



# G1000<sup>®</sup> Integrated Flight Deck



**Pilot's Training Guide**  
*Instructor's Reference*

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# INTRODUCTION

## *G1000 Integrated Flight Deck*

The G1000® is a completely integrated avionics system, designed to fit a broad range of aircraft models. It is an all-glass flight deck that presents flight instrumentation, location, navigation, communication, and identification data on large-format, high-resolution displays. The digital data presentation on the G1000 puts all flight-critical information literally at the pilot's fingertips.

### *Purpose*

This Pilot's Training Guide is provided to help the pilot transition to Garmin G1000-equipped aircraft. Use this study guide in combination with the G1000 Simulator and/or the G1000 Pilot's Guide as well as the flight instructor's guidance and feedback to maximize G1000 training before taking delivery of a new G1000-equipped aircraft.



**NOTE:** *Ground lessons should be completed before starting flight training.*



**NOTE:** *In this training guide, each lesson contains exercises as well as a list of resources that are recommended before completing these exercises.*

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### *Flight and Ground Instruction*

It is important to coordinate ground lessons with a properly trained flight instructor. Work with an instructor to make sure that the system is fully understood. This training guide works best if an instructor is involved from the very beginning. Work with an instructor to ensure that the flight lessons cover all appropriate material. Note that the instructor may determine that additional training is required to review aircraft systems, procedures, airspace, or other knowledge areas. Practice under an instructor until confidently proficient with the G1000 system.

### *Level of Knowledge Attained*

The material contained in this guide is designed to help pilots progress from basic to advanced levels of knowledge. The basic skills of interpreting the Primary Flight Display (PFD), tuning the radios, and operating the Audio Panel are covered early on in the training material. Later sections cover navigation, terrain, and other more complex material. The Pilot's Training Guide is designed so that pilot and instructor can begin basic training quickly.



**NOTE:** *It is not necessary to complete the Navigation portion of the material before taking off on a local training flight.*

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# Ground Lesson 1

## INTRODUCTION AND G1000 SYSTEM OVERVIEW

### Objectives

Upon completion of this lesson, the pilot should be able to do the following:

- Describe the basic components of the G1000 Integrated Flight Deck
- Describe the communication between G1000 components

### Resources

- G1000 Pilot's Guide
- Aircraft Flight Manual (AFM) and supplements
- Pilot's Operating Handbook (POH) and supplements
- Aeronautical Information Manual (AIM)
- Federal Aviation Regulations (FAR)

### Exercise 1.1:

#### Terminology and Review of Pertinent Federal Aviation Regulations

1. Define and describe the following navigation abbreviations and acronyms:

- WAAS

**The Wide Area Augmentation System is a satellite navigation system consisting of equipment and software which augment the GPS Standard Positioning Service (SPS). It provides enhanced integrity, accuracy, availability, and continuity over and above GPS SPS. The differential correction function provides improved accuracy required for precision approach.**

- LNAV

**Lateral Navigation provides lateral guidance to a profile or path. This terminology is used for GPS non-precision approaches.**

- LNAV/VNAV

**Lateral Navigation/Vertical Navigation describes an approach in which lateral guidance as well as vertical glide slope guidance is provided.**

- LPV

**Localizer Performance with Vertical guidance is a new type of APV approach procedure in which the angular lateral precision is combined with an electronic glidepath. TERPS approach criteria are very similar to that used for ILS approaches.**

- VNAV (or VNV)

**Vertical Navigation manages the altitude profile. The concept of the VNAV is to assign a target altitude to assist in controlled decent operations. Using the flight plan, a target altitude may be assigned to any waypoint. To reach the target altitude, the rate of descent is calculated and displayed and vertical guidance is provided to reach the descent profile.**

- APV

**Approach with vertical guidance is an International Civil Aviation Organization (ICAO) term referring to specific ICAO criteria adopted in May 2000. This approach classification allows stabilized descent using vertical guidance without the accuracy required for traditional precision approach procedures. The US has developed criteria for lateral/vertical navigation (LNAV/VNAV) and LPV approach procedures that meet this approach classification. LNAV/VNAV and LPV approaches provide guidance in both the lateral and vertical planes.**

- SBAS

**Satellite-based augmentation systems use satellites and networks of ground stations to provide improved accuracy for received GPS satellite signals. Internationally, many countries are working with the International Civil Aviation Organization (ICAO) to standardize satellite-based augmentation systems (SBAS) globally. WAAS is an SBAS currently being implemented in the United States**

2. Describe how WAAS provides improved accuracy.

**The Wide Area Augmentation System (WAAS) uses a network of ground stations to provide necessary corrections to received GPS SPS navigation signals. Precisely surveyed ground reference stations are strategically positioned across the country, including in Alaska, Hawaii, and Puerto Rico, to collect GPS satellite data. Using this information, a message is developed to correct any signal errors. These correction messages are then broadcast the same frequency as GPS signals by communication satellites to receivers on board aircraft. WAAS is designed to provide the additional accuracy, availability, and integrity necessary to enable users to rely on GPS for all phases of flight, from enroute through approach for all qualified airports within the WAAS coverage area.**

**WAAS supplies two different sets of corrections: <sup>1</sup>corrected GPS parameters (position, clock, etc.) and <sup>2</sup>ionospheric parameters. The first set of corrections is user position independent (i.e., they apply to all users located within the WAAS service area). The second set of corrections is area specific. WAAS supplies correction parameters for a number of points (organized in a grid pattern) across the WAAS service area. The user receiver computes ionospheric corrections for the received GPS signals based on algorithms which use appropriate grid points for the user location. Furthermore, the appropriate grid points may differ for each GPS satellite signal received and processed by the user receiver, since GPS satellites are located at various positions in the sky relative to the user. The combination of these two sets of corrections allows for significantly increased user position accuracy and confidence anywhere in the WAAS service area.**

3. Explain the capabilities of TSO-C146a GPS equipment during instrument approaches, per the AIM.

**The equipment automatically utilizes WAAS error corrections for safe navigation of LNAV/VNAV instrument approaches. These approaches provide both horizontal and vertical guidance. This equipment can also navigate LPV approaches developed specifically for WAAS, providing ILS-like performance.**

4. Equipped with TSO-C146a GPS equipment, what other navigational instruments must your aircraft have on board to navigate in National Airspace?

**Using TSO-C146a GPS equipment, a pilot could legally navigate solely by use of WAAS GPS, even in areas where VOR or NDB reception is poor or non-existent. All TSO C129/C129a systems require the presence of another approved navigation system appropriate to the intended route of flight.**



5. When filling a flight plan, what suffix is used for a current Global Positioning System (GPS) database with WAAS?

**“/G” is the suffix used for GPS flight plans.**

6. What are the position accuracy improvements with the WAAS?

**TSO-C129a systems:**

- **Horizontal position accuracy  $\approx$  50 feet (15m)**
- **Vertical position accuracy  $\approx$  74 feet (23m)**
- **GPS position update rate = 1 Hz**

**TSO-C146a systems:**

- **Horizontal position accuracy < 10 feet (3m)**
- **Vertical position accuracy < 15 feet (4.5m)**
- **GPS position update rate = 5 Hz**

7. Describe the differences between fly-by and fly-over GPS waypoints and draw their respective symbols.

**Fly-by waypoints allow for turn anticipation, whereas fly-over waypoints must be crossed, most often due to terrain clearance issues. Both symbols can be found on approach plates.**

8. What does RAIM stand for? Describe its purpose and relationship with WAAS GPS receivers.

**Receiver Autonomous Integrity Monitoring provides integrity check capability to ensure the safe use of GPS for IFR flight operations (see AIM for drawing verification). The only time RAIM prediction is needed for TSO-C146a systems is when WAAS is not available.**

## Exercise 1.2: Component Review

### 1. Define the following equipment abbreviations and acronyms:

- AHRS

**An Attitude and Heading Reference System is a solid-state electrical gyro system.**

- ADC

**An Air Data Computer calculates and digitizes pitot, static, and temperature inputs.**

- TIS

**The Traffic Information Service is Mode S-carried traffic awareness FAA service.**

- TAWS

**Terrain Awareness and Warning System is a TSO-C151b, Class B, certified optional feature on the G1000, designed to increase situational awareness and aid in reducing Controlled Flight into Terrain (CFIT).**

- AFCS

**An Automatic Flight Control System provides pitch/roll steering guidance and sends commands to an autopilot to operate the flight control surfaces.**

### 2. Describe the function of the following components of the G1000 Integrated Flight Deck:

- GRS 77

**The Attitude and Heading Reference System (AHRS) provides aircraft attitude and heading information to the Primary Flight Display (PFD) and the primary Integrated Avionics Unit (IAU; GIA #1). The AHRS contains advanced sensors (including accelerometers and rate sensors) and interfaces with the Magnetometer to obtain magnetic field information, with the ADC to obtain air data, and with both IAUs to obtain GPS information.**

- GMU 74

**The tri-axis magnetometer measures local magnetic field and sends data to the AHRS for processing to determine aircraft magnetic heading. This unit receives power directly from the AHRS.**

- GIA 63

**The Integrated Avionics Units (IAU) function as the main communications hub, linking all LRUs with the PFD. Each IAU contains VHF COM/NAV/GS receivers and system integration microprocessors.**

- GDU 10XX

**Primary Flight and Multi Function displays (PFD and MFD) show flight instruments and navigation information, respectively. GDU number may differ depending on aircraft installation.**

- GTX 33

**The solid-state Transponder provides Modes A, C, and S capability.**

- GMA 1347

**The Audio Panel integrates navigation/communication radio (NAV/COM) digital audio, intercom, and marker beacon controls, and is installed between the displays. This unit also provides manual control of display reversionary.**

- GDL 69/69A

**The Datalink Satellite Radio Receiver provides real-time weather information to the G1000 MFD and PFD Inset Map, as well as digital audio entertainment (GDL 69A only). A subscription to XM Satellite Radio Service is required to enable the GDL 69A capability**

- GWX 68

**The Airborne Weather Radar is a four-color digital pulsed radar.**

- GFC 700

**The GFC 700 is a fully-integrated Automatic Flight Control System (AFCS), which includes a flight director, autopilot, and manual electric trim capability.**

3. What is the primary interface used between the G1000 components?

**Digital, uni-directional Ethernet buses using a proprietary Garmin protocol are the primary communication links between G1000 Line Replaceable Units (LRUs).**

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## ***Ground Lesson 2***

### ***TRANSITION TO THE PRIMARY FLIGHT DISPLAY (PFD)***

#### ***Objectives***

Upon completion of this lesson, the pilot should be able to read, understand, and interpret the six primary flight instruments displayed on the PFD that indicate airspeed, attitude, altitude, vertical speed, turn rate/coordination, and heading.

#### ***Resources***

- G1000 Pilot's Guide
- G1000 Cockpit Poster

#### ***Exercise 2.1: Instrumentation Layout***

In the space provided below, sketch the six primary flight instruments as displayed. Also, include additionally displayed instruments, such as the Vertical Deviation/Glideslope Indicator, Marker Beacon Annunciation, Traffic Annunciation, and TAWS Annunciation on the PFD.

### *Exercise 2.2: Instrumentation Depiction*

Assume that the aircraft is flying with the following indications and fill in the appropriate fields on the sketch with this data. Note that some data is not displayed for certain G1000 installations.

- Airspeed = 140 KIAS
- True Airspeed = 154 KTAS
- Altitude = 6760 ft
- Vertical Speed = 0 fpm
- Heading = 95°
- Barometric Altimeter Setting = 30.02 in Hg
- Outside Air Temperature = 4°C

## **Ground Lesson 3**

### **POWER-UP, SELF-TEST, CHECKLIST**

#### **Objectives**

Upon completion of this lesson, the pilot should be able to correctly identify proper alignment of the AHRS/ADC, complete a system self-test, and verify the database data.

#### **Resources**

- G1000 Pilot's Guide
- G1000 PC-based Simulator

#### **Exercise 3.1: System Initialization**

1. How does one verify the aircraft software upon power-up?

**The aircraft system version information is located on the top right corner of the MFD power-up splash screen and also on the AUX – System Status Page. It is very important to make sure the correct aircraft software is loaded, especially after the aircraft has undergone any maintenance action.**

2. Is the aircraft required to remain stationary while the AHRS and ADC align?

**No, the AHRS/ADC can align while the aircraft is moving and even in flight at bank angles of up to 20°.**

3. Is any warm-up time required for the engine instrumentation to be accurate?

**No, a warm-up period is not required for engine instrument display accuracy.**

4. What pilot action should be taken if the MFD system self-test does not pass?

**The pilot should shut down the aircraft and contact maintenance.**

5. Where can one verify the effective dates of the Jeppesen database during the initial system start-up?

**The Jeppesen database effective dates are located at the right-hand side of the MFD start up splash screen at the conclusion of the scrolled text sequence.**

6. If the Jeppesen database is not current in the G1000, can the system still be used for IFR flight?

**Yes, but one cannot file a "/G" flight plan for GPS use or use the GPS for instrument approach procedures.**

7. How does one verify if the autopilot has passed its preflight system test?

**Upon completion of the preflight test, the AFCS Status Annunciation 'PFT' will extinguish and aural tone will be generated.**

8. How does one verify if TAWS passed its preflight system test?

**Upon completion of the preflight test, the 'TAWS TEST' annunciation will extinguish and the voice alert, "TAWAS system test OK", will be generated.**

9. A pilot is planning a flight to KAPA (Centennial Airport, Denver, CO) from KCOU (Columbia, MO). When arriving at the aircraft, the pilot notices that the Jeppesen database is out of date by 3 cycles (84 days).
- Can the pilot make the flight under Instrument Flight Rules (IFR)?  
**Yes, but one cannot file “/G” on the flight plan form, and the VOR/LOC/GS receivers must be used for navigation.**
  - What enroute flight planning considerations must be made?  
**All enroute ground navigational aids (NAVAIDs) must be operational. This can be verified by checking the Notices to Airmen (NOTAMs).**
  - What destination flight planning considerations must be made?  
**One can only accept a VOR/LOC/ILS approach at KAPA.**



## **Ground Lesson 4**

### **TRANSPONDER OPERATION**

#### **Objectives**

Upon completion of this lesson, the pilot should be familiar and comfortable with the operation of the integrated transponder controls located on the PFD of the G1000 System. This includes the selection of the transponder operating mode, squawk code entry, and IDENT activation.

#### **Resources**

- G1000 Pilot's Guide
- G1000 PC-based Simulator

#### **Exercise 4.1: Operating Modes and Code Entry**

1. To which transponder operating mode does the G1000 System default when it is first powered up, if equipped with the Garmin Mode S Transponder (GTX 33)?

**The Transponder begins operating in Ground mode, indicated by the letters 'GND' in the Transponder Status Box.**

2. Describe the process for entering a newly assigned transponder code.

1. **On the PFD, press the XPDR Softkey**
2. **Press the CODE Softkey.**
3. **Use the appropriate digit softkeys to enter the assigned code. On certain airframes, the transponder code can also be entered using the numeric keypad on an MFD/PFD Control Unit (GCU).**

3. Which Garmin LRU failure will cause the G1000 to lose Mode C/S capability?

**If an Air Data Computer (GDC 74) fails, the GTX 33 Transponder will lose the pressure altitude source, leaving it to operate in Mode A only.**

4. Equipped with a GTX 33 Transponder, how is the G1000 able to receive traffic information?

**Once the aircraft is airborne, the GTX 33 Transponder is able to receive traffic data and display it graphically on the PFD/MFD maps. The aircraft must be within the coverage of terminal Mode S radar sites to display TIS information.**

5. What is acquisition squitter?

**Acquisition squitter is transponder transmission that is sent periodically regardless of the presence of interrogations. Its purpose is to make Mode S ground stations and Traffic alert and Collision Avoidance System (TCAS)-equipped aircraft aware of the presence of Mode S-equipped aircraft.**

### *Exercise 4.2: Practice (Optional)*

Using the G1000 PC-based Simulator, review the start-up process and verify the Jeppesen database effective dates. Also, practice entering various transponder codes and changing the operating mode using the PFD softkeys.

## **Ground Lesson 5**

### **COM RADIO AND AUDIO PANEL OPERATION**

#### **Objectives**

Upon completion of this lesson, the pilot should be comfortable manually and automatically tuning and selecting communication frequencies, while properly configuring the selections on the GMA 1347 Audio Panel.

#### **Resources**

- G1000 Pilot's Guide
- G1000 Cockpit Poster
- G1000 PC-based Simulator

#### **Exercise 5.1: COM Operation and Methods of Frequency Tuning**

1. Are active frequencies displayed toward the inside or outside of the PFD and MFD in the NAV/COM Frequency boxes?

**Active frequencies are displayed toward the inside of the displays.**

2. In what color are active frequencies displayed?

**Active frequencies are indicated in green.**

3. Which key should be pressed to change between the standby and active frequencies? Draw the label on this key.

**The Frequency Transfer keys are used to transfer the standby and active frequencies for the selected navigation (NAV) and communication (COM) radios. Refer to the Pilot's Guide System Overview section for a depiction of the key.**

4. If the **COM Frequency Transfer** Key is held for two seconds, what occurs?

**The emergency COM frequency (121.50 MHz) is tuned in the active field of the selected COM radio.**

5. When manually tuning a frequency, what is the large **COM** Knob used for? What is the small **COM** Knob used for?

**The large COM Knob changes the MHz, while the small knob changes the kHz.**

6. When the **NRST** Softkey is pressed on the PFD, a list of the nearest airports appears, with runway length and tower/CTAF frequencies listed. How can one directly tune one of these frequencies without having to manually tune it into the COM radio?

1. **Press the FMS Knob.**
2. **Use the large FMS Knob to highlight the desired frequency**
3. **Press the ENT Key (this places the frequency into the selected COM1 or COM2 standby field based on location of the COM Tuning Box).**
4. **Press the COM Frequency Transfer Key to place the frequency into the active field.**

### ***Exercise 5.2: Practice (Optional)***

Using the G1000 PC-based Simulator, power up the system.

- 1.** Verify the Jeppesen database effective dates and note those dates in the space provided below.
- 2.** Enter the transponder code “3470” and set the transponder to ‘ALT’ mode.
- 3.** In COM1, enter 124.30 MHz as the active frequency and 133.00 MHz as the standby frequency.
- 4.** In COM2, enter 135.325 MHz as the active frequency and 118.90 MHz as the standby frequency.

### *Exercise 5.3: Audio Panel Operation*

1. Which key should be pressed on the Audio Panel (GMA 1347) to monitor a COM radio frequency without transmitting?

**Press the COM Key for the selected radio (COM1 or COM2) to monitor the desired communication radio.**

2. If available, describe how the split COM feature works and provide a sample scenario of its use.

**Split COM allows the pilot to use COM1 while the copilot uses COM2. This proves very helpful for talking to an FSS enroute without leaving the ARTCC frequency. Pressing the COM1/2 Key on the Audio Panel turns on the Split COM function.**

3. What purpose does the red button located at the bottom of the Audio Panel (GMA 1347) serve?

**The DISPLAY BACKUP Button forces the G1000 displays to enter reversionary mode, showing the flight instruments together with the engine instruments in the event of display failure. Refer to the System Overview in the Pilot's Guide for details.**

4. Does COM MIC Key selection have any impact on the display of the COM frequencies on the PFD or MFD? Explain.

**Pressing a COM MIC Key changes the corresponding active frequency to green. Note that the active COM1 and COM2 frequencies in the COM Frequency Box can be green simultaneously only when Split COM function is selected (i.e., when COM1/2, COM1 MIC, and COM2 MIC are annunciated on the Audio Panel).**

5. Two pilots on a long cross-country flight encounter bad weather. The pilot flying the plane wants a weather update, but is struggling to get on frequency and be heard because the ARTCC frequency is very busy handling multiple reroutes. What tools are available to get the necessary weather information to continue the flight?

**Stormscope or datalink weather information may be available, although the most useful tool is the other pilot. By using the split com function, the ARTCC frequency can be monitored on COM1 while the other pilot can contacts Flightwatch or the Flight Service Station on COM2.**

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## Ground Lesson 6

### NAVIGATION

#### Objectives

Upon completion of this lesson, the pilot should be able to navigate using ground-based NAVAIDs and GPS while manually tuning VOR/LOC/ILS frequencies and creating GPS direct-to and flight plans.

#### Resources

- G1000 Pilot's Guide
- G1000 Cockpit Poster
- G1000 PC-based Simulator

#### Exercise 6.1: Land-based Navigational Aids

1. Is the process to manually tune a NAV frequency the same as it is for a COM frequency?

**Yes, NAV frequencies are tuned in the same manner as are COM frequencies.**

2. When using the database to automatically tune a NAV frequency, is the process the same as it is for automatically loading a COM frequency?

**Yes, the processes for automatically tuning NAV and COM frequencies are similar.**

3. What type of information is provided about a ground-based navigational aid when it is highlighted by panning on the map and the **ENT** Key is pressed?

**NAVAID name, type of NAVAID, and frequency are displayed when panning over a NAVAID, after the ENT Key is pressed.**

4. How and where can the pilot select the Course Deviation Indicator (CDI) navigation source displayed on the HSI for the NAV1 or NAV2 frequency?

**The CDI Softkey on the PFD cycles through NAV1, NAV2, and GPS navigation sources.**

5. Does the G1000 System automatically attempt to identify the tuned NAV frequency? How is this visually presented?

**Yes, a three- (for VOR) or four-letter identifier (for ILS, LOC) is displayed to the right of the NAV frequency.**

6. How and where can the pilot select additional bearing pointer information displayed on the HSI for the NAV1 or NAV2 frequency?

1. **Press the PFD Softkey**

2. **Press the BRG1 and/or BRG2 Softkey. The appropriate Bearing Information window(s) will be displayed next to the HSI. The bearing pointer(s) will be displayed when the appropriate NAV radio is receiving the tuned VOR station.**

7. With the NAV radio receiving the tuned VOR station, the corresponding Bearing Information Window displays the distance to bearing. What source provides the distance information?

**The GPS-derived great circle distance is displayed (note that this is not a DME distance).**

8. How and where can the pilot select the DME information displayed on the PFD?
  1. **Press the PFD Softkey on the PFD.**
  2. **Press the DME Softkey. The DME Information Window will be displayed next to the HSI.**



### ***Exercise 6.2: Practice (Optional)***

Using the G1000 PC-based Simulator, power up the system and configure the G1000 as needed for the following IFR clearance out of KAPA (Centennial Airport, Denver, CO):

“N12345 is cleared to the Goodland, KS, airport, via the Thurman VOR, Byers VOR, then direct. Climb and maintain eight thousand, expect one-two thousand in ten minutes. Departure frequency is 126.75, squawk 3470.”

**The student should have accomplished the following actions:**

- **Entered the following active flight plan: KAPA – TXC – BVR – KGLD**
- **Set the Selected Altitude to 8,000 feet**
- **Entered the departure frequency 126.750 in one of the standby COM fields**
- **Entered the transponder code 3470**

### Exercise 6.3: GPS Navigation

1. Can a direct-to/flight plan be created using GPS on both the PFD and the MFD or must one or the other be used (if so, which one)?

**Either display can be used for creating a GPS direct-to or flight plan; the data automatically cross-fills to the other display.**

2. Describe the process for canceling a direct-to.

1. **Press the Direct-to Key.**
2. **Press the MENU Key.**
3. **Use the FMS Knob to highlight the option “Cancel Direct-to Nav”.**
4. **Press the ENT Key.**

3. Describe the process for entering a flight plan.

1. **Press the FPL Key on either display. When on the ground at start-up, the departure airport is automatically entered if the GPS has acquired a solution.**
2. **Press the FMS Knob to activate the cursor.**
3. **Use the FMS Knob to enter a waypoint identifier (use the small knob to select a character and the large knob to change cursor location).**
4. **Once an identifier is entered, press the ENT Key.**
5. **Repeat the process on the next line. If installed, the alphanumeric keypad on an MFD or MFD/PFD Control Unit (GCU) can be used to enter flight plan information.**

4. When flight plan information has been entered, does the G1000 System auto-sequence the waypoints and does the autopilot continuously fly the programmed route?

**Yes, that is the key reason for using the G1000’s flight planning function.**

5. Describe some of the advantages of flight planning as opposed to using continuous direct-to navigation.

**Flight planning reduces workload during the enroute phase of flight, allows for smooth autopilot navigation, and minimizes the number of key presses when an assigned route changes (for example, it allows one to skip waypoints in a SID or STAR, as instructed by ATC, without losing the rest of the procedure).**

### ***Exercise 6.4: Practice (Optional)***

Using the G1000 PC based Simulator, power up the system.

- 1.** Verify the Jeppesen database effective dates and note those dates in the space provided below.
- 2.** Enter the transponder code “1252” and set the transponder to ‘ALT’ mode.
- 3.** In COM1, enter the ATIS frequency for KAPA as the active frequency and the ground control frequency as the standby frequency.
- 4.** In COM2, enter the KAPA Tower frequency as the active frequency and the departure frequency for an eastbound departure as the standby frequency.
- 5.** Tune in and place Thurman, CO VOR (TXC) into the active NAV1 frequency; tune in and place Byers, CO VOR (BVR) into the active NAV2 frequency.
- 6.** Create a flight plan from KAPA to KIXD via Thurman, Goodland, Hill City, Salina, and Topeka VORs and the RUGBB intersection.

## Exercise 6.5: Instrument Approaches

1. When first selecting an approach, what is the default option that appears when the **PROC** Key is pressed?

**“Select Approach” is the first option displayed when the PROC Key is pressed.**

2. What is the difference in how the HSI presents data between selecting Vectors-to-Final or an Initial Approach Fix during an instrument approach?

**When Vectors-to-Final is selected, the HSI sets the inbound approach course automatically and it can be intercepted in the same way it would when getting vectors to a ground-based NAVAID. When the full approach is selected, the system provides guidance to the Initial Approach Fix.**

3. Describe the CDI scaling that occurs when flying a GPS approach, according to the AIM.

- **When transitioning to within 30 nm of the destination, the CDI gradually scales down from 2.0 nm to 1.0 nm full-scale deflection.**
- **When within 2 nm of the FAF, the CDI gradually scales down to 0.3 nm (556 meter) full-scale deflection for LNAV and LNAV/VNAV approach mode, to 40 meters for LPV.**
- **Also adds vertical integrity monitoring, for LNAV/VNAV and LPV approaches vertical error to 50 meters.**
- **On the missed approach, the scaling changes to 0.3 nm when the first leg of the missed approach is a track to fix leg aligned within 3° of the inbound course until the turn initiation point for the first waypoint in the missed approach procedure, at which time it will change to 1.0 nm sensitivity.**

4. When navigating using the GPS, if an ILS, LOC, or VOR approach is selected, where is the frequency for the primary approach navigational aid automatically placed?

**The primary approach NAVAID frequency is placed in the active frequency field of NAVI.**

5. When flying an ILS approach, where do the Glideslope Indicator and Marker Beacon Annunciation appear on the PFD?

**The Glideslope Indicator appears to the left of the Altimeter and the Marker Beacon Annunciation appears above the Glideslope Indicator.**

6. Can GPS be used to fly a VOR approach?

**Yes, but only if the title of the approach plate is “VOR or GPS”.**

7. Does GPS provide guidance data to the autopilot to allow it to fly a coupled holding pattern?

**Yes, GPS guidance is provided to the autopilot for flying holding patterns.**

8. Can GPS be used in lieu of DME when flying a DME arc associated with a VOR, LOC, or ILS approach procedure?

**Yes, provided the arc procedure is depicted in the database.**

9. What key must be pressed to add a departure procedure (DP or SID) and/or arrival procedure (AP or STAR) to a flight plan?

**Pressing the PROC Key gives access to a list of options that includes adding a departure or arrival procedure. Note that softkeys on the Flight Plan Page also allow addition of a departure or an arrival procedure.**

10. When navigating using VOR1, VOR2, LOC1, or LOC2, if an ILS, LOC, or VOR approach is selected, where is the frequency for the primary approach navigational aid automatically placed?

**The primary approach NAVAID frequency is placed in the standby frequency field of the selected NAV.**

## Exercise 6.6: Practice (Optional)

Using the G1000 PC-based Simulator, power up the system.

1. Verify the Jeppesen database effective dates and note those dates in the space provided below.
2. Enter the transponder code “5455” and set the transponder to ‘ALT’ mode.
3. In COM1, enter the ATIS frequency for KAPA as the active frequency and the ground control frequency as the standby frequency.
4. In COM2, enter the KAPA Tower frequency as the active frequency and the departure frequency for an eastbound departure as the standby frequency.
5. Assume that a pilot is departing KAPA and selects and loads the Plains Two Departure, Goodland Transition (PLAIN2.GLD). The rest of the flight plan goes from KAPA to KMKC via Hill City and Salina VORs with the Jayhawk Five Arrival via the Emporia Transition (EMP.JHAWK5). Expect the ILS 3 Approach into Kansas City Charles B. Wheeler Downtown Airport.

Load VOR frequencies as appropriate to monitor the progress of the flight along with the GPS navigation.

6. Initiate the flight on the Simulator. Enroute just east of Goodland, the pilot receives the following amended clearance from ARTCC:

“N12345, I am showing level-4 radar returns on my radar over the Hill City VOR, in a line that runs from 40 miles to the southwest of Hill City to 150 miles to the northeast. The entire storm appears to be moving east at 30 knots.”

The pilot was planning on stopping for fuel in Salina, but realizes that the storm will be on top of the airport by the time of arrival. Note that the aircraft is not equipped with a Stormscope or datalink weather.

What are the pilot’s options? Rank these options from best to worst.

**Best option: Deviate to another airport for fuel (possibly even to Goodland), check the weather on the ground, and plan the rest of the flight based on weather deviations.**

**Acceptable option: Continue to the next airport closest to Hill City, land for fuel, and check weather, asking ARTCC for PIREPS as the aircraft approaches the area of the storm.**

**Poor option: Continue on the current flight path, delaying decision on deviation actions until closer to the weather and hoping that ARTCC has the capacity to provide vectors around the storm. The problem with this proposed scenario is two-fold:**

- ARTCC may prove too busy to provide vectors.
- ARTCC radar has limited ability to detect areas of significant weather accurately

**Worst option: Continue the current flight path and try to penetrate the storm.**

### *Exercise 6.7: Vertical Navigation (VNAV)*

1. Where does one go to program a VNAV flight plan on the G1000?

**In the flight plan, assign VNAV target altitudes to programmed waypoints for enroute and descent phases of flight. Altitudes may also be loaded from the database. The G1000 calculates Top Of Decent (TOD) and Bottom Of Decent (BOD) based on ground speed.**

2. Are any VNAV messages provided to the pilot?

**TOD and BOD message are displayed in the PFD Navigation Data Box.**

3. Are visual references for VNAV operations shown on the moving map?

**A gray hollow dot is placed at the calculated TOD along the flight path; a white hollow dot is used to represent the BOD.**

4. How do you verify the GFC 700 autopilot is correctly moded to capture the current VNAV profile?

**After pressing the VNV Key, verify that 'VPTH' is annunciated in the AFCS Status Box on the PFD. White annunciations represent armed modes; active modes are shown in green.**

5. How do you cancel a VNAV profile?

**Press the CNCL VNAV Softkey on the Active Flight Plan Page or use the "Cancel VNAV" menu option. The G1000 still follows the active flight plan, but stops vertical navigation.**

## Exercise 6.8: Charts

1. How does one view the Safe-Taxi diagram on the MFD as well as on the PFD?

**The Safe-Taxi diagram can be viewed by enabling it in the Navigation Map Setup:**

1. **On the MFD, press and hold down the CLR Key. This returns the MFD to the default MAP – Navigation Map Page.**
  2. **Press the MENU Key.**
  3. **Select the “Map Setup” option and press the ENT Key.**
  4. **Use the small FMS Knob to select the “Aviation” group and press the ENT Key.**
  5. **Using the large FMS Knob, scroll down to “SafeTaxi”.**
  6. **Enable the function by using the small FMS Knob to select a display range other than “Off”.**
2. On which MFD pages can JeppView charts be viewed?

**On the first of the five pages of the Waypoint (WPT) Page Group, the charts can be viewed by pressing the CHRT Softkey.**
  3. How does one verify the currency of the charts?

**The currency of all the databases, including the JeppView database, can be reviewed on the AUX – System Status Page in the box labeled “Database”.**
  4. Can one legally replace paper charts with electronic charts?

**As of June 2006, electronic charts cannot be used instead of paper charts.**



## **Ground Lesson 7**

### **MULTI FUNCTION DISPLAY (MFD) OPERATION**

#### **Objectives**

Upon completion of this lesson, the pilot should be able to locate, use, and configure data on the MFD during flight operations.

#### **Resources**

- G1000 Pilot's Guide
- G1000 Cockpit Poster
- G1000 PC-based Simulator

#### **Exercise 7.1: MFD Configuration and Controls**

1. Which main type of data is presented on the default MFD page display?

**Map data is the main data type presented on the default Navigation Map Page.**

2. What data types can be overlaid on the MFD map? Where are the controls for this data overlay located?

**Terrain, topography, traffic, and weather information can be overlaid on many MFD map pages by pressing the MAP Softkey and then the respective information softkey.**

3. Which MFD page within which page group must be accessed to verify the status of the G1000's GPS receivers?

**The AUX - GPS Status Page displays GPS receiver status.**

4. How are the Nearest (NRST) pages accessed?

**Turn the large FMS Knob on the MFD (or remotely-mounted MFD or MFD/PFD Control Unit) to the NRST Page Group (the last main page group). Note that on the PFD, pressing the NRST Softkey accesses the Nearest Airports Window.**

5. What types of information can be accessed via the Waypoint (WPT) pages?

**The Waypoint pages show all of the Jeppesen database data for airports, NAVAIDs, and user-created waypoints.**

6. How can map display orientation be changed between north-up and track-up presentations?

1. **From the Navigation Map Page, press the MENU Key.**
2. **Highlight "Map Setup" and press the ENT Key.**
3. **Use the large FMS Knob to scroll to the "Orientation" field.**
4. **Use the small FMS Knob to select the desired orientation and press the ENT Key.**

7. When panning on the Navigation Map Page, where does information appear about the terrain shown at the Map Pointer cursor location?

**Terrain panning information is shown below the page title, at the top of the display.**

8. Which page should be accessed in order to change the navigation data field options at the top of the MFD display?

**The AUX - System Setup Page provides options for changing the navigation information displayed in the MFD Navigation Data Box.**

9. Which key can be pressed and held for two seconds to quickly return to the Navigation Map Page?

**Pressing and holding the CLR Key returns the MFD to its default screen.**

10. A pilot is on a flight from KAPA (Centennial Airport, Denver, CO) to KGJT (Grand Junction Airport, Grand Junction, CO) over the mountains. Weather is predicted to be MVFR with scattered rain over the entire route of flight. How would one configure the MFD to give the best presentation of data for this flight? Assume that a GDL69 Datalink Receiver is installed in the aircraft.

**Since visibility is marginal, display the terrain overlay by selecting the TERRAIN Softkey on the MFD to ensure terrain clearance over the mountains. Periodically check the MAP - Weather Datalink Page for areas and strength of precipitation. The combination of terrain elevation and weather information allows better planning of the flight route, but one must be prepared for unexpected deviations.**

## **Ground Lesson 8**

### **PRIMARY FLIGHT DISPLAY (PFD) OPERATION**

#### **Objectives**

Upon completion of this lesson, the pilot should be able to configure and interpret data presented on the PFD during all phases of flight operations.

#### **Resources**

- G1000 Pilot's Guide
- G1000 Cockpit Poster
- G1000 PC-based Simulator

#### **Exercise 8.1: PFD Configuration and Controls**

1. Which control is used for cycling between GPS, VOR1, VOR2, LOC1, and LOC2 CDI navigation sources?

**On the PFD, press the CDI Softkey to cycle between GPS (magenta), NAV1, and NAV2 (both green) navigation sources.**

2. Name the two display formats available for the HSI (note that some aircraft have only one available display format).

**The HSI can be displayed as a 360° rotating compass rose or a 140° arc (arc HSI display is not available on some aircraft).**

3. What type of data can be overlaid on the PFD Inset Map?

**Softkeys are available to overlay traffic, terrain, topo, and weather information on the Inset Map.**

4. Are the navigation data fields at the top of the PFD configurable by the pilot?

**No, the fields in the PFD Navigation Data Box cannot be changed.**

5. From the PFD, can the pilot enter, view, and edit a flight plan?

**Yes, the active flight plan can be accessed by pressing the FPL Key and the Flight Plan Window can be scrolled through using the FMS Knob.**

6. Where is the knob for course selection or OBS (omni-bearing selector) located?

**For installations with a GDU 1XXX PFD, the CRS Knob is the small triangular portion of the CRS/BARO Knob on the right-hand side of the PFD bezel. For installations with an AFCS Control Unit, the CRS knob(s) are located here rather than on the PFD bezel; refer to the System Overview in the Pilot's Guide for details.**

7. What happens when the HDG Knob is pressed?

**Pressing the HDG Knob centers the Selected Heading Bug on the current aircraft heading.**

8. What happens when the CRS Knob is pressed?

**Pressing the CRS Knob centers the CDI on the current aircraft radial with a "To" indication.**

9. Where is the control for the Altimeter barometric pressure setting located?

**The BARO Knob is located on the right-hand side of the PFD (in some installations, exists as the large outer knob of the CRS/BARO Knob).**

10. What are the ranges of viewable tape in the Altimeter and Airspeed Indicator?

**The Altimeter has 600 feet viewable at a time; 60 knots are viewable on the Airspeed Indicator at any one time.**

11. A pilot is flying through the Rocky Mountains and decides to land at KASE in Aspen, CO. The RNAV (GPS) 15 approach via radar vectors is assigned. It is daytime, although visibility is limited to a few miles with cloud tops at 10,000 feet MSL. What options should be selected for display on the PFD Inset Map?

**Going into Aspen, one should focus on the approach as well as on the other key item-- terrain. Therefore, declutter the display to show the approach and turn on the terrain and traffic display overlays. Eliminating the topography shading provides higher contrast in the displayed colors on the map, allowing the pilot to focus on avoiding a CFIT (Controlled Flight into Terrain) accident and to stand a better chance of being able to see and avoid traffic departing runway 33 out of KASE.**

## **Ground Lesson 9**

### **EMERGENCY PROCEDURES**

#### **Objectives**

Upon completion of this lesson, the pilot should be able to determine the types of emergencies with associated component failures and take appropriate action during emergencies or failures.

#### **Resources**

- G1000 Pilot's Guide
- G1000 Cockpit Poster
- G1000 PC-based Simulator

#### **Exercise 9.1: Emergencies and Failure Modes**

1. If one display fails, what happens to the remaining displays?

**The system enters Reversionary Mode (also called Display Backup Mode)—flight instruments and engine displays are presented in a single-screen format (refer to the System Overview in the Pilot's Guide for specific details on airframes with dual PFDs).**

2. How is an AHRS failure indicated on the G1000?

**An AHRS failure is indicated by red-“Xs” over the affected flight instruments and a loss of the horizon line on the PFD.**

3. When the AHRS and/or ADC fail, what remedial action should be taken by the pilot?

**The pilot should refer to standby instruments.**

4. What information is presented to the pilot when a display is operating in Reversionary Mode?

**Engine instruments, attitude, airspeed, altitude, vertical speed, and HSI information are shown on a display operating in Reversionary Mode.**

5. Describe the aircraft on-board power sources that remain in case of alternator failure and also provide an explanation as to their operation, including a basic description of each power bus.

**Refer to the AFM or POH.**

6. During a cross country flight, an AHRS failure occurs (failure indicated by a red “X” over the Attitude Indicator). Note: the aircraft is equipped with a GFC 700 AFCS.
  - Aside from the backup Attitude Indicator, what items can be used to ensure safe flight?
    - **ARTCC**
    - **Magnetic compass**
    - **DTK and TRK data fields at the top of the PFD**
    - **Map overlay**
  - What are the next actions that should be taken concerning the completion of the flight? Note that depending on the circumstances, the action items may require completion in a different order.
    1. **Notify ARTCC both of the failure and of the need to deviate. Do not hesitate to ask for no-gyro turns if the aircraft must be hand-flown.**
    2. **Based on the information provided by ARTCC, set up a direct-to GPS navigation to the nearest VFR airport or to a nearby airport with the next-best conditions.**
    3. **Check the DTK and TRK data fields at the top of the PFD to help determine whether the aircraft is in straight flight or in a bank angle and use the magnetic (“whiskey”) compass to perform cross-checks against the DTK and TRK data. Note that this is the type of situation in which having an active GPS NAV as an additional cross-check tool is important.**
    4. **Use a map display to verify heading changes.**
  - When the AHRS fails, what is the other piece of information that is lost besides attitude?

**An AHRS failure also causes power loss to the Magnetometer, hence magnetic heading indications are no longer displayed on the HSI and a red “X” appears over the current heading indication. Use the DTK and TRK numbers from the GPS for direction to the runway, and perform cross-checks against the aircraft’s magnetic (“whiskey”) compass.**

## **Ground Lesson 10**

### **TERRAIN AWARENESS/TAWS**

#### **Objectives**

Upon completion of this lesson, the pilot should be able to accurately interpret terrain awareness and TAWS data while both incorporating this information into the aeronautical decision making (ADM) process and understanding the limitations of these systems.

#### **Resources**

- G1000 Pilot's Guide

#### **Exercise 10.1: TAWS Operation**

1. In the TAWS feature, what do the colors red and yellow represent?

**Red signifies that terrain elevation is within 100 feet or above the aircraft altitude. Yellow represents terrain that is within 1,000 feet of the aircraft altitude.**

2. What is the difference between Terrain Awareness and TAWS?

**Terrain Awareness uses a worldwide terrain database to display visual information of the surrounding terrain relation to the aircraft GPS altitude. The color of the terrain changes from black, yellow, red as distance of the aircraft reduces from the terrain.**

**The Terrain Awareness and Warning System (TAWS) employs the worldwide terrain database and displays terrain color in a similar fashion to Terrain Awareness. TAWS also provides aural alerts and additional pop-up visual alerts.**

3. List the types of alerts that Garmin TAWS-B offers.

1. **Forward Looking Terrain Avoidance (FLTA)**
2. **Forward Looking Obstacle Avoidance (FLOA)**
3. **Premature Decent Alert (PDA)**
4. **Excessive Decent Alert (EDA)**
5. **Negative Climb Rate (NCR)**
6. **“Five-hundred” Aural Alert**

4. Can all TAWS alerts be inhibited? Describe how to inhibit TAWS alerts.

**Forward Looking Terrain Avoidance (FLTA), Forward Looking Obstacle Avoidance (FLOA), and Premature Decent Alert (PDA) can be inhibited. The Excessive Decent Alert (EDA), Negative Climb Rate (NCR), and “Five-hundred” Aural Alerts are always on.**

**To inhibit the listed TAWS alerts:**

1. **Select the MAP - TAWS Page.**
2. **Press the MENU Key.**
3. **Select “Inhibit TAWS” using the FMS Knob and press the ENT Key.**

5. List and describe the two functions of the FLTA/FLOA.

**Reduced Required Terrain Clearance (RTC) and Required Obstacle Clearance (ROC) provide alerts when the aircraft flight path is above terrain and/or obstacles and is projected to come within minimum clearance values.**

**Imminent Terrain Impact (ITI) and Imminent Obstacle Impact (IOI) provide alerts when the aircraft is below the elevation of terrain in the aircraft's projected path.**

6. During which phase of flight is PDA active?  
**PDA functions only during descent to land.**
7. The NCR is only active during the departure phase of the flight. What condition(s) must exist to activate this alert?
  1. **Height above the terrain must be less than 700 feet.**
  2. **The aircraft is less than 2 nm from the departure airport.**
  3. **The aircraft heading change from the departure heading is less than 110°.**
8. Does the “Five-Hundred” alert have any pop-up text?  
**No**
9. What aircraft altitude source does TAWS use to determine alerts?  
**TAWS alerts are based on aircraft GPS altitude.**
10. Is TAWS in the G1000 System certified to allow deviations from ATC assigned altitudes?  
**Yes**



# Ground Lesson 11

## TRAFFIC OPERATION

### Objectives

Upon completion of this lesson, the pilot should be able to accurately interpret traffic data while both incorporating this information into the aeronautical decision making (ADM) process and understanding the limitations of these systems.

### Resources

- G1000 Pilot's Guide
- Aeronautical Information Manual (AIM)

### Exercise 11.1: Traffic Information Service

1. To be visible on the TIS display, does the intruder aircraft need to be equipped with transponder?

**Yes, the intruder aircraft must at a minimum have an operating transponder (Mode A, C, or S).**

2. What are the requirements for using TIS?

**In order to use TIS, both one's own aircraft and any intruder aircraft must be equipped with the appropriate equipment and fly within the radar coverage of a Mode S radar site capable of providing TIS. Typically, this will be within a 55-nm range of the sites. Aircraft must be in line-of-sight of the Mode S radar.**

3. With TIS, up to how many intruder aircraft can be displayed on the PFD/MFD.

**The G1000 can display up to eight intruder aircraft.**

4. Describe the service volume for the Traffic Information Service.

**The TIS service volume is defined as 7 nm from one's own aircraft, 3,500 feet above, and 3,000 feet below the aircraft.**

5. How often is TIS information uplinked to the G1000's receiver?

**TIS information is broadcast every five seconds.**

6. Describe difference between Traffic Advisories (TA) and Proximity Advisories (PA).

**Traffic Advisory is a level of alert given to an intruder aircraft within an envelope of  $\pm 500$  feet altitude and within 0.5 nm of one's own aircraft. A TA is issued when aircraft are estimated to be within 34 seconds of potential collision, regardless of distance or altitude. A TA is displayed on the map as a yellow circle. When a TA is issued, the yellow Traffic Annunciation is displayed on the PFD and the audio alert, "Traffic", is generated.**

**Proximity Advisory is a level of alert given when the intruder aircraft approaches within  $\pm 1200$  feet and 4 nm of one's own aircraft.**

7. When a Traffic Advisory is issued, is one allowed to deviate from the ATC assigned instructions?

**No, the traffic display is intended to assist the pilot in visual acquisition of these aircraft in VMC. TIS is not intended to be used as a collision avoidance system and does not relieve the pilot responsibility to “see and avoid” other aircraft. TIS shall not be for avoidance maneuvers during IMC or at other times when there is no visual contact with the intruder aircraft. It is not a tool to be used to deviate from the ATC instructions.**

## **Ground Lesson 12**

### **WEATHER OPERATION**

#### **Objectives**

Upon completion of this lesson, the pilot should be able to understand and interpret weather information displayed in the cockpit. The pilot will be able to use this supporting information to enhance the decision-making process before and during the flight.

#### **Resources**

- G1000 Pilot's Guide
- G1000 PC-based Simulator
- www.xmradio.com
- www.wxworx.com

#### **Exercise 12.1: Weather and Digital Audio Entertainment**

1. Briefly describe how weather and radio information are provided to the aircraft.

**WxWorx's current weather information is delivered through continuous satellite broadcast of data from XM's Satellite Network. Weather data is retrieved and updated constantly from WxWorx sources located at thousands of points across the United States. XM's satellite delivery solution is driven by two commercial satellites. Both satellites simultaneously transmit data and are always in view of the United States. With an XM service subscription, the GDL 69/69A Datalink Receiver receives XM Weather data and displays it, as appropriate, on the PFD and MFD.**

2. What types of datalink weather are displayed on MFD/PFD and how can these weather products be selected for display?

##### **Multi Function Display**

1. **TFRs are always displayed on all maps.**
2. **Display of Cell Movement for all MFD pages is controlled through the Weather Datalink Page Setup Menu.**
3. **Navigation Map Page: NEXRAD and XM Lightning data can be displayed by pressing the MAP Softkey, followed by the appropriately labeled softkey.**
4. **Weather Datalink Page: All available weather products can be displayed via softkeys.**
5. **Weather Information Page: On the first WPT page, press the WX Softkey to display METAR and TAF text information.**
6. **AUX - Trip Planning Page Map: NEXRAD and XM Lightning data are displayed by pressing the MAP Softkey, then appropriately labeled softkey.**
7. **Nearest Pages: NEXRAD and XM Lightning data can be displayed by pressing the MAP Softkey, followed by the appropriately labeled softkey.**
8. **Flight Plan pages: NEXRAD and XM Lightning data can be displayed by pressing the MAP Softkey, followed by the appropriately labeled softkey.**

##### **Primary Flight Display**

**To display NEXRAD and XM Lightning on the Inset Map, press the INSET Softkey, then the appropriately labeled softkey. TFRs are always displayed.**

- List all XM Weather Products and their corresponding update rates.

<b>NEXRAD</b>	<b>5 min</b>	<b>Cloud Tops</b>	<b>15 min</b>
<b>Cell Movement</b>	<b>12 min</b>	<b>County Warnings</b>	<b>5 min</b>
<b>METARs</b>	<b>12 min</b>	<b>AIRMETs</b>	<b>12 min</b>
<b>TAFs</b>	<b>12 min</b>	<b>SIGMETs</b>	<b>12 min</b>
<b>Lightning</b>	<b>5 min</b>	<b>Echo Tops</b>	<b>7.5 min</b>
<b>TFRs</b>	<b>12 min</b>	<b>Winds Aloft</b>	<b>12 min</b>
<b>Surface Analysis</b>	<b>12 min</b>		

- Reported/forecast products use a date/time stamp. On what are the date and time based?

**Date and time are based on Zulu time as reported by appropriate weather stations, not on when the data is received by the datalink receiver.**

- When and how is weather data information received?

**Before the GDL 69/69A can be used, an XM Satellite Radio subscription must be activated. XM Satellite Radio offers several subscriptions at different service levels. Refer to the XM Satellite Radio website for information regarding subscription options.**

- What type of lightning strike information does XM Weather provide?

**Only cloud-to-ground lightning is provided by XM. To receive cloud-to-cloud lightning strike information, the aircraft must be equipped with additional lightning detection equipment, such as Stormscope.**

- What is NEXRAD?

**NEXRAD (NEXt generation RADar) is a Doppler radar system that has greatly improved the detection of meteorological events such as thunderstorms, tornadoes, and hurricanes.**

- What are the coverage areas of the XM Satellite signal? At what altitude must the aircraft be to receive the XM signal?

**The XM signal provides full coverage over the continental United States. The information can be received on the ground and while flying at any altitude throughout North America.**

- A pilot is planning a cross-county flight. Does weather data provided by WxWorx satisfy FAR 91.103 preflight action?

**No, weather data received in the cockpit is not approved to satisfy FAR 91.103. One must receive approved weather data from the National Weather Service/FSS. Use datalink weather as a supporting reference only. XM Weather is not to be used as a main source for making decisions before or during flight.**

**10.** A pilot is on a VFR flight from KXYZ to KABC. Currently, the altitude is 9,500 feet, 50 miles from KABC. Weather is predicted to be MVFR at the destination airport. Using the MFD, describe the steps that must be taken to receive a METAR and/or TAF at the destination airport.

- 1. Select the Weather Data Link Page.**
- 2. Press the METAR Softkey to display colored flags at the airports.**
- 3. Press the LEGEND Softkey to see descriptions of graphic symbols and color codes.**
- 4. Select the Airport Information Page (first page of the WPT Page Group).**
- 5. Enter the destination airport.**
- 6. Press the WX Softkey to display the Weather Information Page with METAR and TAF text.**

### *Exercise 12.2: Lightning Detection*

1. When flying an aircraft with a WX-500 Stormscope installed, where can the lightning data be displayed?

**Stormscope information can be shown on the PFD Inset Map and on the MFD Navigation Map and Stormscope pages.**

2. How is WX-500 data presented by the G1000 System?

**Stormscope lightning information is shown as lightning bolts and “+” (plus) symbols of various sizes.**

3. When a lightning bolt is changed to a “+” (plus) symbol, what does this change denote?

**This means that the data is over one minute old (note that a smaller “+” symbol appears when the data is over two minutes old).**

### Exercise 12.3: Weather Radar

1. Does the GWX 68 Airborne Weather Radar allow you to operate while on the ground?

**Yes, however, a caution will appear alerting the pilot to follow all safety precautions. WARNING: Begin transmitting only when it is safe to do so. If it is desired to transmit while the aircraft is on the ground, no personnel or objects should be within 11 feet of the antenna.**

2. Describe WATCH™.

**Weather Attenuated Color Highlight (WATCH™) is a tool to determine areas of possible inaccuracies in displayed intensity due to weakening of the radar energy. This weakening is known as “attenuation”. The radar energy weakens as it passes through areas of intense precipitation. This has an effect on the return intensity. Accuracy of the displayed intensity of returns located in gray shaded areas are suspect.**

3. Is it safe to continue a flight into a gray shaded area?

**It is never safe to continue flight into shaded area; weather information for shaded areas is indeterminate.**

4. After adjusting the gain manually, why is it important to return the gain setting to the calibrated value?

**Changing the gain will cause precipitation intensity to be displayed as a color not representative of the true intensity. One must return the gain to the calibrated value for the actual intensity of precipitation.**

5. How does one activate or deactivate the bearing line?

1. **Press the MENU Key.**
2. **Turn the large FMS Knob to select “Show Bearing Line” or “Hide Bearing Line”.**
3. **Press the ENT Key.**

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## Ground Lesson 13

### GFC 700 AUTOMATIC FLIGHT CONTROL SYSTEM (AFCS)

#### Objectives

Upon completion of this lesson, the pilot should be able to understand the operation of the Garmin Automatic Flight Control System (AFCS) and use the autopilot throughout various phases of flight.

#### Resources

- G1000 Pilot's Guide

#### Exercise 13.1: Flight Director and Autopilot Operation

1. List all parts (LRUs) associated with the GFC 700 in the aircraft being flown.
  - **GDU 1XXX Primary Flight Display (PFD), Multi Function Display (MFD)**
  - **GIA 63 Integrated Avionics Unit**
  - **GSA 8X Servos**
  - **GSM 85 Servo Mounts**
  - **GTA 82 Trim Adapter (selected installations)**
  - **GMC 71X AFCS Control Unit (selected installations)**
2. Where are the AFCS controls located in the cockpit?

**Generally, the MFD has dedicated AFCS keys located on the lower left side of the bezel. Depending on the aircraft type, autopilot controls may be on the remotely mounted GMC AFCS Control Unit.**
3. Where are flight director mode annunciations displayed? Describe the annunciation colors.

**The AFCS Status Box is displayed towards the top of the PFD, just below the Navigation Status Box. Active modes are displayed in green; armed modes are displayed in white. Roll modes are on the left side and pitch modes are on the right, and autopilot/yaw damper engagement status is shown in the center.**
4. List any flight director pitch and roll limitations.

**Pitch and roll limitations vary from aircraft to aircraft. Consult the approved Aircraft Flight Manual (AFM) or Aircraft Flight Manual Supplement (AFMS) and Pilot's Guide for specific aircraft limitations.**
5. Describe Flight Level Change Mode (FLC).

**When the FLC Key is pressed, FLC Mode is activated and the current airspeed is maintained as the Airspeed Reference while the aircraft is climbing/descending toward the Selected Altitude. It is important to adjust the engine power to allow the autopilot to maintain the aircraft at the pitch attitude that corresponds to the Airspeed Reference and desired flight profile.**
6. Describe the function of the Control Wheel Steering (CWS) Button.

**The CWS Button synchronizes the flight director's command bars to the current aircraft attitude (refer to the Pilot's Guide AFCS Section for CWS behavior in specific modes).**

7. When the go-around control is pressed, what flight director and autopilot functions can be expected?

**Pressing the go-around control engages the flight director in the wings level, nose up attitude and the autopilot disengages automatically.**

8. List several ways the autopilot can be disengaged.

**When there is a system failure, automatic disengagement occurs. Manual disengagement is accomplished by pressing the AP DISC Button, the MET ARM Switch, the AP Key on the MFD, or the go-around control.**

9. An aircraft has just departed from an airport and is performing a runway heading climb-out. Following the departure procedure, the plane climbs to 4000 feet, then turns to a heading of 270°. The final cruising altitude is 9000 feet. How would the pilot configure the autopilot to follow all of the departure procedure up to the final cruising altitude?

1. **Upon takeoff, set the Selected Altitude to 9,000 feet using the ALT or ALT SEL Knob.**
2. **After attaining the desired vertical speed, pitch, or airspeed, press the VS, FD, or FLC Key. When the appropriate mode is activated, press the AP Key to engage the autopilot. The pitch mode selected will be coupled with Roll Hold Mode.**
3. **Set the Selected Heading to 270° using the HDG Knob on the PFD.**
4. **Upon reaching 4,000 feet, press the HDG Key. As the aircraft reaches 9,000 feet, the flight director transitions from the selected pitch mode to Altitude Hold Mode. From this point, the autopilot flies at 9,000 feet and holds a heading of 270°.**

10. Using the scenario above, configure the autopilot to intercept an airway. Currently, the autopilot is set to Heading Select and Altitude Hold modes.

1. **Tune the VOR frequency.**
2. **Set the HSI mode to the correct NAV receiver by pressing the CDI Softkey.**
3. **Select the desired course using the CRS Knob.**
4. **Finally, press the NAV Key to arm VOR Navigation Mode. The autopilot will intercept the course and activate Navigation Mode.**

## ***Appendix***

### ***CONSIDERATIONS ON USING THE G1000 INTEGRATED FLIGHT DECK TO ENHANCE THE AERONAUTICAL DECISION MAKING (ADM) PROCESS AND SINGLE-PILOT RESOURCE MANAGEMENT (SRM)***

The Garmin G1000 Integrated Flight Deck has brought a number of improvements in cockpit technology to General Aviation (GA) aircraft. These improvements range from longer life and greater reliability of the primary instruments to a simplified pilot interface. With the addition of new technologies, the G1000 System is capable of providing the pilot with a wider variety of information about the flight environment, thereby leading to greater situational awareness and reduced pilot workload. The G1000 System allows the pilot to focus on aeronautical decision making (ADM) and single-pilot resource management (SRM).

The majority of GA flight operations are single-pilot operations. The single-pilot, IFR, cross-country flight is often regarded as one of the most challenging flight operations. The need to communicate and navigate while relying solely on aircraft instruments makes the single-pilot cockpit a busy and stressful environment. Since the inability to manage these demands effectively can prove life threatening, understanding and using all the tools available in the cockpit is key to overcoming the challenges presented by single-pilot IFR flights.

#### ***AUTOMATIC FLIGHT CONTROL***

The autopilot is a fundamental tool that is often overlooked in the current aviation training environment. As an SRM tool, no other piece of avionics is as valuable in reducing pilot workload as the autopilot. Pilots should routinely practice using the autopilot and gain a full understanding of their particular system. Using the autopilot allows the pilot to focus on other flight management tasks such as route deviation planning and general aircraft system monitoring without reaching a point of sensory overload.

In the case of system failures or emergencies, the autopilot relieves the pilot of the workload of manually flying the aircraft and thus allows the problem to be addressed. It is important to note that many GA aircraft are equipped with a rate-based autopilot that receives roll inputs from an electric turn-coordinator. In aircraft equipped with a vacuum-driven attitude indicator, failure of the vacuum pump should prompt the pilot to immediately change to a partial panel scan and to engage the autopilot in at least a roll and pitch mode. In aircraft equipped with a GPS coupled to the autopilot, the pilot should activate GPS direct-to navigation to the nearest suitable airport, then place the autopilot in navigation mode to fly straight to the airport. In either case, the autopilot reduces pilot workload by helping to ensure that the wings remain level and that standard-rate turns are used.

The G1000 System will interface with third-party, rate-based autopilots as well as with the Garmin GFC 700 Automatic Flight Control System (AFCS). Third-party manufactured autopilots are linked to a remote-mounted rate-based gyro independent of the G1000 System; therefore, the above-mentioned methodology still applies if attitude information is lost. Indeed, using the autopilot in roll-control or navigation mode at the point of attitude failure allows the pilot to maintain control of the aircraft while taking appropriate emergency actions. Again, the use of the autopilot reduces pilot workload and should allow the pilot to better manage the

emergency. Nonetheless, it is imperative that the pilot double-check all autopilot inputs in order to avoid mode confusion and monitor them to ensure that the intended operation is taking place.

If equipped with a GFC 700 AFCS, it is also important for pilots to understand the capabilities and limitations of the system. For example, losing number two Integrated Avionics Unit (GIA #2) causes the autopilot to be disabled; however, the flight director function will still be available. This allows pilots to program the flight direct as an additional tool for assistance during flight.

## ***COMMUNICATION AND NAVIGATION***

While the autopilot is the single most valuable tool for SRM, it is also important that the pilot develop a consistent approach to using the communication (COM) and navigation (NAV) tools present in the G1000 System. The two COM and NAV receivers combined with the ability to tune COM and NAV frequencies from the Jeppesen database give the pilot a streamlined process for frequency selection and management.

A typical methodology for COM/NAV frequency management is to designate COM1 and NAV1 as the primary airborne and enroute frequencies. COM2 can then be reserved for both weather (ATIS, ASOS, AWOS) and ground frequencies. Meanwhile, NAV2 is set as the backup to NAV1. If established as part of a standard operating procedure, these selections help to minimize confusion over which COM and/or NAV is selected and active. When a consistent approach to frequency management is not used, the pilot is more likely to run into mode confusion concerning the use of the Audio Panel (GMA 1347); this can in turn lead to missed radio calls and/or transmissions on the incorrect frequency.

## ***FLIGHT PLANNING***

While managing frequencies for ground-based NAVAIDs is important, proper use of the GPS flight planning function can also prove beneficial. Rather than performing continuous direct-to navigation with the GPS, taking the time on the ground to enter a full flight plan allows the G1000 to enhance the navigation experience. First, the pilot will be able to visually inspect the route of flight on the map, once at altitude, to verify both terrain clearance (using the Terrain Awareness overlay) and active airspaces (if active, MOAs and Restricted areas call for a re-routing from ARTCC). Secondly, using the flight planning function allows for seamless autopilot turn anticipation. Finally, taking a moment to program the flight plan on the ground makes it easier to react quickly to in-flight routing changes. Pilots should program the flight plan prior to takeoff on even short cross-country flights.

Likewise, the maps on both the Multi Function Display (MFD) and Primary Flight Display (PFD) help the pilot to manage the navigation functions of the system. By using the maps to verify GPS navigation inputs, the pilot is able to visually cross-check data entry by looking at the course lines drawn on the map. This visual representation of the active navigation is the quickest way to determine whether all of the correct waypoints were entered for the intended route of flight.

## WEATHER AWARENESS

In this discussion so far, the focus has been on SRM. Now, attention will be turned to leveraging the various data inputs from the on-board weather sensors, datalinks, traffic awareness, and terrain awareness functions. Proper understanding of both the operation of these various tools and their integration with the pilot's aeronautical decision making (ADM) process can bring significant safety gains to the GA fleet.

Weather datalink and airborne lightning detection equipment have brought unprecedented weather avoidance capabilities to the GA aircraft. Datalink weather receivers can bring a wide variety of information into the cockpit besides the well-known NEXRAD radar images. While these weather tools provide valuable information, they do have limitations that must be considered to be used appropriately by the pilot in the ADM process. Neither datalink weather nor airborne lightning detection equipment is to be used for storm penetration. Instead, these planning tools should be used to help the pilot make a timely and well-informed decision on how to proceed with the flight.

While avoiding strong thunderstorms and other areas of heavy precipitation is desirable, the ability to also review textual weather information for the destination while enroute allows the pilot to maintain better situational awareness for airport selection in case of an emergency. This capability also allows the pilot to evaluate all approach options based on ceilings at the destination airport or whether to divert to an alternate airport much earlier in the flight. This, coupled with the ability to review weather information well outside of the transmission range of ATIS/AWOS/ASOS systems, enables the pilot to better prepare for arrival and reduces last-minute workload.

Thunderstorms are typically used as a main selling point for datalink weather receivers due to their visual NEXRAD presentation, whereas ice—the other main weather concern for flight—is often not emphasized enough. However, it should be stressed that the potential for icing is also provided textually and, in some cases, graphically via datalink weather. This becomes a very powerful tool in the winter months. The ability to display information about icing potential in either format (textual or graphical) is a significant improvement for the overall safety of flight.<sup>1</sup>

Overlaying both the NEXRAD and lightning images on either the G1000 MFD or PFD map serves to corroborate information on the location of the strongest storms. When lightning detection equipment is installed in the aircraft, the unique strike-aging capability of the G1000 provides additional visual cues as to the current state/stage of the storm. Continuously growing strike rate counts, as well as, an increase in the number of lightning bolts (bold or normal) often denotes a developing severe thunderstorm. On the other hand, decreasing strike rates combined with a growing number of “plus” (+) symbols indicates a decrease in the strength of the storm and its possible dissipation.<sup>2</sup>

While this type of information is very powerful and convincing, it is important to use it to plan the flight path and not to attempt penetration of an area of severe weather. The data should be used to plan a deviation well clear of areas indicating storm activity to ensure the remainder of the flight can be safely executed. One should always remember that discretion is often the better part of valor and that no technology can depict actual meteorological conditions with 100% accuracy.

## ***TRAFFIC AWARENESS***

Traffic Collision and Avoidance Systems (TCAS) represent another technological advance that has been made in the area of traffic avoidance. Originally developed for large commercial aircraft, TCAS technology is now starting to trickle down features and capabilities to the GA fleet. For example, the GTX 33 Mode-S Transponder can be used as an optional component in G1000-equipped aircraft and brings Traffic Information Service (TIS) data directly to the cockpit.

TIS data is provided and transmitted by the FAA over Mode-S terminal radar sites and is derived from the actual transponder returns of aircraft as seen on the air traffic controller's scope. A key difference between TIS and a TCAS system is that TIS should only be used as an additional tool to see and avoid traffic. Therefore, the pilot should not become reliant on TIS and try to avoid traffic solely by reference to the traffic display in the cockpit. Mode-S radar coverage and TIS service are only available in areas equipped with Mode-S terminal radar. Since TIS service may not always be available in the enroute environment, the pilot should not entirely depend on this tool to acquire traffic visually and should always scan for traffic. Deviations should not be performed until the pilot has visually acquired the threat traffic.

## ***TERRAIN AWARENESS***

The last tool to be discussed given its benefit to the ADM process is the new generation of GA terrain awareness systems. Terrain awareness systems are split into two generic classes, that is, certified systems and non-certified systems. Certified devices are classified as Terrain Awareness and Warning Systems, classes A and B (TAWS-A and TAWS-B). These systems provide a number of terrain avoidance features that are not available in the non-certified terrain awareness systems. The G1000 includes a non-certified terrain awareness feature that can be displayed on both the MFD and the PFD Inset Map. TAWS-B is an option available on certain G1000-equipped aircraft.

A map terrain overlay is available to depict dangerous terrain elevations relative to aircraft altitude. Red terrain indicates that terrain elevation is within 100 feet of or higher than the aircraft altitude. Yellow terrain indicates that terrain is within 1,000 feet of the aircraft altitude. These two colors allow the pilot to look at the planned route and then decide on an optimal altitude for completion of the flight. This color scheme also provides additional situational awareness during the critical approach phases of the flight in both VFR and IFR conditions. With the interest in preventing Controlled Flight into Terrain (CFIT) accidents, even simple situation awareness tools such as the built-in G1000 terrain awareness feature can provide yet another helpful input to the ADM process.

## ***FINAL THOUGHTS***

In conclusion, as GA aircraft and pilots transition to 21st-century technology, the G1000 Integrated Flight Deck provides a number of safety-enhancing benefits. Although automation in the cockpit should be embraced, both its positive and negative impacts on the safety of flight should be recognized and understood. Proper autopilot use is key to enhancing safety by reducing pilot workload; this is particularly true in certain emergency situations. In addition, the ability to develop a methodical approach to other cockpit tasks, even as simple as COM/NAV frequency selection and GPS management, can help the pilot to maintain better situational awareness while minimizing the overall cockpit workload.

The ability to view weather, traffic, and terrain information to improve the ADM process represents another significant benefit brought to the cockpit by the G1000 Integrated Flight Deck. From satellite downlink weather with both NEXRAD radar images and textual weather to real-time lightning detection data, the pilot now has access to a wealth of information directly in the cockpit. Although the combination of weather, TIS, and terrain awareness information can increase the safety of flight, it is also critical that the pilot use this information properly and consistently. Too often, human beings rely on technology alone to provide the solution to hazardous situations. However, in the dynamic, three-dimensional flight environment, it is the pilot who represents the most significant component of the avionics system. It is from the cockpit that the most important calculations are made using the information and inputs provided by the avionics to ensure a safe flight. These calculations are enhanced both by regular recurrent training and by the full understanding of the strengths and limitations of the various data inputs. Good ADM and SRM practices are of critical importance to the long-term improvement of the GA safety record.

**1** G1000 GDL 69/69A use XM Satellite Radio with WxWorx data. Refer to [www.wxworx.com](http://www.wxworx.com) for more information on available weather data products.

**2** Refer to appropriate manufacturer documentation concerning the complete operation of lightning detection equipment.

**3** For more information on the TIS system, refer to [www.tc.faa.gov/act310/projects/modes/tis.htm](http://www.tc.faa.gov/act310/projects/modes/tis.htm).



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