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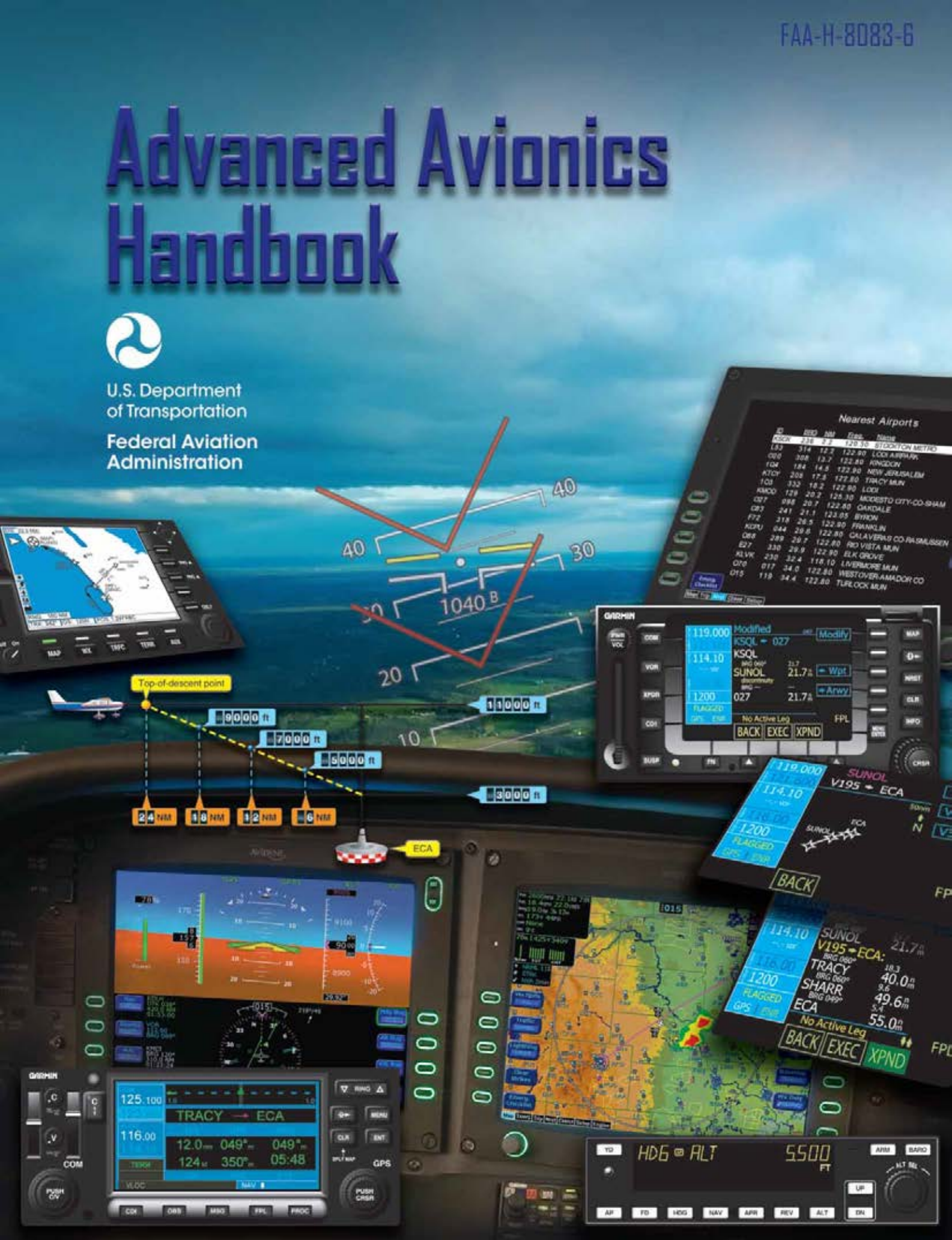
Advanced Avionics Handbook

U.S. Department of Transportation

Federal Aviation Administration



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Advanced avionics systems can automatically perform many tasks that pilots and navigators previously did by hand. For example, an area navigation (RNAV) or flight management system (FMS) unit accepts a list of points that define a flight route, and automatically performs most of the course, distance, time, and fuel calculations. Once en route, the FMS or RNAV unit can continually track the position of the aircraft with respect to the flight route, and display the course, time, and distance remaining to each point along the planned route. An autopilot is capable of automatically steering the aircraft along the route that has been entered in the FMS or RNAV system. Advanced avionics perform many functions and replace the navigator and pilot in most procedures. However, with the possibility of failure in any given system, the pilot must be able to perform the necessary functions in the event of an equipment failure. Pilot ability to perform in the event of equipment failure(s) means remaining current and proficient in accomplishing the manual tasks, maintaining control of the aircraft manually (referring only to standby or backup instrumentation), and adhering to the air traffic control (ATC) clearance received or requested. Pilots of modern advanced avionics aircraft must learn and practice backup procedures to maintain their skills and knowledge. Risk management principles require the flight crew to always have a backup or alternative plan, and/or escape route. Advanced avionics aircraft relieve pilots of much of the minute-to-minute tedium of everyday flights, but demand much more initial and recurrent training to retain the skills and knowledge necessary to respond adequately to failures and emergencies.

The FMS or RNAV unit and autopilot offer the pilot a variety of methods of aircraft operation. Pilots can perform the navigational tasks themselves and manually control the aircraft, or choose to automate both of these tasks and assume a managerial role as the systems perform their duties. Similarly, information systems now available in the cockpit provide many options for obtaining data relevant to the flight.

Advanced avionics systems present three important learning challenges as you develop proficiency:

1. How to operate advanced avionics systems
2. Which advanced avionics systems to use and when
3. How advanced avionics systems affect the pilot and the way the pilot flies

How To Operate Advanced Avionics Systems

The first challenge is to acquire the "how-to" knowledge needed to operate advanced avionics systems. This handbook describes the purpose of each kind of system, overviews the basic procedures required to use it, explains some of the logic the system uses to perform its function, and discusses each system's general limitations. It is important to note that this handbook is not intended as a guide for any one manufacturer's equipment. Rather, the aim is to describe the basic principles and concepts that underlie the internal logic and processes and the use of each type of advanced avionics system. These principles and concepts are illustrated with a range of equipment by different manufacturers. It is very important that the pilot obtain the manufacturer's guide for each system to be operated, as only those materials contain the many details and nuances of those particular systems. Many systems allow multiple methods of accomplishing a task, such as programming or route selection. A proficient pilot tries all methods, and chooses the method that works best for that pilot for the specific situation, environment, and equipment. Not all aircraft are equipped or connected identically for the navigation system installed. In many instances, two aircraft with identical navigation units are wired differently. Obvious differences include slaved versus non-slaved electronic horizontal situation indicators (EHSIs) or primary flight display (PFD) units. Optional equipment is not always purchased and installed. The pilot should always check the equipment list to verify what is actually installed in that specific aircraft. It is also essential for pilots using this handbook to be familiar with, and apply, the pertinent parts of the regulations and the Aeronautical Information Manual (AIM).

Advanced avionics equipment, especially navigation equipment, is subject to internal and external failure. You must always be ready to perform manually the equipment functions which are normally accomplished automatically, and should always have a backup plan with the skills, knowledge, and training to ensure the flight has a safe ending.

Which Advanced Avionics Systems To Use and When

The second challenge is learning to manage the many information and automation resources now available to you in the cockpit. Specifically, you must learn how to choose which advanced cockpit systems to use, and when. There are no definitive rules. In fact, you will learn how different features of advanced cockpit avionics systems fall in and out of usefulness depending on the situation. Becoming proficient with advanced avionics means learning to use the right tool for the right job at the right time. In many systems, there are multiple methods of accomplishing the same function. The competent pilot learns all of these methods and chooses the method that works best for the specific situation, environment, and equipment. This handbook will help you get started in learning this important skill.

How Advanced Avionics Systems Affect the Pilot

The third challenge is learning how advanced avionics systems affect the pilot. The additional information provided by advanced avionics systems can affect the way you make decisions, and the ability to automate pilot tasks can place you in the role of system supervisor or manager. These ideas are presented throughout the handbook using a series of sidebars illustrating some of the issues that arise when pilots work with advanced avionics systems. This series is not a complete list; rather, its purpose is to convey an attitude and a manner of thinking that will help you continue to learn.

The Learning series provides tips that can help expedite mastery of advanced avionics. You will learn why taking the time to understand how advanced systems work is a better learning strategy than simply memorizing the button-pushing procedures required to use each system. The importance of committing to an ongoing learning process will be explained. Because of the limits of human understanding, together with the quirks present in computerized electronic systems of any kind, you will learn to expect, and be prepared to cope with, surprises in advanced systems. Avionics equipment frequently receives software and database updates, so you must continually learn system functions, capabilities, and limitations.

The Awareness series presents examples of how advanced avionics systems can enhance pilot awareness of the aircraft systems, position, and surroundings. You will also learn how (and why) the same systems can sometimes decrease awareness. Many studies have demonstrated a natural tendency for pilots to sometimes drift out of the loop when placed in the passive role of supervising an FMS/RNAV and autopilot. You will learn that one way to avoid this pitfall is to make smart choices about when to use an automated system, and when to assume manual control of the flight; how cockpit information systems can be used to keep you in touch with the progress of the flight when automated systems are used; and how some advanced cockpit systems can be set to operate in different modes, with each mode exhibiting a different behavior. Keeping track of which modes are currently in use and predicting the future behavior of the systems is another awareness skill that you must develop to operate these aircraft safely.

The Risk series provides insights on how advanced avionics systems can help you manage the risk faced in everyday flight situations. Information systems offer the immediate advantage of providing a more complete picture of any situation, allowing you to make better informed decisions about potential hazards, such as terrain and weather. Studies have shown that these same systems can sometimes have a negative effect on pilot risk-taking behavior. You will learn about situations in which having more information can tempt you to take more risk than you might be willing to accept without the information. This series will help you use advanced information systems to increase safety, not risk. As much as advanced information systems have improved the information stream to the cockpit, the inherent limitations of the information sources and timeliness are still present; the systems are not infallible.

When advanced avionics systems were first introduced, it was hoped that those new systems would eliminate pilot error. Experience has shown that while advanced avionics systems do help reduce many types of errors, they have also created new kinds of errors. This handbook takes a practical approach to pilot error by providing two kinds of assistance in the form of two series: Common Errors and Catching Errors. The Common Errors series describes errors commonly made by pilots using advanced avionics systems. These errors have been identified in research studies in which pilots and flight instructors participated. The Catching Errors series illustrates how you can use the automation and information resources available in the advanced cockpit to catch and correct errors when you make them.

The Maintaining Proficiency series focuses on pilot skills that are used less often in advanced avionics. It offers reminders for getting regular practice with all of the skills you need to maintain in your piloting repertoire.

Chapter Summary

This introductory chapter provided a broad perspective into the advanced avionics now found in many aircraft. This new equipment relieves the pilot of some tedious tasks while adding new ones and the requirement for more preflight study to learn the advanced capabilities and how to use the features. The pilot now has more and sometimes better means of fixing position, but has to contend with greater data loss when equipment breaks. It is important to maintain proficiency with the standby instruments and be proficient with the emergency tasks associated with the advanced avionics. Since these are electrical devices, the electrical generation and backup systems on the aircraft are even more important than ever.

Advanced avionics generally incorporate displays allowing pictures of the flight route as well as basic flight instrument data. While this can be most helpful to you, it can also lead you into areas where the pilot has no recourse, if any circumstances such as weather or equipment operation changes for the worse. You should never fly further into marginal conditions with advanced avionics than you would

fly with conventional instruments. Advanced avionics do not enable an aircraft and pilot to break the laws of physics.

Advanced avionics were designed to increase safety as well as utility of the aircraft. Safety is enhanced by enabling better situational awareness. Safety can be increased by providing more information for you in an easier to interpret presentation.

Safety of flight can be hampered if you are not aware of what data the presentation is displaying or confuses that data with other information. Safety of flight can be compromised if you attempt to use the advanced avionics to substitute for required weather or aerodynamic needs. Safety of flight can be negated if you attempt to learn the advanced avionics system while in flight. You should use advanced avionics to reduce risk. Proper use of checklists and systematic training should be used to control common error-prone tasks and notice errors before they become a threat to safety of flight.

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This FAA handbook provides general aviation users with comprehensive information on the advanced avionics equipment available in technically advanced aircraft (TAA). VFR and IFR operations in aircraft with the latest integrated "glass cockpit" instrumentation are covered here, helping pilots understand which advanced avionics systems to use and when.

Readers will learn the "knob-ology" associated with operating cockpit-computers, including data entry, maintaining current databases, and accessing information from the various screens. Common errors, catching errors and instrument failures are discussed, as well as recommendations for how to use standby instruments during both normal and emergency operations. Each phase of flight is covered, so readers will know how to execute departure, enroute and approach procedures using glass cockpit instrumentation.

Subjects covered include the Primary Flight Display (PFD), Multi-Function Display (MFD), moving maps, terrain, cockpit weather, traffic data, fuel management systems, and electronic charts and checklists. Essential skills checklists and summaries conclude each chapter for a comprehensive review and quick-check reference.

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