FAA Industry Training Standards (FITS)

Scenario Based Transition Syllabus

For ADS-B/CDTI Systems

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EMBRY-RIDDLE AERONAUTICAL UNIVERSITY

UND AEROSPACE UNIVERSITY OF NORTH DAKOTA

FITS CDTI Training Master Syllabus
Scenario Based Training Guide

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How to use this generic FITS Syllabus

This FITS Cockpit Display of Traffic Information (CDTI) Syllabus is intended as a guide for aircraft manufacturers, training providers, and flight schools to use in developing specific FITS curriculum for a specific aircraft, geographic region, and customer base. The syllabus lays out a series of flight scenarios that enable a pilot transitioning into an airplane equipped with ADS-B technology that displays traffic information on a multi-function display (MFD) to master the technology, use the information displayed effectively in maintaining situational awareness and traffic avoidance, and most importantly, to master the concepts of Risk Management and Aeronautical Decision Making.

This syllabus assumes that the pilot in training (PT) is proficient in using GPS for navigation. If this is not the case, this syllabus can be combined with a GPS specific syllabus to comprise a training program in which the PT can learn both GPS navigation in addition to ADS-B. If a suitable ADS-B training device is available, this may be substituted for flight training provided that all learner-centered outcomes can be met in a scenario-based training format.

To Instructors

Each lesson consists of a scenario description followed by a list of specific tasks to be accomplished by the student. Each scenario also includes a "student centered" set of grading criteria. Within the confines of each scenario the Pilot in training (PT) and instructor are free to plan all the training activities in a way that supports the overall scenario flow, and provides the most realistic replication of real world, day to day flying.

To Pilots in Training (PT)

The emphasis in each scenario is on PT planning and the execution of each scenario with as little help as possible from the instructor. The value of scenario-based training is in the opportunities it provides to plan, execute, and respond to changing situations in a logical and thoughtful way.

To Aircraft Manufacturers, Training providers, and Flight Schools

This generic syllabus is a guide for you to use in developing your specific transition curriculum. FITS "acceptance" is achieved by developing your specific curriculum and submitting it to:

The FITS Program Manager,
800 Independence Avenue, SW, Washington DC, 20591
202-267-8212

Use of the FITS logo.
Once your FITS syllabus is accepted, you are authorized to display the FITS Logo on approved FITS curriculum and in advertising about the particular curriculum. The FITS logo may not be used in relationship to non-FITS products.

Section 1 - FITS Introduction

FAA Industry Training Standards (FITS)

This FITS Program is a joint project of the FAA-sponsored Center for General Aviation Research (CGAR), Embry Riddle Aeronautical University, The University of North Dakota, and the General Aviation Industry.

FITS Mission Statement

Improve pilot training to enable pilots to more safely, competently, and efficiently operate a Technically Advanced Aircraft (TAA) in the National Airspace System (NAS).

FITS "Essentials"

Pilot training in TAA requires an emphasis on realistic scenario-based training that will develop essential risk management skills, decision-making skills, and other higher-order thinking skills that are crucial in helping to reduce the general aviation (GA) fatal accident rate. Reduction of the GA fatal accident rate is one of the cornerstones of the FAA's "SAFER SKIES" initiative. FITS scenario-based training will also involve training for new communication, navigation and surveillance (CNS) systems, related airspace and procedures, and the challenge of training new-entrant pilots that want to fly for transportation purposes

FITS recognizes the variety of advanced technology systems and the different combinations and permutations of these systems-

- Within a type of system (e.g. different operations of GPS navigators)
- Within categories of advanced technology systems such as a-
    - Primary Flight Display (PFD) that normally includes the following primary information on a single display:
        - Attitude
        - Heading
        - Altitude
        - Airspeed
        - Navigation (HSI, bearing, course, ground speed, etc.)

- Multi Function Displays (MFD) that may include any combination of the following information on a single display:
  - Traffic
  - Weather
  - Terrain and obstacles
  - Navigation (bearing, course, ground speed, ETA, Sectional, En route or Terminal Approach charts, etc.)
- Autopilot

FITS Training Goals

The advancement of:

- Higher Order Thinking
  - Risk Management
  - Aeronautical Decision-Making
  - Situational Awareness (SA)
  - Pattern Recognition (Emergency Procedure) and Decision-Making
- Aircraft Systems Competence
- Planning and Execution
- Procedural Knowledge
- Motor skills that do not require higher cognitive thinking before taking action (i.e. Psychomotor Skills.)

Section 2 -FITS Terminology/Definitions

Key Terms

Technically Advanced Aircraft (TAA)– is a general aviation aircraft that contains a GPS navigator with a moving map display, plus any additional systems. Traditional systems such as autopilots when combined with GPS navigators are included. It includes aircraft used in both VFR and IFR operations, with systems certified to either VFR or IFR standards. Note: there will be application to non-TAAs.

Light Turbine TAA- a jet or turboprop TAA certified for single-pilot operations, weighing 12,500 lbs or less, equipped with cabin pressurization, conventional (non-swept) wings and capable of operating in Class A airspace on normal mission profiles. (Note: Light Turbine TAA is specifically defined as having a non-swept wing due to the significantly increased training demands for pilots transitioning to swept wing aircraft)

Scenario-based Training (SBT) – is a training system that uses a highly structured script of real-world experiences to address flight training objectives in an operational environment. Such training can include initial training, transition training, upgrade training, recurrent training, and special training. The appropriate term should appear with the term "Scenario-based," e.g., "Scenario-based Transition Training," to reflect the specific application.

Single Pilot Resource Management (SRM) – is the "art and science" of managing all resources available to a single-pilot to ensure the successful outcome of the flight.

Related Terms and Abbreviations

Aircraft Automation Management – is the demonstrated ability to control and navigate an aircraft by means of the automated systems installed in the aircraft.

Automated Navigation leg – is a flight of 30 minutes or more conducted between two airports in which the aircraft is controlled primarily by the autopilot and onboard navigation systems.

A ***VFR Automated Navigation Leg*** is flown on autopilot beginning from 1,000 ft above ground level (AGL) on the departure until the 45-degree entry to the downwind leg in the VFR airport traffic pattern.

An ***IFR Automated Navigation Leg*** is flown on autopilot beginning from 500 ft AGL or the lowest altitude permitted by the AFM or AFM supplement on departure until reaching the decision altitude or missed approach point on the instrument approach. If a missed approach is flown, it will also be flown using the autopilot and on-board navigation systems.

Automation Competence- is the demonstrated ability to understand and operate the automated systems installed in the aircraft.

Automation Surprise- is the ability of an automated system to provide different cues to pilots when compared to the analog systems they replace, especially in time-critical situations.

Automation Bias – is the relative willingness of the pilot to trust and utilize automated systems.

Candidate Assessment- is a system of critical thinking and skill evaluations designed to assess a student's readiness to begin training at the appropriate level.

Critical Safety Tasks/Events – are those mission related tasks/events that, if not accomplished quickly and accurately, may result in aircraft damage, injury, or loss of life.

Data link Situational Awareness (SA) Systems – *a*re systems that feed real-time information to the cockpit on weather, NAS status information, traffic, terrain and obstacles, and flight planning. This information may be displayed on the PFD, MFD, or on other related cockpit displays.

Learner (Student) Centered Grading - Desired Pilot in Training (PT) Scenario Outcomes

(1) The objective of scenario-based training is a change in the thought processes, habits, and behaviors of the students during the planning and execution of the scenario. Since the training is learner centered, the success of the training is measured in the following desired student outcomes.

(a) Maneuver Grades (Tasks)

- Explain –at the completion of the scenario the PT will be able to describe the scenario activity and understand the underlying concepts, principles, and procedures that comprise the activity. Significant instructor effort will be required to successfully execute the maneuver.
- Practice – at the completion of the scenario the student will be able to plan and execute the scenario. Coaching, instruction, and/or assistance from the CFI will correct deviations and errors identified by the CFI.
- Perform - at the completion of the scenario, the PT will be able to perform the activity without assistance from the CFI. Errors and deviations will be identified and corrected by the PT in an expeditious manner. At no time will the successful completion of the activity be in doubt. ("Perform" will be used to signify that the PT is satisfactorily demonstrating proficiency in traditional piloting and systems operation skills)
- Not Observed – Any event not accomplished or required

(b) Single Pilot Resource Management (SRM) Grades

- Explain – the student can verbally identify, describe, and understand the risks inherent in the flight scenario. *The student will need to be prompted to identify risks and make decisions.*
- Practice –the student is able to identify, understand, and apply SRM principles to the actual flight situation. *Coaching, instruction, and/or assistance from the CFI will quickly correct minor deviations and errors identified by the CFI.* The student will be an active decision maker.
- Manage/Decide - the student can correctly gather the most important data available both within and outside the cockpit, identify possible courses of action, evaluate the risk inherent in each course of action, and make the appropriate decision. *Instructor intervention is not required for the safe completion of the flight.*

(2) Grading will be conducted independently by the student and the instructor, and then compared during the post flight critique.

(3) Learner centered grading (outcomes assessment) is a vital part of the FITS concept. Previous syllabi and curriculum have depended on a grading scale designed to maximize student management and ease of instructor use. Thus the traditional: "excellent, good, fair, poor" or "exceeds standards, meets standards, needs more training" often meet the instructor's needs but not the student's. The learner centered grading described above is a way for the instructor and student to determine the student's level of knowledge and understanding. "Perform" is used to describe proficiency in a skill item such as an approach or landing. "Manage-Decide"

is used to describe proficiency in the SRM area such as ADM. Describe, explain, and practice are used to describe student learning levels below proficiency in both.

(4) Grading should be progressive. During each flight, the student should achieve a new level of learning (e.g. flight one, the automation management area, might be a "describe" item by flight three a "practice" item, and by flight five a "manage-decide" item.

Emergency Escape Maneuver - is a maneuver (or series of maneuvers) performed manually or with the aid of the aircrafts automated systems that will allow a pilot to successfully escape from an unanticipated flight into Instrument Meteorological Conditions (IMC) or other life-threatening situation.

Mission Related Tasks - are those tasks required for the safe and effective accomplishment of the mission.

Multi-Function Display (MFD) - is a device that combines primarily navigation, systems, and situational awareness (SA) information onto a single electronic display.

Primary Flight Display (PFD) – is a device that combines the primary six flight instruments plus other related navigation and situational awareness (SA) information into a single electronic display.

Proficiency Based Qualification- is a qualification based on demonstrated performance rather than other flight time or experience.

Simulation- is any use of animation and/or actual representations of aircraft systems to simulate the flight environment. PT interaction with the simulation and task fidelity for the task to be performed are required for effective simulation.

Training Only Tasks – are training maneuvers that, while valuable to the PT's ability to understand and perform a mission related task, are not required for the PT to demonstrate proficiency. However, instructor pilots would be required to demonstrate proficiency in training-only tasks.

TIS-B: **Traffic Information Services-Broadcast-** Traffic information from ATC radars that is broadcast from ground-based transmitters and can be received by suitable avionics and displayed on MFDs.

UAT: **Universal Access Transceiver-** A radio data link system that supports broadcast services, e.g., ADS-B, FIS-B, and TIS-B. The onboard UAT data link transceiver broadcasts continuously whether or not any ground station is receiving the signal.

Section 3 - FITS TAA Training Philosophy

FITS TAA Training is an approach to training pilots that is scenario based rather than maneuver based and structured to emphasize development of critical thinking and flight management skills. The goal of this training philosophy is accelerated acquisition of higher-level decision-making skills necessary to prevent pilot error accidents in Technically Advanced Aircraft (TAA).

Previous training philosophy assumed that newly certificated pilots would generally remain in the local area until recently acquired aviation skills are refined. This is no longer true with the advent of Technically Advanced Aircraft (TAA). Offering superior avionics and performance capabilities, these aircraft travel faster and further than their predecessors. As a result, a growing number of entry-level pilots suddenly have the capability of long distance/high speed travel—and its incumbent challenges. Flights of this nature routinely span diverse weather systems and topography requiring advanced flight planning and execution skills. Advanced cockpits and avionics, while generally considered enhancements, require increased technical knowledge and finely-tuned automation competence. Without these skills, the potential for increased human-error accidents is daunting. A scenario-based method of training is required to accelerate acquisition of these skills during the training process.

Research has proven that learning is enhanced when training is realistic and authentic. In addition, the underlying skills needed to make good judgments and decisions are teachable. Both the military and commercial airlines have embraced these principles through integration of Line Oriented Flight Training (LOFT) and Cockpit Resource Management (CRM) training into their qualification programs. Both LOFT and CRM lessons mimic real-life scenarios as a means to expose trainees to realistic operations and critical decision-making opportunities. The most significant shift in these programs has been to move away from traditional maneuver-based training to incorporate training that is scenario-based.

Maneuver-based training puts emphasis on the mastery of individual tasks or elements. Completion standards are driven by regulation, as well as Practical Test Standards, that use flight hours and the ability to fly within plus or minus some specified tolerance as the measurement of competence. The emphasis is on development of motor skills to satisfactorily accomplish individual maneuvers. Only limited emphasis is placed on decision-making, and as a result, when the newly trained pilot goes on to fly in the real-world environment, he or she is inadequately prepared to make crucial decisions unassisted.

Scenario Based Training (SBT) and Single Pilot Resource Management (SRM) are similar to LOFT and CRM training but tailored to the general aviation TAA pilot's needs. They use the same individual tasks as Maneuver Based Training, but arrange or script them

into scenarios that mimic real-life TAA cross-country travel. By emphasizing on each lesson that the goal is getting to a destination safely, the trainee readily correlates the importance of individual training maneuvers to safe mission accomplishment. In addition, throughout the scenario, the instructor poses "What if?" discussions as a means of providing the trainee with increased exposure to proper decision-making. Because the "What if?" discussions are in reference to the scenario, there is a vivid connection between decisions made and the final outcome.

The "What if?" discussions are designed to accelerate development of decision-making skills by posing situations for the trainee to ponder. Once again, research has shown that these types of discussions help build judgment and offset low experience.

Questions or situations posed by the instructor must be somewhat open-ended (rather than requiring only rote or one-line responses.) In addition, the instructor guides the trainee through the decision process by:

1) Posing a question or situation that engages the trainee in some form of decision-making activity.
2) Examining the decisions made.
3) Exploring other ways to solve the problem.
4) Evaluating which way is best.

For example, when the trainee is given a simulated engine failure, the instructor might ask questions like:

- "What should we do now?"
- "Why did you pick that place to land? Is there a better choice?
- Which place to land is the safest? Why?"

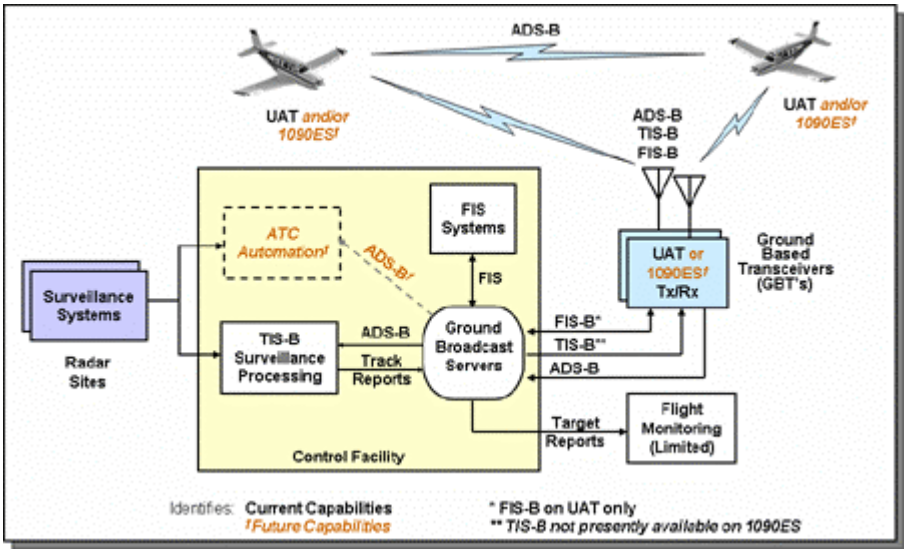
Questions of this nature force the trainee to focus on the decision process, which accelerates acquisition of judgment. Judgment, after all, is simply the decision-making process, which is learned primarily from experience. It is not innate. All life experiences mold the judgment tendencies brought into flight situations. By artificially injecting decision opportunities into routine training lessons, we speed-up acquisition of experience, and thus enhance judgment and decision-making. For further information, please reference "Aeronautical Decision Making" in the FAA Aviation Instructor Handbook.

Section 4 – Overview of ADS-B Technology

While this section provides an overview of the ADS-B technology, it is not intended to be a source of information for the development of this course. Developers of this course should consult the latest information provided by the FAA and industry for appropriate materials to be used during the development of the course content.

ADS-B is an aircraft-based surveillance service being deployed in selected areas of the NAS. This underlying technology broadcasts a radio transmission approximately once-per-second from the aircraft containing its position, velocity, identification, and other pertinent information. ADS-B can also receive reports from other suitably equipped aircraft within reception range. No ground infrastructure is necessary for ADS-B equipped aircraft to detect each other. These reports can be transmitted to ground based transceivers (GBTs) and used to provide air traffic surveillance services and fleet operator monitoring of aircraft.

The following diagram depicts the ADS-B and Broadcast Service system.



System Functional Architecture

There are two basic aircraft equipage data link configurations that provide ADS-B capabilities:

1) Transmit-only systems
2) Combined transmit and receive systems

Users that desire only to be "seen" by other aircraft or ground stations may elect to equip with the transmit-only capability system, a less expensive solution. A transmit-only configuration does not have provisions for a CDTI or the ability to receive and

display up linked broadcast services. For a transmit-only ADS-B system, two main avionics components are required: 1090 Extended Squitter (1090ES) or UAT data link transmitter, and A GPS receiver or another suitable position source able to provide the aircraft's ADS-B transmit system with "own-ship" position with suitable integrity and other Message Set Elements (MSEs) for transmission over the selected data link transmitter.

In a combined ADS-B transmit and receive system, there are three main avionics components required:1090ES or UAT data link transceiver, A Global Positioning System receiver (or other position source) that provides one's "own-ship" position with suitable data integrity, plus other MSEs, and a single or multifunction display and processing system for managing and displaying the broadcast data. CDTIs can be installed in the instrument panel or be portable, depending upon the specific aircraft equipage implementation and/or aircraft certification basis.

For the purpose of FAA operational approval authorization, aircraft that do not have an installed CDTI or that do not have a data link modem certified to either TSO C-154 (UAT) or TSO C-166 (1090ES) do not fall under the umbrella of those aircraft equipped with surveillance systems that require operational approval. First generation 1090ES systems that were certified under TSO C-112A may not be used for any ground-based surveillance function except the flight monitoring function, unless the equipment has been shown to function satisfactorily in the NAS.

ADS-B avionics systems need to be properly installed and maintained. This is called continued airworthiness. Follow the manufacturer's recommendations to ensure initial and continued airworthiness. Care should be given to ensure that all components are specifically approved for installation in the particular make/model aircraft. Maintenance programs should identify inspection items, establish in-service intervals for maintenance and inspections, and include any calibration procedures necessary to ensure continued airworthiness.

The following operational capabilities of Automatic Dependent Surveillance-Broadcast (ADS-B) aircraft-to-aircraft, aircraft-to-ground, and uplink services delivery are supported in the deployment of ADS-B. As these services may be updated or enhanced over time, course developers should always consult the latest literature from the FAA and industry.

Automatic Dependent Surveillance-Broadcast (ADS-B)

Air-to-air, air-to-ground, and ground-use applications are for situational awareness purposes only. This includes the detection and display of suitably equipped airport surface vehicles to support enhanced "see and avoid."

For air-to-air applications, the Universal Access Transceiver (UAT) data link is not intended to provide information for guidance or control purposes. Rather, it is intended to provide information to enhance pilot/flight deck situational awareness.

ADS-B services have been approved for air traffic surveillance use ONLY in Alaska.

Additionally, there are several efforts underway to further mature advanced ADS-B applications such as air-to-air in-trail spacing, delegated separation, and airborne cockpit management. Operational approval is required for use of these applications in commercial service.

Traffic Information Service-Broadcast (TIS-B)

TIS-B was developed to support ground-to-air and ground-to-ground surveillance services. This technology supports the visual acquisition of proximate aircraft for enhanced "see and avoid" in the air and on the airport surface, dependent upon an airport ground radar system and an ADS-B ground based transceiver (GBT) co-located on the same airport. These two TIS-B applications are intended to improve the pilot's ability to visually see other traffic in the air and on the airport surface so that pilots can more effectively apply the traditional "see-and-avoid" techniques. TIS-B is NOT intended to be used as a collision avoidance system and does NOT relieve the pilot of responsibility to "see-and-avoid" other aircraft. (See Aeronautical Information Manual, Paragraph 5-5-8, "See and Avoid"). TIS-B shall not be used for avoidance maneuvers during times when there is no visual contact with the intruding aircraft. No avoidance maneuvers are provided for, nor authorized, as a direct result of a TIS-B target being displayed in the cockpit.

A developmental version of the TIS-B is now available from operational ground stations. TIS-B traffic consists of transponder equipped aircraft being seen by radar and then relayed to your aircraft via the Universal Access Transceiver (UAT) ADS-B data link. In order to see the transponder traffic, the aircraft must be within radar coverage and you must be within the communication range of a ground station. Pilots needs to be aware of the following regarding TIS-B:

- You may receive an intermittent TIS-B target of your aircraft, typically when you are maneuvering (e.g., climbing turn) - due to the radar not tracking you as quickly as ADS-B does.
- A TIS-B target of your aircraft will tend to lag behind your current position/altitude, but may be positioned anywhere around your aircraft's position.
- The TIS-B position update is approx 3-13 seconds depending on the radar coverage in which you are flying. The update rate for ADS-B is approximately every second.
- The TIS-B system currently only sees transponder equipped aircraft.

- No transponder = no TIS-B target. Always look outside.

Pilots flying in visual meteorological conditions (VMC) are reminded that visual contact remains the only means of self-separation. There is currently no indication provided when you are operating inside (or outside) the TIS-B Service Volume, therefore it is difficult know when you should be receiving all traffic information – assume you are not.

Guidance From the FAA Air Traffic Division:

All pilots/operators are reminded that the airborne equipment that displays other ADS-B equipped aircraft and transponder-equipped aircraft via TIS-B is only for pilot situational awareness. This equipment is not approved as a collision avoidance tool. Any deviation from an air traffic control clearance based on cockpit information must be approved by the controlling ATC facility prior to commencing the maneuver. Uncoordinated deviations may place an aircraft in close proximity to other aircraft under ATC control not seen on the airborne equipment and may possibly result in the issuance of a pilot deviation.

Flight Information Services-Broadcast (FIS-B)

FIS-B products are advisory and will be provided free of charge using the UAT data link. Initial product offerings include:

- Text Meteorological Aviation Reports (METARs) and Special Reports (SPECIs),
- Text Terminal Area Forecast (TAFs), and
- Graphical Next Generation Weather Radar (NEXRAD) depictions.
- Other products that will be introduced in the future.

Flight Monitoring Functionality

ADS-B data can be used for flight monitoring, flight management, surface traffic airline asset management, and other safety and efficiency purposes contingent upon appropriate FAA authorization and approvals.

Section 5- FITS ADS-B Master Syllabus

GOAL

The goal of ADS-B FITS training is to help prevent accidents by ensuring pilots have proper training in the specified systems and operating characteristics of ADS-B to enhance situational awareness. ADS-B training, therefore, concentrates on areas unique to ADS-B technology and information. No attempt is made to review general piloting knowledge or skills that would be the same in any airplane. Instruction in these areas is highly beneficial, but should be accomplished through other means. While this syllabus is designed to teach the elements of ADS-B in dedicated flight lessons, it may be possible to combine this lesson content with other topics that the PT or instructor feel would be appropriate to cover in that same flight.

As the use of GPS is integral to the overall ADS-B system, there is an assumption that a pilot training under a FITS-accepted ADS-B syllabus is proficient in the use of the GPS equipment installed in the airplane being used for training. If this is not the case, the ADS-B syllabus can be combined with the appropriate FITS-accepted equipment specific syllabus to comprise a training package for that pilot and equipment in a modular approach. It is suggested that GPS specific training be conducted before conducting the ADS-B training. However, it is possible that if the GPS training consists of multiple scenarios, the ADS-B training can be included in the latter stages of that training.

MASTER SYLLABUS

This document, the Master Syllabus, is a general outline of the items to be included in the ground and flight training of pilots learning how to use ADS-B equipment. The Master Syllabus should be used by companies or individuals to develop an ADS-B Training Guide for a specific airplane, or avionics equipment package. A typical ADS-B avionics package consists of a GPS navigator, an ADS-B data link transceiver, and a MFD, each of which can be from different manufacturers. Therefore, it may be necessary to combine equipment specific syllabi in order to complete a program for a specific combination of avionics equipment.

ADS-B GUIDES

An ADS-B Training Guide is written for specific equipment and is based on the Master Syllabus. It may be produced by any person or company, such as a Certificated Flight Instructor (CFI), training organization, manufacturer, or aviation publisher. Because sequence of training may need to be altered to accommodate individual progress or special circumstances, the training syllabus should be flexible.

As technical complexity varies among specific types of equipment, those who develop ADS-B Training Guides may find it necessary to expand upon the information described in the Master Syllabus. If the prescribed sequence of training is changed, it is the responsibility of the curriculum developer to make sure that all necessary training is accomplished.

NOTE: It is important to understand that ADS-B is an emerging technology and as such, curriculum developers must insure the information being presented is up-to-date must constantly monitor information regarding the current status. Information regarding the latest developments regarding ADS-B technology and capabilities can be found on the following websites:

- www.flyadsb.com
- www.faa.gov/safeflight21/
- http://www.alaska.faa.gov/capstone/

Also, use current manuals and other information available from manufacturers to remain abreast of the technology as it evolves.

STANDARDS

In every airplane system there are limitations based on two factors:

1. The absolute capability of the equipment to perform a particular function and;
2. The individual pilot's ability to use that equipment.

Effective training and experience can enable safe operation of an airplane within these limitations. Some aircraft systems are more complex and require a higher level of skill and interpretation. Pilot skills and knowledge vary with a pilot's total flight time, time-in-type, and recent flight training or experience. Pilots, therefore, must be trained to recognize their personal limitations as well as the airplane's limitations.

Throughout the ground school and flight curriculum, emphasis should be placed on operating within aircraft and pilot limitations. Risk management and decision-making skills (also referred to as Single Pilot Resource Management (SRM)) should be consistently integrated into each scenario. A discussion of limitations, as they apply to the pilot's experience level, and with reference to potential problem areas, will enhance the decision process. ADS-B Training Guides should include discussions of system limitations, characteristics of the specific equipment, and how these items apply to a particular pilot.

GROUND TRAINING

The ground-based segments of the syllabus are an integral part of the SBT course and should be mastered prior to the in-flight training experience. The pilot-in-training (PT) should demonstrate, through written and oral review, the knowledge to safely operate the specific equipment, using the operating guides or manuals supplied with the equipment, the POH or Approved Airplane Flight Manual, and airplane checklists. All immediate-action emergency procedures particular to any piece of equipment covered by this syllabus must be committed to memory. The CFI will discuss each incorrect response with the pilot to ensure complete understanding. The instructor must integrate SRM concepts and techniques in each of these discussions.

The ground training materials for ADS-B specific training need to provide the student with an overall picture of ADS-B and how it is being used in the National Airspace System, the key components of a complete system, and the overall system logic. Specific exercises should take the PT through the use of all knobs, buttons, keys, and other controls that may be used during the operation of the equipment. If there is a computer program that simulates the operation of the device, it should be used to the maximum extent practical to allow the PT to practice all phases of operation prior to flying. In some cases, specific equipment simulators may be available and should be used to the maximum extent possible to allow the PT to practice all system functions prior to flying. If these computer programs or simulation devices allow, the practice should be constructed to use realistic scenarios as soon as practical. In some cases, the equipment installed in the airplane may be used to provide ground training in the basic equipment operation. If this is the case, consideration should be made for an adequate external power supply to prevent depletion of the aircraft's on-board batteries and attention should be paid to the equipment operating limitations, if any, with respect to temperatures while on the ground.

FLIGHT TRAINING

The flight-training lesson consists of a highly scripted scenario consisting of a minimum of two legs. The first, or outbound leg, is designed to allow the student to practice all equipment functions while describing and explaining how to use the information gaining to enhance situational awareness and collision avoidance. The second, or return leg, is designed to allow the student to perform all functions of the equipment and to manage the flight and make appropriate decisions regarding all aspects of the flight while using the ADS-B equipment to enhance situational awareness and to meet the completion standards for this course. There should be a break after the outbound leg during which the PT and instructor will debrief that leg, resolve any questions or concerns, and prepare for the return leg.

The intent is for the student to study the lesson script, prepare a scenario plan, and brief it as part of the preflight preparation.

It is vitally important that the pilot learn to "manage" the aircraft in the automated mode, as well as fly the aircraft by hand. Good SRM demands that the pilot be able to rely on the autopilot and automated navigation systems during times of high cockpit task loads. Instructors must ensure that emphasis is given to both automated and manual flight modes as described in each scenario.

The pilot-in-training should demonstrate the necessary skill and experience required for the specific aircraft. Operations must be accomplished within the tolerances specified in the Practical Test Standards appropriate to the pilot's airmen certificate.

FLIGHT LESSON
MASTER SYLLABUS - SCENARIO BASED TRAINING

OBJECTIVE

The Pilot in Training (PT) will be able to describe and explain the components and elements of the ADS-B equipment installed in the aircraft, will be able to perform all functions necessary for complete operation of the equipment, including all menu and display functions, and will be able to interpret display information to enhance situational awareness, identify potential traffic conflicts and manage/decide on appropriate actions necessary to avoid collisions in flight operations, runway incursions in ground operations, and to use all available information to aid in SRM and ADM.

SCENARIO

Preflight

The PT will plan a VFR cross-country flight of about one and one-half hours to two hours in duration, to include a full stop landing an airport other than the departure airport, and return to the airport of origin.

The PT will perform all normal preflight activities, including determining the status of the ADS-B ground stations and relevant NOTAMS, and describe his/her approach to management of the specific risks involved in this flight using ADS-B for situational and traffic awareness and collision avoidance. The instructor will provide the necessary guidance to insure that the plan provides for all the scenario activities and sub-activities listed for this lesson. The PT is evaluated on the ability to plan a comprehensive flight with conscious attention to all the required scenario activities.

The PT will perform all preflight procedures, engine start-up, avionics set-up, taxi and before-takeoff procedures for each leg of the scenario. This will include GPS flight plan programming for the flight as well as MFD initialization and status assessment, and an effective pre-takeoff briefing. If the equipment allows, emphasize the use of ADS-B for situational awareness during taxi operations to preclude runway incursions. If the equipment does not allow for ground use at a specific airport, the instructor should review this type of operation in ground training to ensure student comprehension and familiarization.

These Preflight activities will be accomplished prior to takeoff for each leg of the flight.

Leg 1 (Outbound flight)

The PT will perform a normal takeoff and departure to a safe altitude. During the departure phase, the PT will be expected to set the MFD to an appropriate range setting to identify traffic in the airport vicinity. The PT will be asked to identify any targets depicted on the MFD and to locate them visually if possible. The PT will be asked to explain the potential conflict each target has with his/her aircraft.

During the en route phase of the flight, the PT will practice changing the range settings on the MFD and identify targets at varying distances from the aircraft. The PT will practice identifying targets and explaining the differences between ADS-B targets and TIS-B targets as depicted on the MFD. The PT will practice various menu functions to change the depiction of airport, airspace, and other information depicted on the MFD ranging from a cluttered to de-cluttered screen. The PT will practice changing the ADS-B target predictor lines and explain how this information is used to assess potential conflicts. The PT will select a target and explain how to resolve potential conflicts should it become necessary. If the pilot is instrument rated, the pilot should perform some of these functions while in IFR or simulated IFR conditions.

The PT will practice getting destination airport information using the FIS-B feature if equipped. If weather information, such as graphical NEXRAD information, can be displayed on the MFD, the PT will set the display appropriately. The PT will use this information to decide which runway to expect and how to manage the entry into the airport.

As the flight approaches the destination airport, the PT will set the range scales such that traffic around the airport can be identified. The PT will use this information to plan the entry into the airport if it is a non-towered airport, or to help identify and follow assigned traffic if so required by an ATC control tower. In either case, ADS-B will be used to help visually identify all relevant targets for the purpose of proper spacing and collision avoidance in the airport traffic pattern.

After landing, the aircraft will be shut down and the instructor and PT will debrief the first leg of the flight.

Leg 2 (Return flight)

A different route will be programmed into the GPS flight plan for the return trip. During this leg, the PT will perform all of the same functions as on the outbound flight, except the learning standards will be perform, manage and decide. The instructor is not expected to provide any assistance. The PT may use the autopilot if installed, but should be able to operate the ADS-B equipment without it and maintain positive aircraft control at all times. If the pilot is instrument rated, the pilot should be able to perform the functions while flying in IFR or simulated IFR conditions. If available, the PT should practice using ADS-B during taxi operations to become more familiar with the equipments capabilities and limitations in the event of poor visibility conditions. The PT should also be introduced to implications of ADS-B technology in relation to ground collision and runway incursion avoidance procedures.

Post-flight

The PT will perform all aircraft shutdown and securing procedures.

PREREQUISITES

Completion of training provider pre-training packet corrected to 100%.

Completion of a Quiz on normal operating procedures, aircraft systems, and avionics corrected to 100%.

PILOT IN TRAINING PREPARATION

Review the following:

a. Normal operating procedures in the POH
b. A worksheet on systems and procedures
c. Airport information for departure and destination airports.
d.
e. Route of flight information for both trips.
f.
g. Aircraft and avionics systems display and procedures.

BRIEFING ITEMS

A. INITIAL INTRODUCTION:

PTs should have a clear understanding of the Pilot in Command concept and how command is transferred. This should include a detailed pre-takeoff briefing procedure and format.

B. SINGLE PILOT RESOURCE MANAGEMENT (SRM)

a. Basic pre-flight and in-flight decision-making and risk management and how ADS-B can be a valuable tool.

C. SAFETY

The following safety items should be briefed to all PTs:

a. Mid-air collision avoidance procedures, including the use of ADS-B traffic information and how to identify potential conflicts and resolve them. Also, the limitations of ADS-B should be discussed to preclude over-reliance on it.

Taxi procedures and how to use ADS-B, if possible, to monitor progress and prevent runway incursions.

Scenario Outcomes

(Note: These activities will be completed as part of the training scenario and are not intended to be a list of training tasks to be completed in numerical order)

Learner (Student) Centered Grading - Desired Pilot in Training (PT) Scenario Outcomes

The objective of scenario-based training is a change in the thought processes, habits, and behaviors of the students during the planning and execution of the scenario. Since the training is learner centered, the success of the training is measured in the following desired student outcomes.

(a) **Maneuver Grades (Tasks)**

- Explain –at the completion of the scenario the PT will be able to describe the scenario activity and understand the underlying concepts, principles, and procedures that comprise the activity. Significant instructor effort will be required to successfully execute the maneuver.
- Practice – at the completion of the scenario the student will be able to plan and execute the scenario. Coaching, instruction, and/or assistance from the CFI will correct deviations and errors identified by the CFI.
- Perform - at the completion of the scenario, the PT will be able to perform the activity without assistance from the CFI. Errors and deviations will be identified and corrected by the PT in an expeditious manner. At no time will the successful completion of the activity be in doubt. ("Perform" will be used to signify that the PT is satisfactorily demonstrating proficiency in traditional piloting and systems operation skills)
- Not Observed – Any event not accomplished or required

(b) **Single Pilot Resource Management (SRM) Grades**

- Explain – the student can verbally identify, describe, and understand the risks inherent in the flight scenario. *The student will need to be prompted to identify risks and make decisions.*
- Practice –the student is able to identify, understand, and apply SRM principles to the actual flight situation. *Coaching, instruction, and/or assistance from the CFI will quickly correct minor deviations and errors identified by the CFI.* The student will be an active decision maker.
- Manage/Decide - the student can correctly gather the most important data available both within and outside the cockpit, identify possible courses of action, evaluate the risk inherent in each course of action, and make the appropriate decision. *Instructor intervention is not required for the safe completion of the flight.*

Scenario Outcomes- Outbound Leg

Scenario Activities	Scenario Sub Activities	Desired PT Scenario Outcome
Preflight Planning	1. ADS-B system availability 2. ADS-B system status 3. Change Data Card	1. Manage/Decide 2. Manage/Decide 3. Perform

Preflight, Engine Start, and Taxi	1. System Initialization and self-tests. 2. Currency of Data Card 3. MFD Setup 4. Airport Diagrams Displayed 5. SRM/Situational Awareness	1. Explain/Practice 2. Explain/Practice 3. Explain/Practice 4. Practice 5. Explain/Practice
Takeoff and Departure	1. MFD range setting 2. Traffic Identification 3. Traffic Alerts/Conflict Identification 4. Traffic Conflict Resolution	1. Practice 2. Explain/Practice 3. Explain/Practice 4. Explain/Practice
En route	1. Identify Targets at various ranges 2. Target Display Options 3. MFD Display Options 4. Identification of Potential Conflicts 5. Conflict Resolution/ Collision Avoidance 6. FIS-B Weather Information	1. Practice 2. Explain/Practice 3. Explain/Practice 4. Explain/Practice 5. Explain/Practice 6. Explain/Practice
Airport Arrival	1. FIS-B Weather Information 2. Destination Airport Information 3. Identify Traffic at Destination Airport 4. Identify Potential or Actual Conflicts and Resolve 5. Establish Approach and Landing Sequence 6. Airport/Runway Situational Awareness after Landing	1. Explain/Practice 2. Explain/Practice 3. Explain/Practice 4. Explain/Practice 5. Explain/Practice 6. Explain/Practice

Scenario Outcomes- Return Leg

Scenario Activities	Scenario Sub Activities	Desired PT Scenario Outcome
Preflight Planning	1. ADS-B system availability	1. Manage/Decide
	2. ADS-B system status	2. Manage/Decide
	3. Change Data Card	3. Perform
Preflight, Engine Start, and Taxi	1. System Initialization and self-tests.	1. Perform
	2. Currency of Data Card	2. Manage/Decide
	3. MFD Setup	3. Perform
	4. Airport Diagrams Displayed	4. Perform
	5. SRM/Situational Awareness	5. Manage/Decide
Takeoff and Departure	1. MFD range setting	1. Perform
	2. Traffic Identification	2. Perform
	3. Traffic Alerts/Conflict Identification	3. Perform
	4. Traffic Conflict Resolution	4. Manage/Decide
En route	1. Identify Targets at various ranges	1. Perform
	2. Target Display Options	2. Perform
	3. MFD Display Options	3. Perform
	4. Identification of Potential Conflicts	4. Perform-Manage/Decide
	5. Conflict Resolution/ Collision Avoidance	5. Manage/Decide
	6. FIS-B Weather Information	6. Perform-Manage/Decide
Airport Arrival	1. FIS-B Weather Information	1. Perform-Manage/Decide
	2. Destination Airport Information	2. Perform-Manage/Decide
	3. Identify Traffic at Destination Airport	3. Perform-Manage/Decide
	4. Identify Potential or Actual Conflicts and Resolve	4. Perform
	5. Establish Approach and Landing Sequence	5. Manage/Decide
	6. Airport/Runway Situational Awareness after Landing	6. Manage/Decide

Section 6 - FITS Master Learning Outcomes List

CDTI 01	**ADS-B Equipment Operation**	
Lesson Objective- The student will demonstrate mastery of ADS-B equipment functions, the use of all available information depicted by the equipment for enhanced situational awareness, traffic identification and collision avoidance, planning, weather awareness, SRM, and Aeronautical Decision Making.		
Performance	Conditions	Standards
The training task is:	The training is conducted during:	The pilot in training will:
1. Overview of ADS-B System and Equipment Requirements	Pre-arrival eLearning, home study course, or classroom training	a) be able to explain the major components of a general aviation ADS-B system and how they work together. b) be able to explain the equipment installed on the training airplane. c) be able to explain ADS-B use in air traffic control. d) be able to explain how ADS-B equipment is similar and different than more traditional avionics equipment found onboard the aircraft.
2. ADS-B Equipment Operation	a) Pre-arrival eLearning, home study, or classroom training b) Simulator, training device, or static airplane In all phases of flight	a) locate and be able to change the data card for the MFD. b) turn on the equipment, monitor system initialization, resolve any messages, and decide if the system is functional and current. c) be able to operate all menu functions via the function keys, soft or "smart" keys, or other input devices. d) change the range settings, add and remove information from the display and display any aircraft, airport, weather, and/or airspace information available. e) Be able to explain why these operations are important to the safe operation of the aircraft.

3. Preflight Planning	a) Pre-arrival eLearning, home study course, or classroom training b) Pre-Flight Planning	be able to determine ADS-B system, including ground-based transmitters, availability and status via NOTAMS or other acceptable means.
4. Takeoff and Departure, En route, and Arrival Operations, with emphasis on SRM, ADM and Risk Management	a) Pre-arrival eLearning, home study course, or classroom training b) Simulator, training device, or static airplane c) In all phases of flight	a) identify ADS-B and TIS-B targets at various range settings on the MFD. b) visually identify targets depicted on MFD whenever possible. c) identify potential traffic conflicts using traffic path predictor projections at various settings. d) decide on appropriate courses of actions to resolve traffic conflicts. e) obtain weather information for en route and destination using FIS-B functions f) make adjustments to route of flight based on weather information obtained/depicted. g) plan arrival into destination using weather and traffic information displayed. h) manage flight path to; decide on landing sequence (non-towered airports), or to maintain proper spacing from assigned traffic (at controlled airports) during arrival at destination. i) use ADS-B information to maintain situational awareness during taxi and other ground operations to avoid runway/taxiway incursions.

APPENDIX

Suggested Outline for Pre-Arrival Learning Guide

In an effort to assist the student in getting the most out of their ADS-B flight training sessions, it is strongly recommended that they first complete a home study course. This home study course, or pre-arrival learning guide, is intended to introduce the PT to the ADS-B equipment and its intended use. It is a basic overview of ADS-B, and not an all-encompassing study guide. At the completion of the home study course, the PT should have a basic understanding of ADS-B and a familiarity with its basic functions.

Lesson 1: Introduction to ADS-B

Purpose: The purpose of this lesson is to introduce the PT to what ADS-B technology is. The intended applications of the equipment, as well as its limitations will also be introduced.

What is ADS-B? Automated Dependent Surveillance – Broadcast is a technology that is designed to be most effective when paired with a GPS system. Not only does ADS-B provide the pilot with map displays, but it can also alert the pilot to other ADS-B equipped aircraft and non charted obstacles.. ADS-B equipped aircraft also allow ATC facilities to locate and track suitable equipped aircraft.

One of the primary applications of ADS-B is to improve a pilot's situational awareness. ADS-B can track and identify other ADS-B equipped aircraft, this can allow the pilot to contact other pilots and directly obtain pilot reports for their intended route of flight.

Another application of a MFD is to aid a pilot in situational awareness. When paired with a GPS system, and ADS-B mapping features, pilots can access accurate moving map displays along their intended flight path. This is one of the six elements of enhanced situational awareness.

ADS-B is not designed nor is it intended to replace ATC, or ATC advisories. The pilot will still be responsible for maintaining separation from other aircraft. ADS-B is not another form of TCAS and does not provide conflict resolution guidance to avoid conflicts with other traffic.

Lesson 2: ADS-B Equipment

Purpose: The purpose of this lesson is to introduce the PT to the primary components involved with ADS-B equipment.

Hard Keys - These are the keys that possess designated functions that do not change with the menu or programming features being accessed. The manufacturer of the equipment designates which keys are hard keys and what function they will perform. Typically hard keys can only access one function, regardless of what menu or function is currently in use.

Soft Keys – Soft Keys also contain designated functions, but the functions will change depending upon the menu item or function that is currently being accessed.

Menus – Menu options that are typically available include moving map displays, flight planning, setting in barometric pressure for the aircrafts current location.

Displays – ADS-B displays typically pair with information contained in the data card and GPS systems. Displays can be as detailed as airport maps to assist the pilot taxiing at an unfamiliar airport to a terrain map comparable to the pilots' choice of a VFR chart or low altitude instrument chart.

Selecting line items – The selection of line items typically involves the use of the Soft Keys. The line items will vary from one menu to the next, and dependent upon the menu being accessed, the key used to select a line item will vary.

Lesson 3: Flight Planning

Purpose: The purpose of this lesson is to introduce the PT to the basic steps required in programming in a flight plan into the ADS-B equipment. This lesson will not address each individual step involved in planning a flight from beginning to end, but those items that the ADS-B equipment will need for the most basic flight plan.

Proper preflight planning and briefing procedures are necessary for any flight. After having completed weight and balance, fuel computations, and estimated time en route in the preflight, this information will need to be programmed into the computer system onboard the aircraft.

While programming in the route of flight, communication and navigation frequencies should also be entered to aid the pilot in reducing his or her workload during the flight. This reduced workload is intended to enhance the pilot's situational awareness during the flight.

Lesson 4: Terminology

Purpose: The purpose of this lesson is to introduce the PT to the manufacturer specific terminology used with their ADS-B equipment. Consult the latest information from the manufacturer and the FAA when developing this lesson.

Lesson 5: Symbology

Purpose: The purpose of this lesson is to introduce the PT to the most common visual features and symbology used by ADS-B equipment. It is important to note that some visual alerts will vary not only in color, but also by the actual symbol used from one manufacturer to the next. Consult the latest information available from the manufacturers and other sources to show how ADS-B and TIS-B traffic is displayed, the limitations on those displays, and weather via FIS-B is displayed.

Lesson 6: Data Card

Purpose: The purpose of this lesson is to introduce the PT to the function and importance of the Data Card to the ADS-B system.

The Data Card contains information such as map data, and should be checked for currency. Much like a VFR or Instrument charts, Data Cards do expire and must be kept current to ensure the pilot has the most up to date and correct information available. Check with the individual manufacturer to locate information regarding the expiration date or status of the Data Card.

The Data Card can be easily removed and installed on most systems. A typical configuration consists of a data card ejector button. After the Data Card has been released, pull it straight out of the slot. When installing the new Data Card do not touch the connector end of the card, push the Data Card straight into the slot until it is flush or slightly recessed with the faceplate.