up, Down, Left, Right ARROWS	To move a flashing cursor in a text area. The cursor (appearing as a single dashed line beneath content) can be moved with no effect on content.
EDARC (gray)	Switches from NAS mode to DARC mode. Must be struck simultaneously with Multi Func key to accomplish the switch.
MSG ACK	For controllers operating on the D-Side, the keyboard's left 'Shift' key is MSG ACK. With this key, D-Side controller can acknowledge messages appearing in CRUD.

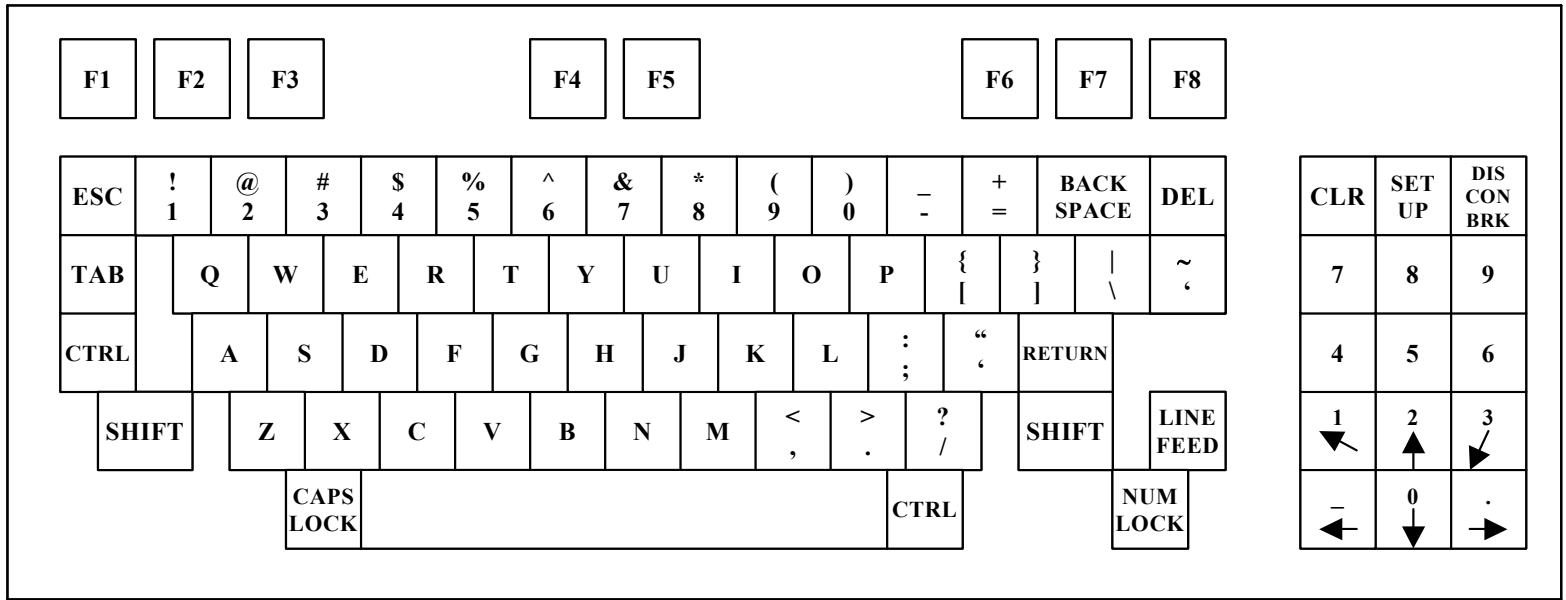This is a 3180 KVDT keyboard used to interact with the HOST system.

Host Keyboard (Note: this represents a top view of the keyboard, all of the gray rectangles represent information that is on the front of the respective key. The key Dup PA1 has 'Swap' on its front face, the key FldMk PA2 has 'ChgSc' on its front face, And the key immediately to its right [with the 'increase size' symbol] has 'PA3' on its face).

Functions associated with the dedicated function keys on the HOST keyboard

Setup	Uses the 24 PF keys to set up the display
Record	Used with the 24 PF keys to save frequently used commands
Play	Used with the 24 PF keys to save frequently used commands
Erase EOF	Erase data from curser to EOF
Clear	Clear the screen
Enter	Used to enter data to the Host
Caps lock	The Padlock key located 2 keys above the reset key
Reset	Resets a locked keyboard
PA2	Clears the display
PA1	Stops audio alarm

| F1 | F2 | F3 | | F4 | F5 | | F6 | F7 | F8 |

ESC	! 1	@ 2	# 3	$ 4	% 5	^ 6	& 7	* 8	(9	) 0	_ -	+ =	BACK SPACE	DEL		CLR	SET UP	DIS CON BRK
TAB	Q	W	E	R	T	Y	U	I	O	P	{ [	}]	| \	~ `		7	8	9
CTRL	A	S	D	F	G	H	J	K	L	: ;	" `	RETURN		4	5	6
SHIFT	Z	X	C	V	B	N	M	< ,	> .	? /	SHIFT	LINE FEED		1	2	3
CAPS LOCK						CTRL	NUM LOCK		_	0	.

RCL Keyboard

Appendix D

Shortcut Key Combinations

System	Key Combo or Key	Command Name	Meaning
ARTS	Ctrl + A		Cursor returns to beginning of a line
	Ctrl + B		Cursor goes BACK one character
	Ctrl + D		Current character is DELETED
	Ctrl + E		Cursor moves to END OF LINE (EOL)
	Ctrl + F		Cursor moves FORWARD one character
	Ctrl + H		Previous character is deleted
	Ctrl + K		Information is deleted from cursor to EOL
	Ctrl + L		Redraws a LINE
	Ctrl + N		Moves to NEXT Command
	Ctrl + P		Moves to PREVIOUS Command
	Ctrl + U		Deletes an entire line
	Ctrl + W		Deletes the last WORD of a line
Codex	Shift + Shell /Cmnd Key		Creates a process shell
CTAS	Ctrl+ S	Save As	Also accessed from the 'Map' pull down menu
	Ctrl + P	Print Window	Also accessed from the 'Map' pull down menu
	Ctrl + F	Find	Also accessed from the 'Edit' pull down under 'Object By Selection Name'
	Ctrl + A		Find an object by ATTRIBUTE also from the 'Edit' pull down menu
	Ctrl + H	Highlights	Also from the 'View' pull down menu and under 'Selected Highlights'
DARC	Ctrl + A		Allows specialist to make manual input to the system
Event Manager	Shift + %		Opens a wild card permitting user to search for an event with a minimum of two characters
HNL	Ctrl + E	Exit	Also found in the 'File' pull down menu
	Ctrl + L	Selected Object List	Selected Objects LISTS
	Ctrl + H	Select Highlights	Select HIGHLIGHTS
	Ctrl + N	Selection Name	Choose objects by selection NAME
	Ctrl + A	By Attributes	Choose objects by ATTRIBUTES
MASS	Ctrl + M	System Message	Display MESSAGES received from MPS

System	Key Combo or Key	Command Name	Meaning
	Ctrl + Q	Quick Desktop	Alternate means of controlling the type of data to be displayed and to enable some display functions
	Ctrl + Shift + A	Acknowledge	Indicate an alarm or alert has been noted
	Ctrl + Shift + C	Commands	Open a COMMAND dialogue box
	Ctrl + Shift + M	Mask	Inhibit display of alarms or alerts for some data on System Monitor and Alarm Summary screens
	Ctrl + Shift + R	Filter	To prevent some subsystem status data from being displayed on the MDT
	Ctrl + Shift + S	MCF Settings	To enter (for display only) condition status indicators for subsystems not connected to a RMS
	Ctrl + Shift + U	Assume	Take control of a subsystem – prevents other users from sending commands to that subsystem
RAPPI	Alt + R		To switch the Radar Data Distribution Unit (RDDU)
DAS/RSD	'5' (with 'NumLock' off)		Jumps the cursor to the next DAS/RSD display monitor
	L	LUID Search	– Permits the specialist to search for a particular LUID
	P	PAGE Search	– Permits the specialist to search for a particular page of data
	R	CANCEL Filtering	– Cancels all filtering effects
	T	Item Search	– Specialists can search for a specified time period
	V	Verify Mask	– Compares current MDT data to the EEPROM data
	A - F	Set Threshold	– Permits specialists to change the error threshold
	A - Q	Configure	– Allows specialists to monitor or unmonitor subsystems
	1 - 6	Reset Counter	– Allows specialists to reset data error counters
	CC		Opens the Central Control and Monitoring System (CCMS) screen
	CD		Acknowledges the Computer Display Channel (CDC) alarms
	CT		Acknowledges the Coded Time Source (CTS) alarms
	DA		Acknowledges the Data Acquisition Subsystem (DAS) alarms
	DC		Acknowledges alarms from the Display Channel Complex (DCC)
	EC		Acknowledges the Emergency Communication System (ECS) alarms
	ED		Acknowledges the Enhanced Direct Access Radar Channel (EDARC) alarms

System	Key Combo or Key	Command Name	Meaning
	FS		Acknowledges Flight Service Data Processing System (FSDPS) alarms
	HA		Acknowledges the HALON fire suppression equipment alarms
	HC		Acknowledges the High Capacity Voice Recorder (HCVR) alarms
	HO		Acknowledges Host alarms
	NA		Acknowledges the National Airspace Data Interchange Network (NADIN) alarms
	NR		Acknowledges the Non Radar Keyboard Multiplexer (NRKM) alarms
	PC		Acknowledges the Power Conditioning System (PCS) alarms
	PV		Acknowledges the layout of the Plan View Displays (PVD) alarms
	UN		Same as using a point device to click on the unmonitored symbol on the master screen