Aircraft Avionics Suitable for Advanced Approach Applications

Volume I, Aircraft Fleet Equipage

Stanley Kowalski
Thomas H. Croswell

RJO Enterprises
4550 Forbes Boulevard
Lanham, Maryland 20706

July 1986

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Aircraft Avionics Suitable for Advanced Approach Applications Vol. I - Aircraft Fleet Equipage

Stanley Kowalski, Thomas H. Croswell

RJO Enterprises, Inc.
4550 Forbes Boulevard
Lanham, Maryland 20706

Department of Transportation Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, D.C. 20591

APM-430 Cockpit Technology Program Office
J. P. McVicker

This report catalogs the aircraft avionics suitable for advanced approach applications. The configuration and model numbers of avionics used in navigation and approaches for landing are provided for 79 different types of aircraft. Aircraft are grouped into five user communities which cover Major Air Carriers, Regional Air Carriers, Executive Jets, General Aviation Aircraft, and IFR Helicopters.

Avionics evaluation includes VOR NAVs, ADFs, DMEs, RNAVs, AFCS, weather radar and the associated display instruments. These navigation systems are the most popular units for navigation and landing in todays aircraft. ILS glideslope receivers, marker beacon systems, navigation management systems, vertical navigation systems, and long range navigation systems are not covered.

Aircraft Cockpit-Panel NAV RADAR
Avionics Equipage ADF RNAV
Navigation Avionics HSI
Navigation Instruments RMI
IFC CDI

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CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND

The National Airspace System is evolving to meet current and future air transportation requirements. System improvements based on new technologies will continue to make the system safe and efficient. The review of current systems aids in the development of compatible and cost effective advanced systems. This study reviews typical avionics configurations for their compatibility in advanced approach applications. Based on this study and other efforts, new concepts will be developed which use existing displays. Simulation experiments will also be developed to analyze systems' capabilities.

The Federal Aviation Administration is in the process of installing the new Microwave Landing System (MLS) as part of the improved navigation and landing system and is studying advanced MLS-guided approaches. In order for current aircraft to achieve maximum advantage from the improved capability of MLS (e.g., curved or segmented approaches) at minimum cost, the FAA needs to identify existing avionics currently installed on various classes of aircraft which could be used as part of the advanced approach display and guidance system. Such data on specific equipage of various classes of aviation users has not been compiled before. This lack of data has prevented the development of comprehensive simulations to check out MLS approach concepts.

Currently the FAA's Cockpit Technology Program Office is working with NASA and the FAA Technical Center in developing scenarios for advanced approaches and simulations to test these scenarios. A necessary input into the scenario is the current avionic equipage of various classes of aircraft. RIO Enterprises, Inc. has been tasked by the Program Engineering and Maintenance Service (APM) at FAA Headquarters to compile data on the avionics that are now installed in various types of aircraft and that could be integrated with the MLS to support advanced approaches.
1.2 SCOPE

This report catalogs MLS-compatible avionics. It identifies specific equipment currently found in aircraft which could be used in conjunction with the MLS angle receiver during approach operations. Because of the diverse range of users which are candidates for the advanced approach concept, we developed a representative sample of each class of aircraft used by each group. The users under consideration include the commercial carriers, general aviation, and rotorcraft. The commercial carriers are divided into the major air carriers and the commuter and air taxi operators, called regional air carriers. The general aviation class is composed of cabin class aircraft and single engine and light twin engine aircraft. Rotorcraft constitutes a separate category because of this aircraft's unique flight capabilities. However, rotorcraft are combined into one group without regard to the user community (e.g., air taxi, corporate) to which they belong.

1.3 TECHNICAL APPROACH

We limited the aircraft considered as candidates for advanced approaches to those typically operating under Instrument Flight Rules (IFR) and equipped with adequate avionics to meet minimum IFR requirements. This category includes all aircraft which operate above eighteen thousand feet (FL 180), all aircraft operating under Parts 121 and 125, Title 14, Code of Federal Regulations (CFRs) and the majority of aircraft operating under Part 135. In addition, many aircraft operating under Part 91 are IFR certified and therefore included in the study.

We divided the study into major user categories and collected equipage data on each user. Major air carriers were contacted about specific equipment on every aircraft model in the inventory. We chose regional air carriers, including commuter and air taxi, on the basis of the number of passengers carried, and we asked the top 25 carriers for specific equipage of their fleets. We divided executive aircraft into turbo-jets and turbo-prop categories and obtained typical avionic equipage for each aircraft in the categories by contacting airframe manufacturers, avionic manufacturers, and FBOs (Fixed Base Operators). We also researched used aircraft sales publications and FAA avionic surveys. Further, we
developed the general aviation aircraft equipage by talking with airframe and avionic manufacturers and reviewing used aircraft sales publications and FAA avionic surveys. We developed the helicopter equipage on the basis of direct contact with manufacturers and user organizations.

We limited the avionics suitable for advance approaches to auto-pilots, flight directors, specific VHF navigation equipment, navigation displays, distance measuring equipment, and radar systems. We included instrument model numbers for most navigation display instruments. Other instrumentation model numbers for example, attitude direction indicators, can be derived from the associated avionic components where possible. Automatic direction finding (ADF) systems were also included throughout most of the study.

1.4 REPORT ORGANIZATION

This report presents the results of the study identifying aircraft equipage of navigation avionics organized by user groups.

Chapter One presents the background, scope, technical approach and organization of this report.

Chapter Two presents the avionic equipage of the air carriers and identifies avionics by aircraft type.

Chapter Three addresses the regional air carrier community equipage based on the top 25 regional carriers.

Chapter Four focuses on the executive jet fleet of aircraft.

Chapter Five describes the navigation capabilities of the general aviation aircraft. It is divided into two sections: (1) the twin engine cabin class of aircraft, and (2) the light twin engine and single engine aircraft.

Chapter Six presents the results of the helicopter community equipage study, limited to IFR certified helicopters.

Chapter Seven presents the conclusions of the study.
CHAPTER TWO
MAJOR AND NATIONAL AIR CARRIERS

2.1 INTRODUCTION

The air carrier fleet of the United States consists of 27 major and national air carriers as defined by the World Aviation Directory. The combined fleet operates 2443 aircraft comprising 15 types and all models within each aircraft type. The fleet consists of almost all pure jet equipment except for the Convair 580 and the DeHavilland DHC-7 turbo prop aircraft. The dominant aircraft in the inventory is the Boeing 727-200 with 783 aircraft in the fleet. Table 2-1 presents the summary by carrier, based on 1984 statistics compiled by the World Aviation Directory. Although new aircraft are scheduled for delivery to the carriers, and some models are planned for retirement or sale, the FAA does not expect the total population to change dramatically in the next few years.

Table 2-1 Summary of Aircraft Used By Major and National Air Carriers

<table>
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<tr>
<th>Aircraft Type</th>
<th>Models</th>
<th>Manufacturer</th>
<th>Quantity in Service</th>
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<tbody>
<tr>
<td>B-727</td>
<td>-100, -200</td>
<td>Boeing</td>
<td>987</td>
</tr>
<tr>
<td>DC-9</td>
<td>-10/40, 50</td>
<td>McDonnell Douglas</td>
<td>435</td>
</tr>
<tr>
<td>B-737</td>
<td>-100, -200</td>
<td>Boeing</td>
<td>310</td>
</tr>
<tr>
<td>DC-10</td>
<td>-10, -30, -40</td>
<td>McDonnell Douglas</td>
<td>150</td>
</tr>
<tr>
<td>B-747</td>
<td>All</td>
<td>Boeing</td>
<td>128</td>
</tr>
<tr>
<td>L-1011</td>
<td>All</td>
<td>Lockheed</td>
<td>114</td>
</tr>
<tr>
<td>MD-80</td>
<td>All</td>
<td>McDonnell Douglas</td>
<td>86</td>
</tr>
<tr>
<td>DC-8</td>
<td>-50, -60, -70</td>
<td>McDonnell Douglas</td>
<td>81</td>
</tr>
<tr>
<td>B-767</td>
<td>All</td>
<td>Boeing</td>
<td>51</td>
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<tr>
<td>A-300</td>
<td>All</td>
<td>Airbus Industries</td>
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<tr>
<td>BAC-111</td>
<td>All</td>
<td>British Aerospace</td>
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<tr>
<td>B-757</td>
<td>All</td>
<td>Boeing</td>
<td>15</td>
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<tr>
<td>CV-580</td>
<td>All</td>
<td>Convair</td>
<td>15</td>
</tr>
<tr>
<td>DHC-7</td>
<td>All</td>
<td>DeHavilland</td>
<td>7</td>
</tr>
<tr>
<td>F-28</td>
<td>All</td>
<td>Fokker</td>
<td>4</td>
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</table>
2.2 DEVELOPMENT OF AVIONIC EQUIPAGE

We asked a representative sample of the air carrier community for data on the avionics equipage of their fleet of aircraft. During the data collection effort we examined potential variations among models within an aircraft type and discovered that most commercial airlines try to standardize avionics configurations for all of their own aircraft of the same type. Moreover, there are generally no differences in avionic configurations between similar models of aircraft within a fleet (e.g., B727-100 and 727-200).

Each airline contacted, furnished model and quantity data for each aircraft in its fleet covering the following avionic systems:

- Area Navigation Systems
- Flight Directors (FD)
- Flight Management Systems
- Integrated Flight Controls
- Distance Measuring Equipment
- Navigation Receivers
- Radar Systems
- Course Deviation Indicators (CDI)
- Horizontal Situation Indicators (HSI)
- Radio Magnetic Indicators (RMI)

The majority of the air carrier aircraft do not have VOR/DME-based Area Navigation Systems (RNAV) in their aircraft. Long-range aircraft, typically those involved in international flights, have Omega-based systems or inertial navigation systems that provide the area navigation capability. However, these navigation systems have not been listed in this report because they are not certified for non-precision approaches. All air carrier aircraft are equipped with flight directors (FDs) which are either a part of the auto pilot system or a separate system providing the FD function. Integrated flight control systems (IFCS) such as the Sperry SPZ 600/800 or Collins FCS-80 are typically reserved for corporate-class aircraft where a single manufacturer provides the auto pilot, flight director, and air data computer.
components in a single integrated system. The large air carrier aircraft possess the capabilities provided by an IFCS but not necessarily in a single integrated system. The remaining navigation oriented avionics are typically stand-alone units, remotely mounted, with panel or pedestal mounted displays and controls.

The majority of the major and national air carriers specify the Aeronautical Radio, Inc. (ARINC) characteristics (i.e., form, fit, function) for avionics used in their fleet of aircraft. This specification permits interchange of all manufacturers' equipment built to a specific ARINC characteristic and defines the external performance parameters of the avionics. This standardization will make it easy to interface the proposed advanced approach system with existing avionics.

2.3 AIR CARRIER AVIONIC EQUIPAGE

The typical air carrier aircraft is adequately equipped for IFR flights. They are operated by at least a two-man crew, pilot and copilot, usually with identical instruments for each. The aircraft contains two VOR navigation receivers, each driving an HSI with an RMI on the opposite position. DME information, whether derived from a single DME or dual system will drive an indicator usually configured as part of the HSI. Stand-alone indicators for DME are common and are often provided in addition to a DME readout integrated into the HSI. CDIs are usually not included in the panels. Weather radar information is displayed to the crew on either a single, center-mounted CRT, or, in the case of larger air frames, on two CRTs mounted on the lower panels near the fuselage. Cockpit panel space is very limited because engine performance indicators fill all available space outside of the conventional ADIs, VSI, altimeters, and air speed indicators.

New generation aircraft incorporating the Electronic Flight Instrument Systems (EFIS) have much greater display flexibility based on the menu selected by the crew and must be treated separately.

Figures 2-1 through 2-10 present the results of the study by type of aircraft with typical avionic instrumentation. The figures list the total population of aircraft types in the U.S. air carrier fleet, the size of the sample used in this study, typical avionic models encountered in the fleet sample, pilot and copilot instrumentation, and any variations on typical configurations uncovered during the study. In addition a picture of the instrument panel shows the panel area on each aircraft type.

2-3
Manufacturer: Boeing  
Number in Population: 987  
Number of Engines: 3 - Jet  
Number in Sample: 281  
Gross Weight: 160,000 - 191,000 lbs.  
Models: -100, -200

### AVIONICS

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Figure 2-1 Major Air Carrier Typical Equipage for B-727
Manufacturer: McDonnell Douglas  
Number in Population: 435  
Number of Engines: 2-Jet  
Number in Sample: 79  
Gross Weight: 98,000 - 122,200 lbs.  
Models: -10/40, 50

### AVIONICS

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**Figure 2-2** Major Air Carrier Typical Equipage for DC-9
Manufacturer: Boeing  
Number of Engines: 2-Jet  
Gross Weight: 111,000 - 125,000 lbs.  
Number in Population: 310  
Number in Sample: 49  
Models: -100, -200

**AVIONICS**

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Figure 2-3 Major Air Carrier Typical Equipage for B-737
Manufacturer: McDonnell Douglas
Number in Population: 150
Number of Engines: 3-Jet
Number in Sample: 50
Gross Weight: 455,000 lbs.
Models: -10, -30, -40

**AVIONICS**

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Figure 2-4  Major Air Carrier Typical Equipage for DC-10
Manufacturer: Boeing  
Number of Engines: 4-Jet  
Gross Weight: 700,000 - 833,000 lbs.  
Number in Population: 128  
Number in Sample: 18  
Models: All + SP

**AVIONICS**

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Figure 2-5  Major Air Carrier Typical Equipage for B-747
Manufacturer: Lockheed  
Number in Population: 114  
Number of Engines: 3 - Jet  
Number in Sample: 24  
Gross Weight: 430,000 - 496,000 lbs.  
Models: All + 500

### AVIONICS

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### INSTRUMENTS

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*Figure 2-6  Major Air Carrier Typical Equipage for L-1011*
Manufacturer: McDonnell Douglas
Number of Engines: 4-Jet
Gross Weight: 315,000 - 325,000 lbs.

Number in Population: 81
Number in Sample: 41
Models: -50, -60, -70

### AVIONICS

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Figure 2-7  Major Air Carrier Typical Equipage for DC-8
Manufacturer: Boeing  
Number in Population: 51  
Number of Engines: 2-Jet  
Number in Sample: 19  
Gross Weight: 312,000 lbs.  
Models: All

**AVIONICS**

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*Figure 2-8  Major Air Carrier Typical Equipage for B-767*
Manufacturer: Airbus Industrie  Number in Population: 34
Number of Engines: 2 - Jet  Number in Sample: 34
Gross Weight: 313,060 lbs.  Models: A-300

AVIONICS

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Figure 2-9  Major Air Carrier Typical Equipage for A-300
Manufacturer: Boeing
Number of Engines: 2-Jet
Gross Weight: 220,000 lbs.

Number in Population: 15
Number in Sample: 15
Models: 757-200

AVIONICS

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Figure 2-10  Major Air Carrier Typical Equipment for B-757
CHAPTER THREE
REGIONAL AIR CARRIERS

3.1 INTRODUCTION

The Regional Airlines Association (RAA) is composed of commuter and large air taxi operations which typically supplement the major and national air carriers by feeding traffic to major hubs from smaller cities and rural airports. This type of operation usually requires smaller aircraft carrying anywhere from six to thirty passengers. These smaller aircraft are capable of operations from short runways. The RAA fleet is composed of all classes of aircraft from a single engine Piper Super Cub to the 4-Jet engine BA-146, and includes some aircraft typically found in the national air carrier fleets such as the DC-9, BAC 111 and F-28 jets. The top 25 regional air carriers, based on 1984 passenger enplanement data, account for 469 aircraft with the Cessna 402, Embrair EMB-110 and Fairchild METRO III the dominant airframes. The Cessna 402 has eight seats, the EMB-110 19, and the METRO III 22. This passenger capacity is typical of the RAA operations.

3.2 DEVELOPMENT OF AVIONIC EQUIPAGE

We expect the avionic equipage of RAA aircraft to be similar to that carried by the major and national air carriers since the aircraft operate under similar flight rules. However, where the latter carriers specify ARINC characteristic equipment for their fleets, the RAA fleets usually equip with either panel-mounted or remote-mounted avionics designed for the smaller aircraft. The diversity of avionics available to the regional air carriers, and the limited area of operation for each regional airline, affect the type and quantity of avionics in each aircraft. Moreover, because most carriers do not use ARINC characteristics, specific avionic models must be identified to determine the flight guidance capability associated with each aircraft. For this reason, we contacted each of the top 25 carriers and obtained data based on a large sample for each type of aircraft.
3.3 RAA AVIONIC EQUIPAGE

The majority of RAA aircraft have the basic avionics needed for IFR flight plus other useful items such as radar, flight directors, and autopilots. However, many carriers do not include autopilot equipment because the average flight is short and does not require use of an autopilot; they thereby reduce the cost of certification and inspection of these systems. Area navigation (RNAV) equipment is typically not found on RAA aircraft, again because of the short flights. However, new generation aircraft, especially those that have the electronic displays (e.g., SF-340), or large aircraft suitable for longer flights (e.g., DHC-7) often include RNAV capability as part of the factory installed package.

Table 3-1 presents the distribution of aircraft found within the 25 top regional air carriers. Figures 3-1 through 3-26 present the avionics equipage for these aircraft. These figures are arranged in the descending order of Table 3-1 and use generic terminology for model identification. Because of the similarity in avionic equipage among the carriers researched for similar aircraft types we expect that the remaining RAA aircraft will be similarly equipped for each aircraft type operated by RAA members.

All aircraft reviewed were equipped with at least two navigation receivers (nine aircraft were found to carry a third receiver), 98 aircraft (21%) were equipped with the dual DMEs, seven aircraft (2%) did not carry DMEs, and the rest had one DME. The DME equipment varied from panel-mounted to ARINC characteristic equipment, but the distinctions were not based on aircraft type. All but five aircraft were equipped with radar systems ranging from monochrome to digitized color radar.
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Manufacturer: Cessna  
Number of Engines: 2-Piston  
Gross Weight: 6,850 lbs.  

Number in Population: 52  
Number in Sample: 18  
402 Business Liner (II)  
402 Utiliner (II)

## AVIONICS

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Figure 3-1 Regional Air Carrier Equipage for CESSNA 402
Manufacturer: Embraer
Number of Engines: 2-TP
Gross Weight: 13,007 lbs.
Number in Population: 51
Number in Sample: 38
Models: P1/41
        EMB-110 (P1A)(P141)
        (P2)(P2/41)
        Bandeirante

### AVIONICS

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Figure 3-2 Regional Air Carrier Equipment for EMB-110 BANDEIRANTE
Manufacturer: Fairchild Aircraft Corp.  
Number in Population: 44  
Number of Engines: 2-TP  
Number in Sample: 44  
Gross Weight: 14,500 lbs.  
Models: SA-227(AC), METRO III (A), Swearingen Merlin, Metro II  
Similar Corp. versions are Merlin 4 (A)(C)

**AVIONICS**

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* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

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Figure 3-3  Regional Air Carrier Equipage for SA-227 METRO III
Manufacturer: Short Brothers
Number of Engines: 2-TP
Gross Weight: 22,900 lbs.

Number in Population: 36
Number in Sample: 36
Models: SD 3-30 (-200) SHORTS Sherpa

**AVIONICS**

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* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

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Figure 3-4  Regional Air Carrier Equipage for SD 3-30 SHORTS
Manufacturer: Fairchild Aircraft Corp.  
Number in Population: 34  
Number of Engines: 2-TP  
Number in Sample: 34  
Gross Weight: 12,500 lbs.  
Models: SA-226 (TC) Metro, 
Corporate Versions 
Fairchild 300 
Swearingen Merlin 
III & IV (A)

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* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

### Instruments

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Figure 3-5  Regional Air Carrier Equipage for SA-226 METRO II
Manufacturer: Short Brothers
Number of Engines: 2-TP
Gross Weight: 26,000 lbs.

Number in Population: 32
Number in Sample: 32
Models: SD3-60 Shorts Tucano

AVIONICS

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* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

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Manufacturer: DeHavilland
Number of Engines: 2-TP
Gross Weight: 12,500 lbs.
Number in Population: 29
Number in Sample: 29
Models: DHC-6-200, DHC-6-300
Twin Otter

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* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

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Figure 3-7 Regional Air Carrier Equipment for DHC-6 TWIN OTTER

3-10
Manufacturer: Convair  
Number of Engines: 2-TP  
Gross Weight: est. 50,000 lbs.

Number in Population: 29  
Number in Sample: 26  
Models: 580s/600s/640s  
CV-240/-340/-440  
Turbo Prop Conversion  
Convair-Liner  
Metropolitan

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Figure 3-8 Regional Air Carrier Equipage for CONVAIR 580/600/640
Manufacturer: De Havilland Aircraft of Canada, Ltd.
Number of Engines: 4-TP
Gross Weight: 44,000 lbs.

Number in Population: 26
Number in Sample: 26
Models: DHC-7 (100)
        DASH-7

Note: De Havilland now producing DASH-8's

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Figure 3-9 Regional Air Carrier Equipage for DHC-7 DASH 7
Manufacturer: Beech
Number of Engines: 2-TP
Gross Weight: 11,300 lbs.

Number in Population: 23
Number in Sample: 23
Models: 99, B99, C99
Beech-99 Airliner/Commuter

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Figure 3-10  Regional Air Carrier Equipage for BEECH 99
Manufacturer: Beech  
Number of Engines: 2-TP  
Gross Weight: 16,600 lbs.

Number in Population: 18  
Number in Sample: 18  
Models: 1900 Airliner

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Figure 3-11 Regional Air Carrier Equipage for BEECH 1900
Manufacturer: Fokker & Fairchild Indust.
Number in Population: 13
Number in Sample: 13
Number of Engines: 2-TP
Fokker F-27 Friendship
Fairchild/Hiller Aircraft
FH-227, FH-27
New Version Fokker 50

Gross Weight: 45,900 lbs.

### AVIONICS

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* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

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Figure 3-12  Regional Air Carrier Equipage for F-27 FOKKER

3-15
Manufacturer: Fokker  
Number of Engines: 2-Jet  
Gross Weight: 73,000 lbs.

Number in Population: 12  
Number in Sample: 12  
Models: F-28 MK 1000, MK 2000  
         MK 3000, MK 4000  
         New Version is Fokker  
         100

## AVIONICS

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Figure 3-13 Regional Air Carrier Equipage for F-28 FOKKER

3-16
Manufacturer: McDonnell Douglas  
Number in Population: 12  
Number of Engines: 2 Piston  
Number in Sample: 12  
Gross Weight: 25,200 lbs.  
Models: Unknown, Versions of DC-3 (A)

**AVIONICS**

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Figure 3-14 Regional Air Carrier Equipage for DC-3(A)
Manufacturer: Nihon Aeroplane Manuf. Co.  
Number in Population: 9  
Number of Engines: 2-TP  
Number in Sample: 9  
Models: YS-11, YS-11A

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* * Out of production, limited product support is available through Mitsubishi*

Figure 3-15  Regional Air Carrier Equipment for NIHON YS-11(A)
Manufacturer: Gulfstream Aerospace
Number of Engines: 2-TP
Gross Weight: 36,000 lbs.

Number in Population: 9
Number in Sample: 9
Models: G-159, G-159C
Gulfstream 1(C)
G-1

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Figure 3-16  Regional Air Carrier Equipage for G-159 GULFSTREAM I
Manufacturer: Aerospatiale
Number of Engines: 2-Piston
Gross Weight: 23,370 lbs.
Number in Population: 8
Number in Sample: 8
Models: Nord 262 Conversion
N-262
MOHAWK 298

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Figure 3-17 Regional Air Carrier Equipment for MOHAWK 298 (NORD 262 Conv.)
Manufacturer: British Aerospace  
Number of Engines: 4-Jet  
Gross Weight: 82,250/89,500 lbs.  
Number in Population: 6  
Number in Sample: 6  
Models: BAe 146 (-100) (-200)

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* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

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Figure 3-18 Regional Air Carrier Equipment for BAe 146
Manufacturer: British Aerospace
Number of Engines: 2-Jet
Gross Weight: 78,500 lbs.

Number in Population: 6
Number in Sample: 6
Models: BAC-111 (400) (475) (500)
One-eleven

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Figure 3-19 Regional Air Carrier Equipage for BAC 111 ONE-ELEVEN
Manufacturer: Glen L. Martin Co.  
Number of Engines: 2-Piston Radials  
Gross Weight: Estimated 45,000 lbs.  
Number in Population: 6  
Number in Sample: 6  
Models: Martin 404's

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Figure 3-20  Regional Air Carrier Equipment for MARTIN 404

3-23
Manufacturer: McDonnell Douglas
Number in Population: 5
Number in Sample: 5
Models: DC-9 Specifics Unknown

Number of Engines: 2-Jet
Gross Weight: 121,000 lbs.

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Figure 3-21 Regional Air Carrier Equipage for DC-9

3-24
Manufacturer: Saab-Fairchild
Number of Engines: 2-TP
Gross Weight: 27,000 lbs.

Number in Population: 3
Number in Sample: 3
Models: SF-340

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* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

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Figure 3-22 Regional Air Carrier Equipage for SF-340 SAAB
Manufacturer: British Aerospace
Number of Engines: 2-TP
Gross Weight: 15,210 lbs.

Number in Population: 2
Number in Sample: 2
Models: Bae 31, 3100, Jetstream 31

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Figure 3-23 Regional Air Carrier Equipment for BAe 31 JETSTREAM
Manufacturer: British Aerospace
Number of Engines: 2-TP
Gross Weight: 46,500 lbs.

Number in Population: 2
Number in Sample: 2
Models: HS 748 Hawkers

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Figure 3-24 Regional Air Carrier Equipage for HS 748 HAWKER
Manufacturer: Cessna
Number of Engines: 2-Jet
Gross Weight: 11,850 lbs.
Number in Population: 1
Number in Sample: 1
Models: C-500 Citation 1

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Figure 3-25 Regional Air Carrier Equipage for CESSNA CITATION 1
Manufacturer: Piper
Number of Engines: 1-Piston
Gross Weight: 1,750 lbs.

Number in Population: 1
Number in Sample: 1
Models: PA-18-150 Super Cub

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Figure 3-26 Regional Air Carrier Equipage for PIPER SUPER CUB
CHAPTER FOUR
EXECUTIVE AIRCRAFT

4.1 INTRODUCTION

Many corporations in the United States own and operate aircraft intended primarily for transporting executives at times most suited to their needs. These aircraft range from cabin class twin-engine piston aircraft to multi-engined jets. This section addresses the corporate jet fleet and limits the aircraft types to non-air carrier models to avoid duplication of data on aircraft which are similarly equipped. The aircraft considered are twin-engine jet except the Falcon-50, a three-engine jet, with corporate seating for 20 or fewer passengers. The Falcon-50 is the only three-engine jet aircraft in this seating category. The FAA General Aviation Activity and Avionic Survey report of 1983 identifies 3996 active turbojet aircraft in this category, which excludes large aircraft.

4.2 RESEARCH OF AVIONIC EQUIPAGE

We found the avionic equipage of executive aircraft by reviewing airframe manufacturers' portfolios on recommended equipage, specifications for standard factory-installed equipment, used aircraft literature, and by asking avionic manufacturers about typical configurations for their products in the executive aircraft market. The results of the research are presented in the following section, grouped by aircraft models. The typical executive aircraft is well equipped with dual avionics, radar systems, and in many cases, area navigation capability using VOR/DME, Omega, or Loran-C. This study, however, only considers VOR/DME-based area navigation because it is now the only area navigation system approved for non-precision approaches.

4.3 EXECUTIVE AIRCRAFT AVIONIC EQUIPAGE

The aircraft considered in this study are primarily those manufactured by Cessna, Gates, Sabreliner, Gulfstream, Dassault, British Aerospace, and Canadair. The aircraft populations are identified in Table 4-1.
These companies manufacture the majority of corporate jet aircraft used in the United States. Figures 4-1 through 4-10 show the typical avionic equipage for these aircraft based on either the standard avionics installed by the airframe manufacturer or the recommended equipage for the intended class of service.

The avionic models shown in the figures are typical of the systems found in these aircraft. Other avionics manufacturer's equivalent equipment may be substituted without changing the capability of the avionic suite. The customer often adds on area navigation system for RNAV, either VOR/DME based, Omega/VLF, Loran-C, or inertial navigation depending on intended use of the aircraft.

We have combined many models (e.g., Gates Learjet series) because of the similarity of avionics throughout the models. Where distinct variations occur (e.g., Dassault Falcons), each model is presented separately. Also, aircraft manufactured outside the U.S. (e.g., Dassault Falcon) are delivered without avionics and retrofitted to customer specifications at Dassault facilities in the U.S.

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Table 4-1 Executive Jet Aircraft
Manufacturer: Gates Learjet
Number of Engines: 2-Jet
Gross Weight: 15,000 - 18,550 lbs.
Number in Population: 581
Number in Sample: 11
Models: 24, 25, 28, 29, 35A, 36A

**AVIONICS**

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Models:
- VIR 30
- DME 40
- ADF 60
- Jet FC-110, FC-200
- Sperry, Collins
- Collins, Sperry, Bendix

**INSTRUMENTS**

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Figure 4-1  Executive Jet Avionics Equipage for LEARJETS
Manufacturer: Gates Learjet
Number of Engines: 2-Jet
Gross Weight: 21,250 lbs.

Number in Population: 103
Number in Sample: 2
Models: 55, 55ER, 55LR

AVIONICS

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</table>
Manufacturer: Dassault-Breguet
Number of Engines: 2-Jet
Gross Weight: 18,740 lbs.

Number in Population: UNK
Number in Sample: 6
Models: Falcon 10
Falcon 100

### AVIONICS

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Figure 4-3 Executive Jet Avionics Equipage for FALCON 10

4-5
Manufacturer: Dassault  
Number of Engines: 2-Jet  
Gross Weight: 30,650 lbs.  

Number in Population: 216  
Number in Sample: 8 plus Mfgr.  
Models: Falcon C20, F20  
Falcon 200

AVIONICS

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* EFIS for 200, HSI for 20

Figure 4-4 Executive Jet Avionics Equipage for FALCON 20
Manufacturer: Dassault-Breguet  
Number of Engines: 3-Jet  
Gross Weight: 38,800 lbs.

Number in Population: 82  
Number in Sample: Mfgr. Equipage  
Models: Falcon 50

### AVIONICS

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Figure 4-5  Executive Jet Avionics Equipage for FALCON 50
Manufacturer: Sabreliner Corp.  
Number in Population: 341  
Number in Sample: Mfgr. Equipage  
Number of Engines: 2-Jet  
Models: 40(A)(R)(SE), 60, 65, 75(A) Sabreliner  
Gross Weight: 17,450 lbs.  
Number in Sample: Mfgr. Equipage  
Models: NA-265(-40)(-60)(-70)(-40A)  
NA-265-80 SABRE 75A

**AVIONICS**

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Figure 4-6  Executive Jet Avionics Equipage for SABRELINERS
**Manufacturer:** British Aerospace  
**Number of Engines:** 2-Jet  
**Gross Weight:** 25,500 lbs.  
**Number in Population:** Unknown  
**Number in Sample:** Mfr. Equipage  
**Models:** Hawker Siddeley  
Beech BH-125 (-400A)(-600)  
DH 125 (-1A)(-3A)(-3AR)  
(-400)(-600)  
HS-125-700  
BAe-125-700 (-800)  

### AVIONICS

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*Figure 4-7  Executive Jet Avionics Equipage for HS 125 HAWKER*
Manufacturer: Canadair  
Number of Engines: 2-Jet  
Gross Weight: 41,250 - 41,800 lbs.

Number in Population: Limited  
Number in Sample: Mfgr. Equipage  
Models: CL 600/601 Challenger

**AVIONICS**

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* Optional RNAV, VLF

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Figure 4-8 Executive Jet Avionics Equipage for CL 600/601 CHALLENGER
Manufacturer: Gulfstream Aerospace
Number in Population: 250+
Number of Engines: 2-Jet
Gross Weight: 39,100
Number in Sample: Mfgr. Equipage
Models: Gulfstream II (-B)

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<td>-</td>
<td>-</td>
<td>- -</td>
</tr>
<tr>
<td>Radar</td>
<td></td>
<td>-</td>
<td>100</td>
<td>-</td>
<td>Sperry, Collins, Bendix</td>
</tr>
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INSTRUMENTS

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<td>RMI</td>
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</tr>
<tr>
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</table>

Figure 4-9  Executive Jet Avionics Equipage for GULFSTREAM II
Manufacturer: Gulfstream  
Number in Population: 150  
Number of Engines: 2-Jet  
Gross Weight: 68,700  
Number in Sample: Mfgr. Equipage  
Models: Gulfstream III

### AVIONICS

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<tr>
<td>ADF</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>RNAV</td>
<td>-</td>
<td>*</td>
</tr>
<tr>
<td>Auto Pilot</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>Flight Director</td>
<td>-</td>
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<tr>
<td>IFC</td>
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<tr>
<td>Radar</td>
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</table>

* Optional RNAV, VLF

* SPZ 800
* SPI 800

**Radar**

- **IFC**
- **Radar**

### INSTRUMENTS

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<th>CoPilot</th>
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</tr>
<tr>
<td>CDI</td>
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* EFIS available (EDZ 800)

---

**Figure 4-10** Executive Jet Avionics Equipage for GULFSTREAM III
CHAPTER FIVE
GENERAL AVIATION AIRCRAFT

5.1 INTRODUCTION

The general aviation group encompasses all types of aircraft, including those typically found in the air carrier group. However, for the purposes of this study, we limited the general aviation aircraft presented in this chapter to the twin-engine turboprop, twin-engine piston and the single engine aircraft suitable for IFR flight. We expect cabin class twin-engine aircraft typically to be well equipped, exceeding the minimum required avionics for IFR operations. Systems typically found in these aircraft include autopilots, radar, flight directors, area navigation and integrated displays. The annual summary report “General Aviation Activity and Avionics Survey” estimates that these are 5037 active twin-engine turboprop and 24882 active twin-engine piston aircraft in the United States. Similarly, the report lists 164,173 active single engine aircraft. Of these groups we assumed all twin-engine aircraft to be IFR-equipped, and 50 percent of single engine aircraft to be IFR-equipped. These assumptions were based on a comparison of minimum recommended avionics for IFR operation and the statistics contained in the report on navigation equipage for these classes of aircraft.

5.2 DEVELOPMENT OF AVIONIC EQUIPAGE

We have enough data from aircraft resale publications and avionic manufacturers to identify the probable configuration of twin-engine aircraft, especially larger cabin-class twins. Therefore, we have compiled data for each aircraft type using several sources of information. Table 5-1 lists the aircraft that were evaluated, the estimated total population of each, the sample size researched, and the number manufactured since 1979. The latter is important because the newer craft have excellent avionics configurations; avionics manufacturers indicate that the majority of twin-engine aircraft built since 1979 are equipped with the manufacturers’ recommended avionic suites. The aircraft owner typically specifies the avionic manufacturer, panel or remote mounting, and the RNAV or radar system.
Table 5-1  General Aviation Aircraft—Twin Engine Cabin Class

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Manufacturer</th>
<th>Year End '84</th>
<th>Total Population Since 1979</th>
<th>Number in Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 Super King Air</td>
<td>Beech</td>
<td>1309</td>
<td>800</td>
<td>40</td>
</tr>
<tr>
<td>100 King Air</td>
<td>Beech</td>
<td>384</td>
<td>83</td>
<td>11</td>
</tr>
<tr>
<td>90 King Air</td>
<td>Beech</td>
<td>1659</td>
<td>525</td>
<td>45</td>
</tr>
<tr>
<td>425 Conquest I</td>
<td>Cessna</td>
<td>196</td>
<td>196</td>
<td>15</td>
</tr>
<tr>
<td>441 Conquest II</td>
<td>Cessna</td>
<td>332</td>
<td>254</td>
<td>10</td>
</tr>
<tr>
<td>Cheyenne I &amp; II</td>
<td>Piper</td>
<td>808</td>
<td>501</td>
<td>19</td>
</tr>
<tr>
<td>Cheyenne III</td>
<td>Piper</td>
<td>108</td>
<td>108</td>
<td>8</td>
</tr>
<tr>
<td>Aero Commander</td>
<td>Rockwell/Gulfstream</td>
<td>Unknown</td>
<td>376</td>
<td>18</td>
</tr>
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</table>

**Turboprop**

**Piston**

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Manufacturer</th>
<th>Year End '84</th>
<th>Total Population Since 1979</th>
<th>Number in Sample</th>
</tr>
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<td>421 Golden Eagle</td>
<td>Cessna</td>
<td>1899</td>
<td>392</td>
<td>17</td>
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<tr>
<td>414 Chancellor</td>
<td>Cessna</td>
<td>1052</td>
<td>405</td>
<td>21</td>
</tr>
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<td>1520</td>
<td>460</td>
<td>7</td>
</tr>
<tr>
<td>340</td>
<td>Cessna</td>
<td>1283</td>
<td>457</td>
<td>Mfr-Specs</td>
</tr>
<tr>
<td>303 Crusader</td>
<td>Cessna</td>
<td>284</td>
<td>284</td>
<td>Mfr-Specs</td>
</tr>
<tr>
<td>Mojave</td>
<td>Piper</td>
<td>37</td>
<td>37</td>
<td>1</td>
</tr>
<tr>
<td>Navajo/Chieftain</td>
<td>Piper</td>
<td>3827</td>
<td>1080</td>
<td>20</td>
</tr>
<tr>
<td>Aerostar 601-602</td>
<td>Piper</td>
<td>1004</td>
<td>420</td>
<td>10</td>
</tr>
<tr>
<td>B-60 Duke</td>
<td>Beech</td>
<td>596</td>
<td>105</td>
<td>8</td>
</tr>
<tr>
<td>B55/58 Baron</td>
<td>Beech</td>
<td>5711</td>
<td>1087</td>
<td>31</td>
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</tbody>
</table>

The light twins and single engine aircraft present a different problem in identifying typical equipage because of the diversity of available avionics, limitations of available panel space, and intended service of the aircraft. It is safe to assume that an IFR-equipped aircraft will have dual navigation receivers (or combined NAV/COM transceivers) with an ADF receiver and associated indicators. However, the indicators for navigation can be the integrated HSIIs, which provide magnetic heading, glide slope deviation, and course deviation, and the radio magnetic indicator, which provides magnetic heading and dual radio bearings, or the less expensive and more popular combination of directional gyro's, ADF indicators, and CDIs that perform the same functions. Distance measuring equipment (DME) is becoming increasingly popular in smaller aircraft. However, DMEs are not mandatory for flight below 24,000
feet, where the majority of these aircraft fly. In trying to identify the probable equipage of these aircraft, we contacted the leading avionics manufacturers and obtained the total number of avionic units produced since 1970, by model number, year of introduction, and current status of the production. This information, together with the FAA avionic survey results, allowed us to estimate the probable configurations in the light-twin and single-engine aircraft.

5.3 GENERAL AVIATION AIRCRAFT AVIONIC EQUIPAGE

The twin-engine turboprop aircraft included in this section are all manufactured in the United States and used for corporate, business, or private passenger transport. They are designed to accommodate two pilots, although many can be flown with one, depending on the service provided. They are typically very well equipped with remotely mounted avionics, integrated flight controls, area navigation equipment, and radar systems. Every aircraft researched was fitted with integrated functions displayed on an HSI for the pilot, and many provided HSI displays for the co-pilot. A large sample included long range capability such as Omega or Loran-C navigation and HF communications, which indicates that these aircraft occasionally operate outside the continental United States. Figures 5-1 through 5-8 present the equipage for turboprop twin-engine aircraft based on the samples used in the study. It is expected that the majority of the aircraft in the total population will be comparably equipped.

The majority of twin-engine piston type aircraft evaluated are configured for single-pilot operation, with instruments on the left side of the panel only. The aircraft have dual navigation receivers, single DMEs and a single ADF. However, of the 134 aircraft evaluated, only 103 (or 77 percent) were equipped with an HSI on the pilot’s side. The remainder used the less expensive combination of a directional gyro (DG) and separate CDI indicators. Review of the manufacturers’ specifications for these aircraft showed that the DG configuration was the standard for the aircraft with HSIs offered as additional cost options. Thirty seven (37) percent of the cabin class twins were equipped with area navigation equipment while seventy three (73) percent had weather radar capability ranging from monochrome to digitized color displays. Figures 5-9 through 5-18 present the results of the research for cabin class
Manufacturer: Beech
Number in Population: 1309
Number of Engines: 2-TP
Number Produced Since 1979: 800
Models: 200, B200
Number in Sample: 40
Super King Air

AVIONICS

<table>
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<th>Dual</th>
<th>Models</th>
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<td>-</td>
<td>-</td>
<td>100</td>
<td>VIR-30, KNR-634, KFS-564</td>
</tr>
<tr>
<td>DME</td>
<td></td>
<td>-</td>
<td>82</td>
<td>18</td>
<td>DME-40, KDM-706</td>
</tr>
<tr>
<td>ADF</td>
<td></td>
<td>-</td>
<td>100</td>
<td>-</td>
<td>ADF-60, KDF-806</td>
</tr>
<tr>
<td>RNAV</td>
<td></td>
<td>50</td>
<td>50</td>
<td>-</td>
<td>KNC-610, AD-611, ANS-31</td>
</tr>
<tr>
<td>Auto Pilot</td>
<td></td>
<td>-</td>
<td>32*</td>
<td>-</td>
<td>AP-105</td>
</tr>
<tr>
<td>Flight Director</td>
<td></td>
<td>-</td>
<td>30*</td>
<td>-</td>
<td>FD-108</td>
</tr>
<tr>
<td>IFC</td>
<td></td>
<td>-</td>
<td>68</td>
<td>-</td>
<td>SPZ 200, STARS/SPI 400/500, KFC-300, FCS-80</td>
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<tr>
<td>Radar</td>
<td></td>
<td>30</td>
<td>70</td>
<td>-</td>
<td>RDR-1200, RDR-1300, Primus</td>
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</tbody>
</table>

* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

INSTRUMENTS

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<th>% Dual</th>
<th>Models</th>
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<tr>
<td>HSI</td>
<td>100</td>
<td>-</td>
<td>King, Collins, 100</td>
</tr>
<tr>
<td>RMI</td>
<td>100</td>
<td>-</td>
<td>Sperry</td>
</tr>
<tr>
<td>CDI</td>
<td>0</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>CoPilot</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Models</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 5-1 G.A. Turboprop Equipage for BEECH 200 SUPER KING AIRS
Manufacturer: Beech  
Number of Engines: 2-TP  
Number in Population: 384  
Number Produced Since 1979: 83  
Models: 100, A100, B100,  
Beech 100 King Air  
Number in Sample: 11

**AVIONICS**

<table>
<thead>
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<th>Models</th>
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<td>-</td>
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<td>VIR-30, KNR-660, KNR-661</td>
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<tr>
<td>DME</td>
<td>-</td>
<td>100</td>
<td>*</td>
<td>DME-40, KDM-705</td>
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<tr>
<td>ADF</td>
<td>-</td>
<td>100</td>
<td>-</td>
<td>ADF-60, KDF-806</td>
</tr>
<tr>
<td>RNAV</td>
<td>45</td>
<td>55</td>
<td>-</td>
<td>KNC-610, AD-611, ANS-31</td>
</tr>
<tr>
<td>Auto Pilot</td>
<td>27</td>
<td>9*</td>
<td>-</td>
<td>M4D, AP-105</td>
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<tr>
<td>Flight Director</td>
<td>-</td>
<td>*</td>
<td>-</td>
<td>- -</td>
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<tr>
<td>IFC</td>
<td>-</td>
<td>64</td>
<td>-</td>
<td>SPZ 200A (Star IV), FCS-105 (FD-108/FD-109)</td>
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<td>27</td>
<td>73</td>
<td>-</td>
<td>Primus, RDR-130, RDR-1200, 21 RDR-1300</td>
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* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

**INSTRUMENTS**

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<td><strong>CDI</strong></td>
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Figure 5-2  G.A. Turboprop Avionics Equipage for BEECH 100 KING AIRS
Manufacturer: Beech  
Number in Population: 1659  
Number of Engines: 2-TP  
Number Produced Since 1979: 524  
Models: 90, A90, B90, C90, E90, F90  
Number in Sample: 45

AVIONICS

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<td>100</td>
<td>-</td>
<td>DME-40, KDM-705, KDM-706</td>
</tr>
<tr>
<td>ADF</td>
<td>-</td>
<td>100</td>
<td>-</td>
<td>ADF-60, KDF-806</td>
</tr>
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<td>KNS-610, ANS-31, AD-611, ANS-351, 612</td>
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<td>H-14, M4D, AP-200</td>
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<tr>
<td>Flight Director</td>
<td>-</td>
<td>10*</td>
<td>-</td>
<td>FD-108</td>
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<tr>
<td>IFC</td>
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<td>55</td>
<td>-</td>
<td>SPZ 200A/STARS/SI, KFC-300, CENTURY IV</td>
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* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

INSTRUMENTS

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<tr>
<td></td>
<td></td>
<td></td>
<td>Collins, King</td>
<td></td>
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<td>Collins, King</td>
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<td>&quot;</td>
<td>100</td>
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<td>&quot;</td>
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Note: 9% of sample was equipped with panel mounted avionics (Collins, Microline and King Silver Crown)

Figure 5-3  G.A. Turboprop Avionics Equipage for BEECH 90 KING AIRS
Manufacturer: Cessna
Number of Engines: 2-TP
Models: 425 Conquest I
Number in Population: 196
Number Produced Since 1979: 196
Number in Sample: 15

**AVIONICS**

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<td>-</td>
<td>1077</td>
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<td>100</td>
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<td>1046</td>
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<td>33</td>
<td>-</td>
<td>1000RNAY, 612, 616</td>
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<td>-</td>
<td>25*</td>
<td>-</td>
<td>1000 AP, SP 200</td>
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<td>10*</td>
<td>-</td>
<td>SPI-400, Sperry RD-450</td>
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<tr>
<td>IFC</td>
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<td>10</td>
<td>1000 IFCS (FIS-70), (SP2-500)</td>
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<td>-</td>
<td>WXR 300C, RDR-160</td>
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* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

**INSTRUMENTS**

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<td>20</td>
<td>-</td>
<td>3 inch</td>
</tr>
<tr>
<td>RMI</td>
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<td>-</td>
<td>IN-404A</td>
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<td>-</td>
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</tr>
<tr>
<td>CDI</td>
<td>100</td>
<td>-</td>
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<td>0</td>
<td>-</td>
<td></td>
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</tbody>
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Figure 5-4  G.A. Turboprop Avionics Equipage CESSNA 425 CONQUEST I
Manufacturer: Cessna  
Number in Population: 332  
Number of Engines: 2-TP  
Number Produced Since 1979: 254  
Number in Sample: 10  
Models: 441 Conquest  
441 Conquest II

### AVIONICS

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<td>50</td>
<td>-</td>
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<td>*</td>
<td>-</td>
<td>-</td>
</tr>
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* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

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Figure 5-5  G.A. Turboprop Avionics Equipage for CESSNA 441 CONQUEST II
Manufacturer: Piper  
Number in Population: 808  
Number of Engines: 2-TP  
Number Produced Since 1979: 501  
Number in Sample: 19  
Models: PA-31T1, PA-31TA, Cheyenne (I)  
PA-31T, PA-31T2  
Cheyenne II (XL)

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* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

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*Figure 5-6 G.A. Turboprop Avionics Equipage for PIPER CHEYENNE I & II*
Manufacturer: Piper
Number in Population: 108
Number of Engines: 2-TP
Number Produced Since 1979: 108
Models: PA-42-720,
Cheyenne (A)(III)
PA-42-1000
Cheyenne 400LS

Number in Sample: 8

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* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

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Figure 5-7  G.A. Turboprop Avionics Equipage for PIPER CHEYENNE III
Manufacturer: Rockwell/Gulfstream  Number in Population: Unknown
Aerospace  Number Produced Since 1979: 376
Number of Engines: 2-TP  Number in Sample: 18
Rockwell Commander
840, 900, 980, 1000 Commander

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* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

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Figure 5-8  G.A. Turboprop Avionics Equipage for ROCKWELL COMMANDERS
Manufacturer: Cessna  
Number in Population: 1899  
Number of Engines: 2-Piston  
Number Produced Since 1979: 392  

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* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

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Figure 5-9  General Aviation Avionics Equipage for CESSNA 421 GOLDEN EAGLE

5-12
Manufacturer: Cessna  
Number in Population: 1052  
Number of Engines: 2-Piston  
Number Produced Since 1979: 405  
Models: 414, 414 II, 414A Challenger  
Number in Sample: 21

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* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

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Figure 5-10 General Aviation Avionics Equipage for CESSNA 414 CHANCELLOR
Manufacturer: Cessna  
Number in Population: 1520
Number of Engines: 2-Piston  
Number Produced Since 1979: 460
Number in Sample: 7

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* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

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Figure 5-11 General Aviation Avionics Equipment for CESSNA 402
Manufacturer: Cessna  
Number in Population: 1283  
Number of Engines: 2 Piston  
Number Produced Since 1979: 457  
Models: 340, 340 II, 340A II  
Number in Sample: Mfgr. Specs.

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* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

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Figure 5-12 General Aviation Avionics Equipment for CESSNA 340

5-15
Manufacturer: Cessna  
Number in Population: 284  
Number of Engines: 2-Piston  
Number Produced Since 1979: 284  
Models: 303 Crusader  
Number in Sample: Mfgr. Specs.

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* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

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Figure 5-13 General Aviation Avionics Equipment for CESSNA 303 CRUSADER

5-16
Manufacturer: Piper  
Number in Population: 37  
Number of Engines: 2-Piston  
Number Produced Since 1979: 37  
Models: PA-31P-350  
Mojave  
Number in Sample: 1  

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* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

**INSTRUMENTS**

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Figure 5-14  General Aviation Avionics Equipage for PIPER MOJAVE
Manufacturer: Piper  
Number in Population: 3827

Number of Engines: 2-Piston  
Number Produced Since 1979: 1,080

Models:  
- PA-31-310 Navajo  
- PA-31-325 Navajo CR  
- PA-31-350 Chiefian  
- PA-31P-425 Pressurized Navajo  

Number in Sample: 20

### AVIONICS

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* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

### INSTRUMENTS

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Figure 5-15  General Aviation Avionics Equipage for PIPER NAVAJO and CHIEFTAIN

5-18
Manufacturer: Piper
Number in Population: 1004
Number of Engines: 2-Piston Number Produced Since 1979: 420
Models: PA-60-600 Aerostar 600
PA-60-601B Aerostar 601B
PA-60(-601P) (-602P) (-700P)
Pressurized Aerostar 601

AVIONICS

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* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

INSTRUMENTS

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Figure 5-16 General Aviation Avionics Equipage for PIPER AEROSTAR
Manufacturer: Beech  
Number in Population: 596  
Number of Engines: 2-Piston  
Number Produced Since 1979: 105  
Models: Duke 60, A60  
Duke (A60) (B60)  
Number in Sample: 8

AVIONICS

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<td>VIR-351, KX-165, KX-175, KN-53</td>
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<td>DME</td>
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<td>DME-251, KN-65, KN-63, VDI-4</td>
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<tr>
<td>RNAV</td>
<td>62</td>
<td>KR-85, KR-87, ADF-650</td>
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<td>Auto Pilot</td>
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<td>Century III, Century IV, Century 41</td>
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<td>Radar</td>
<td>25</td>
<td>RDR-130, RDR-160, AVQ-50, KWX-60</td>
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* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

INSTRUMENTS

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<td>12</td>
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Figure 5-17 General Aviation Avionics Equipage for BEECH 60 DUKE

5-20
Manufacturer: Beech  
Number in Population: 5711  
Number of Engines: 2-Piston  
Number Produced Since 1979: 1087  
Models: B-55, E-55, 58, 58P, 58 TC, Baron  
Number in Sample: 31

**AVIONICS**

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<td>KN-65, KN-60, DME-451, 2000</td>
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<td>19*</td>
<td>-</td>
<td>B-5, Century III,</td>
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<td>-</td>
<td>*</td>
<td>-</td>
<td>--</td>
</tr>
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<td>IFC</td>
<td></td>
<td>61</td>
<td>65</td>
<td>-</td>
<td>KFC-200, Century IV</td>
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<td>39</td>
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<td>RDR-160, RDR-150, KWX-56</td>
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* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

**INSTRUMENTS**

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<td>-</td>
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<td>CDI</td>
<td>65</td>
<td>35</td>
<td>VOA-3, VOA-9, KI-206</td>
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Figure 5-18  General Aviation Avionics Equipage for BEECH 55 and 58 BARON

5-21
Table 5-2  General Aviation Navigation Avionics Manufactured Since 1970

<table>
<thead>
<tr>
<th>Function</th>
<th>Quantity Produced</th>
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<td>Navigation Receiver</td>
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<tr>
<td>Distance Measuring Equipment</td>
<td>92,949</td>
</tr>
<tr>
<td>Area Navigation</td>
<td>26,196</td>
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<td>Auto Pilots</td>
<td>43,954</td>
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<tr>
<td>Flight Directors</td>
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<td>48,201</td>
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<tr>
<td>RMI</td>
<td>23,545</td>
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<tr>
<td>CDI</td>
<td>253,683</td>
</tr>
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</table>

Twin-engine piston aircraft. The avionic models listed are typical of the equipment installed in these aircraft. Comparable equipment from other manufacturers will be found in the total population and will not change the capability provided by the avionics. We found a variety of indicators during the research. The models are not shown because of the number of different units involved. However, since this class of aircraft uses various standard panel and equipage configurations, the CDI or RMI indicators are usually matched to the avionics and can be readily obtained from manufacturers’ lists. Aircraft manufactured since 1979 are likely to be as well or better equipped than those in the limited sample.

The light twin and single-engine aircraft equipped for IFR operations primarily use panel-mounted avionics with single pilot instrumentation. We contacted King Radio, Collins, Sperry, and Narco, the dominant manufacturers of avionics for this class of aircraft, and obtained the avionic productions quantities manufactured since 1970. Table 5-2 lists the totals for these manufacturers in the areas of interest. Combining the information in Table 5-2 with data contained in the FAA General Aviation Activity and Avionics Survey report shows potential aircraft equipage if we assume that a majority of
the avionics manufactured are installed in aircraft operating under IFR conditions. The FAA report shows 70,713 aircraft in the single and light twin category have flown IFR. The remaining active aircraft (i.e., 109,841) are predominantly in the 1-3 seat single engine and 4 or over seat single engine category. The majority (95 percent) of the active twin engine aircraft have flown IFR and therefore we assume they have the proper equipment for IFR flight. Figure 5-19 shows the probable equippage of the single-engine and light twin-engine aircraft based on the IFR population and manufacturers' production quantities. Because of the diversity and age of some avionics, the models are not shown on the figure. However, a listing of suitable avionics produced by the major manufacturers is included in Volume II of this report. Additional manufacturers also produce avionic systems suitable to this class of aircraft, but may not have surfaced in these limited samples of aircraft data. The units produced by these manufacturers would increase the probable equipage percentage for both IFR and non-IFR aircraft.
Manufacturer: Various  
Number in Population: 70,713  
Number of Engines: 1 to 2 Piston

AVIONICS

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</tr>
<tr>
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<td>85</td>
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<tr>
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<td></td>
</tr>
<tr>
<td>RNAV</td>
<td>80</td>
<td>20**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auto Pilot</td>
<td>20</td>
<td>60*</td>
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</table>

* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

** Does not include avionics manufactured by other companies such as Foster, leading manufactures of RNAV.

INSTRUMENTS

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<td>70</td>
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<td>0</td>
</tr>
<tr>
<td>CDI</td>
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<td>70</td>
<td>0</td>
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Figure 5-19 General Aviation Light Twin Engine and Single Engine Avionics Equipage

5-24
6.1 INTRODUCTION

The rotorcraft fleet in the United States is currently approaching 9,500 aircraft that are used for passenger transport, law enforcement, and cargo applications. Helicopters primarily operate at low altitudes and in areas normally not accessible by fixed wing aircraft. Because the ATC was developed to manage aircraft in terminal areas and enroute airspace, the ATC system does not generally serve low flying aircraft. For this reason, a majority of the current rotorcraft operate under VFR conditions. However, IFR rotorcraft must abide by the same rules as fixed wing aircraft and therefore have similar avionics as the fixed wing counterparts. Because this study focuses on aircraft which operate in instrument meteorological conditions (IMC) in the terminal environment, we have concentrated our efforts on rotorcraft that are currently IFR-certified and contain navigation equipment suitable for advanced approaches.

6.2 DEVELOPMENT OF ROTORCRAFT AVIONIC EQUIPAGE

TRIAD Engineering, Inc. under contract to RJO Enterprises, Inc. was tasked to develop the avionic suite common to IFR certified rotorcraft. Because of the dispersement of rotorcraft throughout the United States it was impossible to collect accurate data through contact with each owner. Therefore, TRAID had to talk with the airframe manufacturers and rotorcraft fleet operators and obtain their recommendations for avionic equipage.

Sixteen manufacturers of rotorcraft account for 9,450 units flying in the U.S. Eight of these manufacturers account for 88 percent of the total population and were selected for analysis in this study. Table 6-1 identifies these manufacturers, the number of helicopters in the U.S. fleet, and the number of helicopters that are IFR-certified. On the basis of manufacturers' data at the time of rotorcraft delivery,
only seven percent of the population is IFR certified. Additional units could be IFR certified by companies involved in customizing and equipping helicopters after sale. We talked with two such companies and confirmed the concept of IFR equipage, but these companies did not maintain records on numbers or types involved. One company indicated an average of five helicopters retrofitted every year.

Table 6-1 Helicopter Population in U.S. Fleet

<table>
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<th>Manufacturer</th>
<th>No. of Units</th>
<th>IFR Certified*</th>
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<td>Aerospatiale</td>
<td>735</td>
<td>84</td>
</tr>
<tr>
<td>Agusta</td>
<td>45</td>
<td>40</td>
</tr>
<tr>
<td>Bell</td>
<td>4430</td>
<td>294</td>
</tr>
<tr>
<td>Boeing</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Hiller</td>
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<td>0</td>
</tr>
<tr>
<td>Hughes</td>
<td>1625</td>
<td>0</td>
</tr>
<tr>
<td>MBB</td>
<td>110</td>
<td>0</td>
</tr>
<tr>
<td>Sikorsky</td>
<td>600</td>
<td>160</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td><strong>8348</strong></td>
<td><strong>581</strong></td>
</tr>
</tbody>
</table>

* Certification data based on manufacturers information at time of delivery

6.3 ROTORCRAFT AVIONIC EQUIPAGE

The five rotorcraft manufacturers that offer IFR-certified units provided avionics equipage data for the aircraft in their inventory. Aerospatiale produces eight helicopter models that have been IFR-certified — three of these models have a very small percentage (i.e., less than four percent) of the helicopters certified, while the other five models are 100 percent IFR-certified. Data was available on six of the Aerospatiale models and is included in this study. Agusta manufactures two models, the majority of which are IFR certified. Bell Helicopters has five models certified for IFR operations: one model has five percent of its helicopters certified for IFR flight, the second has 70 percent, the third has 90 percent, the fourth has 95 percent and the fifth has 100 percent. Only the four models with over five percent...
certified were included in this report. Boeing Vertol has delivered only three helicopters for use in the U.S. All are IFR certified and included in this study. Sikorsky's main civilian production helicopter is the S-76 which is used for off-shore oil exploration, corporate transportation, and commercial applications. Most of the S-76 helicopters are IFR-certified. The Sikorsky S-61 and S-62 helicopters are predominantly flown VFR and are not included in the study.

Table 6-2 shows the helicopter population by model number, manufacturer, use, and quantities in service that are IFR certified. Figures 6-1 through 6-14 identify the avionic equipage of each model based on the factory recommended or installed avionics at time of delivery. Modifications or additions by individuals or fleet operators after delivery are not known.

<table>
<thead>
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<th>Manufacturer</th>
<th>Service</th>
<th>Population</th>
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<tr>
<td>330 Puma</td>
<td>Aerospatiale</td>
<td>Commercial</td>
<td>15</td>
</tr>
<tr>
<td>332 Super Puma</td>
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<td>350 Astar</td>
<td>Aerospatiale</td>
<td>Commercial</td>
<td>7</td>
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<tr>
<td>355 Twin Star</td>
<td>Aerospatiale</td>
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<td>365 Dauphin II</td>
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<td>Aerospatiale</td>
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<tr>
<td>109A &amp; 109A-II</td>
<td>Agusta</td>
<td>Corporate</td>
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</tr>
<tr>
<td>212 212</td>
<td>Bell</td>
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<td>S-76</td>
<td>Sikorsky</td>
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<td>86</td>
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<tr>
<td>TOTAL</td>
<td></td>
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<td>506</td>
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6-3
Manufacturer: Aerospatiale  
Type of Service: Commercial  
Model: 330 Puma  
Number in Population: 15  
Number IFR Certified: 15

### AVIONICS

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Figure 6-1  IFR Rotorcraft Equipage for AEROSPATIALE 330 PUMA
Manufacturer: Aerospatiale  
Type of Service: Commercial  
Model: 332 Super Puma

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Figure 6-2  IFR Rotorcraft Equipage for AEROSPATIALE 332L1 SUPER PUMA
Manufacturer: Aerospatiale
Type of Service: Commercial
Model: 350D ASTAR
350B Ecureuil

Number in Population: 250
Number IFR Certified: 7

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Figure 6-3 IFR Rotorcraft Equipage for AEROSPATIALE 350D A STAR

6-6
Manufacturer: Aerospatiale
Type of Service: Commercial
Model: 355F2 Twin Star

Number in Population: 162
Number IFR Certified: 5

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Figure 6-4  IFR Rotorcraft Equipage for AEROSPATIALE 355F2 TWIN STAR
Manufacturer: Aerospatiale
Type of Service: Commercial
Model: 365 Dauphin II

Number in Population: 18
Number IFR Certified: 18

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* Integrated Flight Control (IFC) includes an autopilot and flight director.

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Figure 6-5  IFR Rotorcraft Equipment for AEROSPATIALE 365 DAULPHIN II
Manufacturer: Aerospatiale  
Type of Service: U.S. Coast Guard  
Model: 366 Dauphin II

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Figure 6-6  IFR Rotorcraft Equipment for AEROSPATIALE 366 DAULPHIN II
Manufacturer: Agusta
Type of Service: Corporate
Models: A109A, 109AII

Number in Population: 45
Number IFR Certified: 40

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* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

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Figure 6-7  IFR Rotorcraft Equipage for AGUSTA 109A (II)
Manufacturer: Bell
Type of Service: Commercial
Model: 212
Number in Population: 170
Number IFR Certified: 119

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Figure 6-8  IFR Rotorcraft EQUIPAGE FOR BELL 212
Manufacturer: Bell
Type of Service: Commercial
Model: 214ST Super Transport

Number in Population: 20
Number IFR Certified: 20

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Figure 6-9  IFR Rotorcraft Equipage for BELL 214 SUPER TRANSPORT

6-12
Manufacturer: Bell  
Number in Population: 75  
Type of Service: Commercial  
Model: 222  
Number IFR Certified: 71

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Figure 6-10  IFR Rotorcraft Equipment for BELL 222
Manufacturer: Bell
Type of Service: Commercial
Model: 412

Number in Population: 60
Number IFR Certified: 54

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Figure 6-11  IFR Rotorcraft Equipt for BELL 412
Manufacturer: Boeing Vertol  
Type of Service: Commercial/Off-shore  
Model: 234 Chinook

Number in Population: 3  
Number IFR Certified: 3

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Figure 6-12  IFR Rotorcraft Equipage for BOEING VERTOL 234 CHINOOK
Manufacturer: Sikorsky  
Type of Service: Corporate  
Model: S-76

Number in Population: 51  
Number IFR Certified: 51

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<td>-</td>
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* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

### INSTRUMENTS

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<th>Co-Pilot Models</th>
<th>Pilot Models</th>
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<td>RMI-36</td>
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<tr>
<td>CDI</td>
<td>Collins</td>
<td>Collins</td>
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</table>

Figure 6-13  IFR Rotorcraft Equipage for SIKORSKY S-76 CORPORATE

6-16
**Manufacturer:** Sikorsky  
**Number in Population:** 86  
**Type of Service:** Off-Shore  
**Number IFR Certified:** 86  
**Models:** S-76

### AVIONICS

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<td>ADF</td>
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<td>RNAV</td>
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<tr>
<td>Radar</td>
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</table>

* Integrated Flight Control (IFC) Systems include autopilot and flight director capabilities.

### INSTRUMENTS

<table>
<thead>
<tr>
<th>Function</th>
<th>Co-Pilot Models</th>
<th>Pilot Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSI</td>
<td>Astronautics</td>
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<tr>
<td>RMI</td>
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<td>0 see HSI</td>
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<tr>
<td>CDI</td>
<td>0</td>
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</table>

Figure 6-14  IFR Rotorcraft Equipage for SIKORSKY S-76 OFF-SHORE
CHAPTER SEVEN
CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

The majority of the IFR-equipped fixed-wing and rotorcraft aircraft registered in the United States are well equipped with dual navigation receivers, automatic direction finding equipment, distance measuring equipment, and associated displays and indicators. One hundred percent of the national carriers and 95 percent of the regional air carriers aircraft are equipped with radar systems. Executive jet aircraft are all instrumented with radar systems, while 80 percent of the turboprop population sampled had radar. Twin-engine piston aircraft in the cabin class frequently include radar capability in their avionic suites. RNAV capability is dictated by intended service of the aircraft and normally found on executive and cabin class propeller aircraft. The light twin and single engine IFR population shows almost 20 percent RNAV equipage.

The capabilities of the navigation equipment and displays vary according to the models installed in each airframe. We must research each model of avionics to identify the specific capability of each model, potential application in advanced approaches, and ability for integration of capabilities during the terminal phase of flight. The high percentage of radar systems currently installed in the airframes makes the radar display a prime candidate for providing additional information for advanced approaches.

Rotorcraft represent a large portion of the candidates for operation at large terminal areas, but the current equipage of the majority of the helicopters limits operation in IMC environment.

7.2 RECOMMENDATIONS

The results presented in this study provide the basis for evaluating the adaptation of existing avionics to advanced approach concepts using MLS guidance. However, each class of avionics (i.e., panel, remote...
or ARINC) must be examined to identify whether adequate signal sources are available externally to adapt the avionics without changing them. Similarly, potential displays (e.g., radar systems, HSIs) must be examined by model to identify the feasibility of adding glide slope or course deviation information from the MLS angle receiver or computer without affecting the integrity of the instrument.
APPENDIX

LIST OF ACRONYMS

and

LIST OF AIRCRAFT MANUFACTURE CONTRACTIONS
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADF</td>
<td>Automatic Direction Finder</td>
<td>ILS</td>
<td>Instrument Landing System</td>
</tr>
<tr>
<td>ADI</td>
<td>Attitude Direction Indicator</td>
<td>IMC</td>
<td>Instrument Meteorological Conditions</td>
</tr>
<tr>
<td>APM</td>
<td>Program Engineering and Maintenance Service Division FAA</td>
<td>LORAN</td>
<td>Long Range Navigation</td>
</tr>
<tr>
<td>ARINC</td>
<td>Aeronautical Radio Corporation</td>
<td>MFR-Spec</td>
<td>Manufacture Specifications</td>
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<tr>
<td>ATC</td>
<td>Air Traffic Control</td>
<td>MLS</td>
<td>Microwave Landing System</td>
</tr>
<tr>
<td>CDI</td>
<td>Course Deviation Indicator</td>
<td>NS</td>
<td>Inertial Navigation System</td>
</tr>
<tr>
<td>CFR</td>
<td>Code of Federal Regulations</td>
<td>NASA</td>
<td>National Aeronautics and Space Administration</td>
</tr>
<tr>
<td>CRT</td>
<td>Cathode Ray Tube</td>
<td>NAV</td>
<td>VHF Navigation Radio: VOR/LOC</td>
</tr>
<tr>
<td>DG</td>
<td>Directional Gyro</td>
<td>OMEGA</td>
<td>VLF Navigation System</td>
</tr>
<tr>
<td>DME</td>
<td>Distance Measuring Equipment</td>
<td>PPI</td>
<td>Plan Position Indicator (Radar)</td>
</tr>
<tr>
<td>EFIS</td>
<td>Electronic Flight Instrument System</td>
<td>RAA</td>
<td>Regional Airlines Association</td>
</tr>
<tr>
<td>FAA</td>
<td>Federal Aviation Administration</td>
<td>RJO</td>
<td>RJO Enterprises, Inc.</td>
</tr>
<tr>
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<td>Fixed Base Operator</td>
<td>RMI</td>
<td>Radio Magnetic Indicator</td>
</tr>
<tr>
<td>FD</td>
<td>Flight Directors</td>
<td>RNAV</td>
<td>Area Navigation System</td>
</tr>
<tr>
<td>GA</td>
<td>General Aviation</td>
<td>TP</td>
<td>Turbo Prop (Turbine engine with gear driven propeller)</td>
</tr>
<tr>
<td>GS</td>
<td>Glide Slope</td>
<td>VFR</td>
<td>Visual Flight Rules</td>
</tr>
<tr>
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<tr>
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<td>Integrated Flight Control System</td>
<td>VSI</td>
<td>Vertical Speed Indicator</td>
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<tr>
<td>IFR</td>
<td>Instrument Flight Rules</td>
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</table>

A-1
## LIST OF AIRCRAFT MANUFACTURE CONTRACTIONS

| A-  | Airbus Industry                                      | G-  | (I, II, III) Gulfstream Aerospace Corporation |
| AA- | Grumman Corporation                                  | G-  | (21, 28, 44, 64, 73, 89, 134, 164) Grumman Corporation |
| AC- | Rockwell International (commanders, singles/piston twins and jet) | GA  | Rockwell International (Turbo Props) |
| B-  | Boeing Commercial Airplane Company                   | HS- | British Aerospace Hatfield Chester Division |
| BA- | BAe/BAC British Aerospace Incorporated               | HS- | Hawker Siddeley |
| BE- | Beech Aircraft Corporation                           | LA  | Lake Aircraft |
| BH- | Beech Aircraft Corporation                           | LR  | Gates Lear Jet Corporation |
| BN- | Pilatus Britten-Norman Ltd.                          | M   | Martin |
| C-  | Cessna                                               | MO  | Mooney Aircraft Corporation |
| CL- | Canadair Limited (Challenger)                        | ML  | Maule |
| CV- | Convair                                              | MU  | Mitsubishi |
| DA- | Falcon Jet Corporation 10’s and 20’s                 | NA  | Saberliner Corporation |
| DC- | McDonnell Douglas                                    | PA  | Piper Aircraft Corporation |
| DHC-| DE Havilland Aircraft of Canada, Ltd.                | SA  | Fairchild Aircraft Corporation |
| EMB-| Embraer Aircraft Corporation                         | SF  | Saab—Fairchild |
| F   | Fokker B.V.                                          | SH  | (SD) Short Brothers Ltd. |
| FFJ | Falcon Jet Corporation/Avion Marcel Dassault-Breguet Aviation | WW  | Israel Aircraft Industries |

A-2
The results presented in this study provide the basis for evaluating the adaptation of existing avionics
to advanced approach concepts using MLS guidance. However, each class of avionics (i.e., panel, remote