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RISK MANAGEMENT GUIDE FOR SINGLE-PILOT LIGHT BUSINESS AIRCRAFT

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Introduction

Light business aircraft (LBA) include turbojet, turboprop and piston powered aircraft of 12,500 pounds or less. These aircraft, most of which are certified for a single pilot, provide unmatched business transportation capability for their owners. However, single-pilot operation of these aircraft presents many challenges, not the least of which is managing risks.

Risk management is a crucial pilot skill that is an element of a skill set known as single-pilot resource management (SRM). Other essential SRM skills include automation management, task and workload management, and maintaining situational awareness.

Risk management competency is crucial because poor risk management may be a root cause of most fatal LBA accidents. Accident root cause analysis is not always available from conventional data for many such accidents. For example, loss of control in flight (LOC-I) is the top-cited cause of general aviation and LBA fatal accidents, yet the loss-of control is typically the last event in the accident chain. It answers the “how” of an LOC-I accident, but does not answer the “why.” The accident chain for many LOC-I accidents may begin with poor risk management.

The importance of risk management has been recognized by the FAA and leading aviation organizations, including the NBAA. A coalition of FAA and aviation organizations has begun developing airman certification standards (ACS) to replace the practical test standards (PTS) for all airman certificates and ratings. Unlike the PTS, the ACS requires pilots to demonstrate risk management proficiency in all areas of operations and tasks. The first ACS documents, for the private pilot certificate and instrument rating, were issued in June 2016.

It is not possible to cover all aspects of risk management in this short resource. Rather, this document is meant to outline the critical elements of risk management and provide LBA pilots with a tool to use in guiding their risk management procedures before and during flight. To properly learn and apply the principles outlined in this document, LBA pilots must take formal risk management or SRM training as the first step in mastering risk management. There are convenient online and other courses available. Some of these can be found on the FAA Safety Team (FAAST) web site, www.faasafety.gov. A list of other courses and references is contained in Appendix 5 of this resource.

This resource will begin with a short discussion of risk management fundamentals, followed by discussions of risk identification, assessment and mitigation strategies, as well as using risk management in the “real world.” It will conclude with a case study using the flight risk assessment tool (FRAT) provided in Appendix 1.

Risk Management Fundamentals

Most LBA pilots are familiar with managing risk in their business or profession. The principles of managing risk while flying their LBA are similar. The procedures for flight risk management, however, may not have been a part of their initial or recurrent training. The following key elements are essential to effective risk management while operating LBAs.

There is a sequential three phase process required for effective risk management both before and during flight.

- **Risk Identification** – First, identify any hazards that will affect your flight. A hazard is an object or event that could create a risk to the flight. Once the pilot determines that a hazard poses a potential risk to his flight, he must assess it.
- **Risk Assessment** – Each identified risk must be assessed in terms of its likelihood (probability) and its severity (consequences). A joint assessment of overall risk is then possible, typically by using a risk assessment matrix such as the one included in the FRAT in Appendix 1.
- **Risk Mitigation** – Risk management doctrine dictates that “high” (i.e., “red”) risks must be mitigated by taking action to lower likelihood and/or severity to lower levels. For “serious” (i.e., “yellow”) risks, such actions should be taken. “Medium” (i.e., “green”) and “low” risks do not require mitigation.

The following three sections will provide more detail on these phases of risk management. However, the following principles should also apply.

- **Take no unnecessary risk** – Even if a risk is assessed as “green,” you may still wish to mitigate it. For example, you may want to reject many intersection takeoffs.
- **Accept risks consciously** – Risk is always present at some level. For example, you may legally choose to accept a take-off in your small twin-turboprop if there is adequate runway for all engines operating, even though accelerate-stop and accelerate-go distances exceed the available length. Are you prepared to accept this risk? Are you prepared to accept the risk on behalf of your passengers?

Identifying Risk

Hazards and their associated risks can either be obvious or harder to detect. You should methodically identify and classify risks to a proposed or ongoing flight by maintaining constant situational awareness. To assist this process, it is helpful to apply the simple acronym **PAVE** to your risk management process. The acronym stands for **P**ilot, **A**ircraft, **E**nvironment, **E**xternal pressures. Use the following guidelines and questions to identify risk using the PAVE acronym.

- **Pilot** – There are two sub-categories to consider here:
 - **Qualification** – Do I have the required certificates and ratings? Am I “current” in accordance with the regulations? Most important, am I sufficiently “proficient” to handle any challenges that the flight presents?
 - **Aero-medical** – Am I personally fit for this flight? Use the acronym **IMSAFE** to answer that. It stands for **I**llness, **M**edication, **S**tress, **A**lcohol, **F**atigue, and **E**motion.
- **Aircraft** – The potential risks fall into three basic categories:
 - **Inspections** – Has the aircraft completed all required inspections?
 - **Equipage** – Do I have all required equipment to complete flight under forecast conditions? Is equipment operative?
 - **Performance** – Will I have all the required takeoff, climb, en route and landing performance under expected conditions? Will I have sufficient fuel to complete the trip with adequate reserves for contingencies?
- **Environment** – The following four sub-categories should be considered:
 - **Weather** – What convective, turbulence, icing, low ceiling, wind and other meteorological hazards/risks will I face?
 - **Terrain** – What terrain and obstruction hazards will I have to cope with on departure, en route and for arrival?
 - **Airports and Airspace** – Do the airports and approach aids present undue hazards and risks? What about special use airspace?
 - **Night** – Risks are often amplified at night. What risks will I have to face on a night departure or arrival?
- **External pressures** – You must consider business and personal external pressures. For example, is your boss insisting on pressing ahead in order to get to a meeting? Are you or a passenger trying to get back in time for an anniversary?

Assessing Risk

Once you have identified all hazards and risks to a planned or ongoing flight, you must assess these risks in terms of their likelihood and severity. A common method to accomplish this is by using the following risk assessment matrix.

Risk Assessment Matrix				
Likelihood	Severity			
	Catastrophic	Critical	Marginal	Negligible
Probable	High	High	Serious	Medium
Occasional	High	Serious	Medium	Low
Remote	Serious	Medium	Medium	Low
Improbable	Medium	Medium	Medium	Low

The following definitions will help you classify risk likelihood and severity.

Risk Likelihood Descriptors	Risk Severity Descriptors
Probable - an event will occur several times. Occasional - an event will probably occur sometime. Remote - an event is unlikely to occur, but is possible. Improbable - an event is highly unlikely to occur.	Catastrophic – results in fatalities and/or total loss. Critical – results in severe injury and/or major damage. Marginal – results in minor injury and/or minor damage. Negligible – results in less than minor injury and/or minor damage.

Assessing risk may be the most difficult part of risk management. Applying the subjective terms described above to specific risks takes some practice. Initially, you should be conservative in assessing risks.

Once you have assessed risk likelihood and severity for all identified risks, you can readily classify the overall risk level for that hazard. For example, if you determine that flying into a known area of extreme turbulence could result in severe injury and/or major damage and will probably occur sometime during your flight through that area, then the overall risk of that hazard is “serious” or “yellow” in the risk assessment matrix.

Risk Management Fundamentals

The final step in risk management is mitigation. This is the payoff for accomplishing the entire risk management process. Pilots are goal-oriented and “wired” towards completing the “mission.” By effectively mitigating known risks to acceptable levels, pilots can complete their planned flights safely or ensure that alternate options are selected for those rare occasions when the planned or ongoing flight cannot be completed.

When is risk mitigation required? You will begin by reviewing the risk assessments you have previously made for all identified risks. Your objective is to reduce risk likelihood and/or severity to lower levels for all “unacceptable” risks. You may then use the following guidance to determine if mitigation is required.

RED (HIGH): Risk likelihood and/or severity **MUST** be reduced to lower levels before departure. If in flight, risk likelihood and/or severity **MUST** be reduced by taking appropriate divert or other actions.

YELLOW (SERIOUS): Risk likelihood and/or severity **SHOULD** be reduced to lower levels before departure. If in flight, risk likelihood and/or severity **SHOULD** be reduced by taking appropriate divert or other actions.

GREEN (MEDIUM): Flight can depart or continue, but risk severity and/or likelihood **SHOULD** be reduced whenever possible.

WHITE (LOW): Risks can usually be addressed by following checklists and complying with normal procedures.

How do you mitigate risk? That is, how do you reduce risk likelihood and/or severity for the individual risks you have identified?

There are almost an infinite number of actions you can take, depending on the nature of the hazard or risk. For example, you can change departure times to avoid forecast weather below minimums at your destination, change your route to avoid convective activity, add takeoff fuel or a fuel stop if planned reserves will be minimal, or take on less fuel to improve takeoff performance for your high density altitude departure.

Although risk mitigation is the “payoff” for the entire process, it must also be conducted with the possibility that a flight cannot be made or continued for a variety of reasons. In order to fully understand the risk mitigation element, we will introduce one more acronym: TEAM. Actually, we will want to rearrange the letters a little because the sequence of the steps matters. So think **TEMA**, which stands for **T**ransfer, **E**liminate, **M**itigate, and **A**cept and observe the following description of these elements.

- **Transfer** – Risk management and especially risk mitigation often begins days before a planned flight. This is especially true if you fly a less capable LBA. For example, you may fly a high performance single-engine piston LBA without ice protection and live in the Pacific Northwest. If you are planning a trip in January, you may want to begin the risk management process as much as a week ahead of the planned departure dates, with one eye on the rolling long-range weather forecast. If you absolutely have to be somewhere for a scheduled speech or 50-year anniversary celebration for your parents, this will give you time to transfer the risk to the airlines if the risks of flying your LBA cannot be mitigated.
- **Eliminate** – Continuing the example of the need for advance planning, if your planned flight is designed to get you somewhere for a low-priority meeting or other optional event, sometimes it’s best to either change the date of the event to accommodate weather or other risk issues, or cancel it altogether.
- **Mitigate** – Once you’ve determined that your planned flight is feasible, you may begin the actual risk mitigation process. To continue the previous example, you still might decide to depart a day early from the Pacific Northwest to avoid an incoming low pressure area that will bring low IFR and certain icing conditions. Remember that compliance with the regulations does not guarantee a safe flight or the elimination of risk. In the example above, if there are widespread low IFR conditions you may want to look carefully at the risk of flying a single-engine piston aircraft over mountainous terrain, even in the absence of icing conditions.
- **Accept** – After all mitigating steps have been completed, you must be prepared to accept the remaining risk not only for yourself but for your passengers also. This intuitive but affirmative action is all too often glossed over by pilots who fail to recognize the risk that remains.

Putting It All Together

The risk management process described in the previous pages is generally intuitive, but it requires conscious action and practice by the pilot in order to be effective. To ensure you reach the desired level of proficiency for managing risks in your LBA, take the following steps:

- Complete risk management training – It should be emphasized again that the content of this brochure does not provide the full level of risk management knowledge required to fully and effectively manage risks that you face as an LBA pilot. To acquire this knowledge as a cornerstone for gaining risk management proficiency, take an online or live course that includes all the elements of this brochure, including a case study. Ideally, the training should include all SRM skills, in addition to risk management.
- Complete one or more case studies – After studying this brochure, try your hand at completing the flight risk assessment tool (FRAT) in Appendix 1 by using the data for the sample case study in Appendix 2. After you have completed the FRAT, using the instructions in the document, review the case study “school” solution in Appendix 3 and the completed FRAT for the case study “school” solution in Appendix 4. Remember that the “school” solution is just that. You may come up with better risk mitigations for this hypothetical flight.
- Use the sample FRAT – You should use the FRAT for at least your next five flights in order to gain proficiency. It is always appropriate to use a FRAT, even for non-complex flights. Remember that many pilots have ignored or failed to mitigate serious and high risk hazards and a tragic fatal accident is all too often the result. A line of solid embedded thunderstorms is never safe to penetrate and risk management will also help you manage less obvious hazards.
- Plan far ahead – Remember to begin the risk management process early enough, sometimes days ahead of the flight. The less capable your LBA, the more often you may need to transfer your transportation requirement to the airlines.
- “Thinking” risk management – As you gain proficiency in risk management, the process will start to become intuitive and a part of your normal cockpit “flow.” You may not need to complete the FRAT for many relatively simple flights.

Appendix 1: Flight Risk Assessment Tool Worksheet (Two-Sided)

Three step process: IDENTIFY, ASSESS, MITIGATE.
Conduct before departure and in flight.

STEP 1: IDENTIFY THE RISKS *(Complete second column below)*

RISK CATEGORY	HAZARD AND RISK	Likelihood (probability) (see reverse)	Severity (consequences) (see reverse)	Overall Risk Level (color)	MITIGATION/NEW RISK RED – MUST mitigate YELLOW – SHOULD mitigate GREEN – ACCEPT no unnecessary risk
PILOT					
Qualification/ currency/proficiency					
Aeromedical/ human factors					
AIRCRAFT					
Fuel/range/payload					
Equipage (incl. inoperative equipment)					
Performance					
ENVIRONMENT					
Weather					
Airspace/ATC/ Airports					
Terrain/Day vs. night					
EXTERNAL PRESSURES					
Work-related					
Personal					

Other Data:

STEP 2: ASSESS THE RISKS

(Complete third, fourth and fifth columns on front worksheet using the descriptors in the matrix below)

Risk Assessment Matrix				
Likelihood	Severity			
	Catastrophic	Critical	Marginal	Negligible
Probable	High	High	Serious	Medium
Occasional	High	Serious	Medium	Low
Remote	Serious	Medium	Medium	Low
Improbable	Medium	Medium	Medium	Low

Risk Likelihood Descriptors

Probable: an event will occur several times.

Occasional: an event will probably occur sometime.

Remote: an event is unlikely to occur, but is possible.

Improbable: an event is highly unlikely to occur.

Risk Severity Descriptors

Catastrophic: results in fatalities and/or total loss.

Critical: results in severe injury and/or major damage.

Marginal: results in minor injury and/or minor damage.

Negligible: results in less than minor injury and/or minor damage.

STEP 3: MITIGATE THE RISKS (Complete sixth column on worksheet. Specify new overall risk level after mitigation.)

1. Risk mitigation strategy: Take actions to reduce likelihood and/or severity to lower levels for each identified risk in accordance with step two. Use this worksheet until risk management process becomes intuitive, or conditions remain complex.
2. Mitigation guidelines for assessed risk:

RED (HIGH): Risk likelihood and/or severity MUST be reduced to lower levels before departure. If in flight, risk likelihood and/or severity MUST be reduced by taking appropriate divert or other actions.

YELLOW (SERIOUS): Risk likelihood and/or severity SHOULD be reduced to lower levels before departure. If in flight, risk likelihood and/or severity SHOULD be reduced by taking appropriate divert or other actions.

GREEN (MEDIUM): Flight can depart or continue, but risk severity and/or likelihood SHOULD be reduced whenever possible.

WHITE (LOW): Risks can usually be addressed by following checklists and complying with normal procedures.

Appendix 2: Case Study Details

You are the chief financial officer of an energy services consulting company. You have additional duties as the pilot in command of the company aircraft, a Beech King Air C90B.

It is mid-August and the current trip began at the company's headquarters of Lawrenceville, IL, three days ago. The King Air is based at nearby Mount Carmel Airport (AJG). The company has its own private hangar there, even though the 4,500-foot longest runway at AJG is less than the 5,200 feet available at the closer Lawrenceville-Vincennes Airport (LWV).

During this trip, your boss and managing partner is leading the company team, which also includes the director of business development and chief engineer, for a total of four persons on the airplane including yourself. The team made stops at Bismarck and Williston, ND, and arrived this morning at the current stop of Craig, CO.

In the afternoon the company concluded successful meetings with the client, who plans to entertain the team at a local restaurant beginning at 8:00 p.m. Your team plans to depart the next afternoon after a morning tour of client facilities. Reviewing the weather forecast for the next day, you note that severe convective weather will affect nearly the entire Great Plains and that extensive low IFR conditions were forecast on the east side of the convective system.

The tour will require leaving the hotel at 6:00 a.m. and not be complete until noon. Allowing for lunch and getting to the Craig-Moffat Airport (CAG) and loading the aircraft, you are unlikely to depart before 2:00 p.m. You used the Craig Airport because it was convenient for your company and the client, but it only has a 5,600-foot runway while the Yampa Valley Airport (HDN) with its 10,000-foot runway was less than a twenty-minute drive from Craig. You have already calculated that the runway length is just adequate for an all-engine takeoff, but it is shorter than the calculated engine-out accelerate-stop and accelerate-go distances.

Your boss is excited because the day after tomorrow he is scheduled to make a presentation at 8:00 a.m. to the firm's board on the client activity for this trip, which has been a great success. Your boss emphasized the importance of returning to base tomorrow and suggests that maybe you could make the flight non-stop, a straight-line distance from CAG to AJG of 921 NM. He also reminded you that he often assisted the previous pilot with flying the King Air and that maybe he could help you tomorrow. Your boss has a private pilot certificate without instrument or multiengine ratings and perhaps 100 total flight hours in a Cessna 172.

Back at the hotel you ponder the gross weight takeoff from CAG, your boss's schedule and other factors that will affect your flight. You decide to perform a risk analysis before dinner and discuss the results with your boss.

Supplementary Information

To assist you in identifying the risk factors affecting this flight, use the following supplemental information:

Pilot – You have a Commercial Pilot certificate with Instrument and multi-engine ratings and about 3,500 flight hours, including 700 multi-engine and 50 in the King Air. Your last flight review (in a Bonanza) and instrument proficiency check (in a King Air simulator) was eleven months ago. You have six takeoffs and landings within the last 30 days and eight instrument approaches within the last six months, but only one of those was in the last 90 days. You are not taking any prescription medication, do not smoke, but you are a moderate drinker.

Aircraft – The King Air is fully IFR equipped with known icing protection. The GPS is approved for en route and terminal operation but not for IFR approaches. The King Air has been generally reliable, but on the outbound legs both the weather radar and the number two VOR receiver failed. You will be unable to get either repaired until returning to home base. You have deferred these items in accordance with your FAA Approved Minimum Equipment List (MEL). With full fuel, the King Air will have just enough range to fly the 921 NM to AJG in 4+10 under IFR with nearby (66 road miles) Evansville, IN (EVV), as an alternate. Sunset in AJG is 7:40 p.m.

Environment – The graphical convective forecast on ADDS is predicting a solid line of thunderstorms 60 nm wide from the Canadian border through the Dakotas all the way south to Kansas/Oklahoma border. Oklahoma has only isolated thunderstorms forecast. Tulsa (TUL) (607 nm from departure airport and 415 nm to destination) has a good forecast. However, on the east side of the convective line ceilings are forecast to be 500-700 feet with one to two miles visibility and moder-

ate rain extending all the way to the Appalachians. With the forecast surface winds, only non-precision circling approaches with an MDA of 571 AGL will be available at AJG. EVV has precision approaches. If the flight to AJG is made non-stop and departure is at 2:00 p.m. MDT, the approximate arrival time would be 7:10 p.m. CDT.

Passengers – In addition to your boss’s previously expressed expectations, both of your other colleagues have made personal requests. One told you she would like to arrive in time for her son’s piano recital at 7:30 p.m. Another passenger said she and her husband have dinner reservations for their tenth wedding anniversary at 9:00 p.m. Both events are in Mt. Carmel.

Appendix 3: Case Study “School” Solution

Your risk analysis the evening before the flight discloses several hazards and risks that must be assessed and mitigated. You reach the following conclusions and complete the FRAT to record them (Appendix 4).

Pilot – Although your instrument currency exceeds the regulatory minimum, you are concerned about the possibility of conducting a night circling approach to minimums in heavy rain at the end of a long duty day. This could have critical consequences and at least occasional frequency, creating a serious or “yellow” risk. You decide to mitigate this risk by adding 200 feet to the published minimums to create your “personal” minimum for the flight. You decide this makes the likelihood of a mishap remote, reducing the risk of this hazard to “green.” To mitigate fatigue as a hazard, you decide to eschew alcohol and retire early.

Aircraft – The VOR2 outage is easily mitigated by using the en route approved GPS. The radar outage is best resolved by modifying the direct routing to completely circumvent the convective area. This will make a non-stop flight impossible, but a fuel stop is needed anyway to mitigate the risk of the maximum range original flight plan with marginal destination weather.

Environment – The high risk associated with the line of thunderstorms, regardless of the radar availability, is best mitigated by circumnavigating the convective area. The potential requirement for a night non-precision circling approach to land on a short wet runway at AJG is best mitigated by conducting a straight-in ILS approach to the alternate of EVV.

External pressures – External pressures are some of the hardest risks to mitigate. The pressures associated with requests by colleagues to arrive in time for their personal events are easily mitigated by arriving early enough to accommodate their schedule. However, you must negotiate with your boss to reduce the length of the client tour, depart early, make a re-fueling stop, and agree to land at EVV and take a limousine from EVV back to Lawrenceville.

Based on this analysis, you meet with your boss before dinner with the client. You inform him that you would like to skip the client dinner and subsequent entertainment so you could retire early. You recommend that the potential risks of the proposed flight be mitigated and you show him the FRAT you have completed. You state that you can ferry the King Air from CAG to HDN for the gross weight take off, with a fuel stop in TUL. You recommend wheels up at 11:00 a.m., rather than 2:00 p.m., and say that you will arrange catering for an on-board lunch. Finally, you say that you will welcome his help during the flight and brief him on the limited SIC duties you would like him to perform. He is amazed at the extent of your risk analysis and tells you that he was not taught how to do that during his private pilot training.

Appendix 4: Completed FRAT for Case Study

Three step process: IDENTIFY, ASSESS, MITIGATE.
Conduct before departure and in flight.

STEP 1: IDENTIFY THE RISKS *(Complete second column below)*

RISK CATEGORY	HAZARD AND RISK	Likelihood (probability) (see reverse)	Severity (consequences) (see reverse)	Overall Risk Level (color)	MITIGATION/NEW RISK RED – MUST mitigate YELLOW – SHOULD mitigate GREEN – ACCEPT no unnecessary risk
PILOT					
Qualification/ currency/proficiency	Minimal instrument capacity	Occasional	Critical	YELLOW	Add 200' to minimums. Remote + critical = GREEN risk.
Aeromedical/ human factors	Alcohol + lack of sleep = fatigue	Occasional	Catastrophic	RED	Skip alcohol. Retire early. Remote + critical = GREEN.
AIRCRAFT					
Fuel/range/payload	Marginal fuel reserves	Occasional	Catastrophic	RED	Add refueling stop at TUL. Remote + negligible = "Low"
Equipage (incl. inoperative equipment)	Radar out. VOR2 out. TRW avoid- ance.	Remote	Critical	GREEN	Circumnavigate TRW. Use GPS as backup. Remote + negligible = "Low"
Performance	Short runway. Engine-out T0.	Remote	Catastrophic	YELLOW	Reposition to HDN for dep. Remote + negligible = "Low"
ENVIRONMENT					
Weather	-Convection -Low ceilings	Occasional	Catastrophic	RED	Deviate to TUL. Land EVV. Remote + marginal = GREEN
Airspace/ATC/ Airports	-Wet runway	Occasional	Critical	YELLOW	Land at EVV. Call for limo. Remote + negligible = "Low"
Terrain/Day vs. night	Night arrival (IMC + circle)	Remote	Catastrophic	YELLOW	Land at EVV. Precision app. Improb. + negligible = "Low"
EXTERNAL PRESSURES					
Work-related	-Boss wants to fly	Occasional	Catastrophic	RED	Brief boss on limited duties. Remote + negligible = "Low"
Personal	-Colleague events	Occasional	Critical	YELLOW	Depart early. Limo home. Remote + negligible = "Low"

Other Data: Brief boss evening before. Recommend earlier departure, deviation around weather, landing at TUL to refuel, change destination to EVV, and have limo waiting to take everybody home. Four RED, five YELLOW, and one GREEN risks reduced to three GREEN and seven LOW risks.

Appendix 5: Training and Other References

References

Risk Management Handbook (FAA-H-8083-2), Federal Aviation Administration, 2009.

Tips for Teaching Practical Risk Management, brochure, Federal Aviation Administration.

Safety Risk Management Policy, Order 8040.4A, Federal Aviation Administration, April 2012.

Training courses

Practical Risk Management for Pilots, King Schools, San Diego, CA, www.kingschools.com.

Practical Risk Management for Single Pilot IFR, King Schools, www.kingschools.com.

Single Pilot Resource Management, online course, TrainingPort.net, Richmond, BC, Canada, www.trainingport.net.



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ACKNOWLEDGMENTS

The National Business Aviation Association wishes to thank the members of its Safety Committee Single-Pilot Work Group, who assisted in the development of this document. We also wish to thank Wright Aviation Solutions LLC, who provided reference and source material for the guide's development.

ABOUT NBAA

Founded in 1947 and based in Washington, DC, the National Business Aviation Association (NBAA) is the leading organization for companies that rely on general aviation aircraft to help make their businesses more efficient, productive and successful. Contact NBAA at 800-FYI-NBAA or info@nbaa.org. Not a member? Join today by visiting www.nbaa.org/join.