Impeccable Quality, Performance & Customer Service Since 1983

FAR 135.331

Emergency Crewmember Training Student Resource Handout

FAR 135.331 is required annually & has been offered by CAPS for over 25 years.

CAPS' training:

CAPS Aviation in Van Nuys, CA (Weekly)
CAPS Buda, TX. Near Austin (Twice Monthly)
At your own site (On Demand)
Online Emergency Training (Always Available)
Emergency Drill Training (As needed)
G550 Evacuation Crewmember Training (On Demand)

An electronic version of this handout can be found on CAPS' website under Training Resources (September 2023):
www.capsaviation.com/training-resources

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CAPS 135.331 Crewmember Emergency Training

Course/Handout Organization

Handout Organization

Module 01: Introduction

Module 02: Pre-Flight Considerations

Module 03: Location and Operation of Emergency Equipment

Module 04: Inflight Fires, Smoke and Fumes

Module 05: Crash Physics & Off-Field Landings

Module 06: Ditching and Evacuation Procedures

Module 07: Emergency Communications

Module 08: Survival Basics & Signaling

Module 09: Search & Rescue

Module 10: Aviation Physiology – Hypoxia

Module 11: Medical Issues

Module 12: Handling Emergency Situations

Module 13: Security & Terrorism

Module 14: Reporting Incidents

Module 15: Final Comments

CAPS Commitment to Students:

CAPS has been offering aviation safety courses to thousands of pilots, flight attendants, evacuation specialists, mechanics, owners, and frequent flyers for over three decades. Our commitment has always been to deliver the best training possible, using only highly qualified instructors. We pride ourselves in offering up-to-date, relevant, and useful information in a fast-paced, engaging and interesting manner. We hope you will enjoy taking this online course and return to CAPS annually for your required training. If you are not satisfied with the training for any reason or have a suggestion about the course, please feel free to email CAPS at cabinsafetyteam@capsaviation.com.

Welcome to CAPS Aviation

Getting Acquainted with CAPS Aviation

CAPS Aviation is an industry leader in global aftermarket support of business aircraft products and services. As a leading provider to the world-wide business aviation community, we are committed to delivering fair and competitively priced products and services, with constant and consistent world-class customer service. We accomplish this through a daily commitment to building dynamic and enduring partnerships with our clients and fellow employees and associates, while upholding the highest standards of integrity, service, and innovation. More detailed CAPS' information here.

Products and Services

If we can ever do anything to support your aviation needs, please contact our customer service team cabinsafetyteam@capsaviation.com. Our primary services include:

1. **Sales, service & rentals of rafts** and other overwater and survival equipment.
2. **Sales of corporate aircraft products** including lighting, oils, AEDs, first aid kits, cabin safety supplies, and a variety of other equipment.
3. **Precision tool calibration -** In aviation, more so than any other industry, accuracy is paramount to safety. Calibration is necessary for any precision tool or equipment used to certify an aircraft or component and should only be accomplished by experienced professionals. Our team calibrated 6,000 tools a year, following this standard of excellence.
4. **CAPS Flight Crew Training (times are approximate):**
    a. **FAR 135.331 Crewmember Safety Training**
    CAPS Aviation's 135.331 Crewmember Emergency Training course covers all the requirements outlined in CFR 135.331.
    b. **Training options:**
        i. **At CAPS Aviation** – In California or Texas. (8 hours)
        ii. **CAPS' Mobile Training** - At your location, anywhere in the world with our Mobile Training Team. (8 hours).
        iii. **Online 135.331 Training -** CAPS online 135.331 Crewmember Safety Training has the same content as our in-person programs. It can be credited as initial training by attending CAPS' "Emergency Drill Training" course offered several times a year. (6 hours).
        iv. **Emergency Drill Training**
        This in-person training class is offered as an enhancement to the 135.331 Crewmember Emergency Online Training. Part 135 operators are required to create individual FAA approved training programs. Depending on your company's FAA Approved Training Program, you may need both the 135.331 Crewmember Emergency Online Training and Emergency Drill Training to complete your requirements. (3 hours).
        v. **G550 Evacuation Specialist** – Since its introduction in 2002, over 650 Gulfstream G550 aircraft have been sold. During the certification process, the FAA asked Gulfstream to increase the size of their typical over-wing emergency elliptical exits. As an alternative, Gulfstream proposed to allow them to continue using the same elliptical windows in exchange for requiring their owners to have a trained "evacuation crewmember" on every flight with 10 or more passenger. Plus give a mandatory briefing. On request at CAPS or your location. (4 hours).
        vi. **Cabin Services** - trains industry professionals in all aspects of inflight service for both domestic and international flights. Those new to corporate aviation, getting back into corporate aviation, or transitioning from Part 121, will find this an extremely valuable course - 8 hours (offered as requested several times a year)
        vii. **Classroom rental** – several options exist for those needing a quality training or meeting space.

CAPS's Course Instructors

CAPS contracts with highly knowledgeable, experienced, and renowned educators. The late Neil Looy, CAPS founder, taught our FAR 135.331 course until 2008, when he hired **Tim Kneeland**, a former USAF Survival Instructor to take over. Tim's occasional backup is **Brett Stoffel**, a former USAF combat bomber pilot. Both instructors specialize in aircrew safety, survival and handling all types of emergency situations. Tim and Brett also make up CAPS' Mobile Training Team. Tim is also a certified America Heart Association instructor. And the extremely talented and experienced corporate flight attendant **Deborah Puopolo**, has been teaching our Cabin Services course since 2006.

Several Commonly Used FAA Aviation Abbreviations and Definitions

Most aviators are, of course, intimately familiar with many definitions and resources commonly used in Aviation. Below are several definitions and resources you will find helpful. Many are referenced heavily throughout the course.

FAR: Federal Aviation Regulations (general info and links)

FARs: Current Aviation Regulations

FAA: Definitions

FAA: Regulations & Policies

ACs: Advisory Circulars - The Advisory Circular (AC) system provides a single, uniform, agency-wide system that the FAA uses to deliver advisory material to FAA customers, industry, the aviation community, and the public. ACs cover a broad range of topics within the FAA. The FAA maintains all current and updated ACs in a single database.

TSOs: Technical Standard Orders - A TSO is a minimum performance standard for specified materials, parts, and appliances used on civil aircraft. When authorized to manufacture a material, part, or appliances to a TSO standard, this is referred to as TSO authorization. Receiving a TSO authorization is both design and production approval.

FSIMS: - Order 8900.1, Flight Standards Information Management System. The Order 8900.1 (often referred to as the Flight Standards Information Management System) is a web-based repository of Flight Standards policy and guidance documents.

Part 25: **Airworthiness Standards: Transport Category Airplanes -** Regulations - Under the FAA's regulations, transport category aircraft can fall into one of two categories: jets with at least 10 seats or a maximum takeoff weight (MTOW) above 12,500 pounds; or propeller **aircraft** with either more than 19 seats or an MTOW above 19,000 pounds.

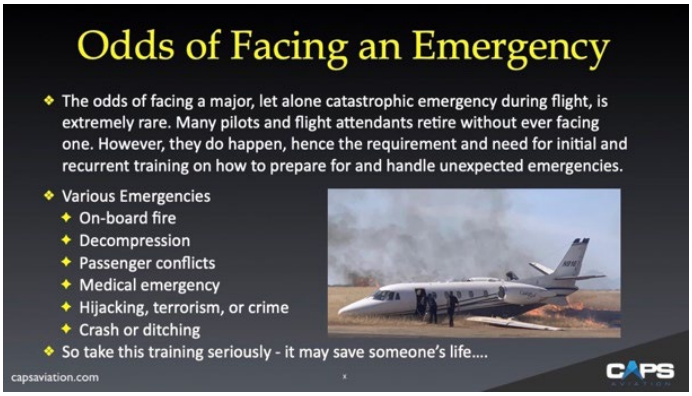
Part 91: General Operating and Flight Rules - Regulations - A Part 91 operator is only permitted to provide flights for non-commercial purposes, and works under regulations defined by the US Federal Aviation Administration (FAA) for non-commercial operations. This means that Part 91 operators cannot under any circumstances receive compensation or even reimbursement for flights conducted.

Part 121: Operating Requirements: Domestic, Flag, and Supplemental Operations - Regulations - Part 121 deals with commercial air service, flights that are scheduled, and have paying passengers, i.e. customers. A Part 121 carrier is a regularly scheduled air carrier. Typically large, U.S.-based airlines, regional air carriers, and cargo carriers operating under 14 CFR Part 121 must be certified as such through the Federal Aviation Administration (FAA).

Part 135: Air Carriers and Operators for Compensation or Hire: Certification and Operations - Regulations - Part 135 regulates the on-demand flights and scheduled charter flights. Scheduled charter flights are usually limited to a few days a week.

Module 2: Pre-Flight Considerations

Odds of Facing a Serious Emergency



The odds of facing a catastrophic emergency during flight are, thankfully, extremely rare. However, incidents happen on a statistically predictable basis, hence the requirement and need for initial and recurrent training on how to prepare for and handle these emergencies. Consider several factors that usually increase the odds of experiencing an emergency:

- A lack of flight experience (personal or other crewmembers)
- Flying beyond your experience or capabilities
- A hurry-up attitude, often leading to missteps, a lack of situational awareness and poor judgement.
- Failing to perform a complete and thorough pre-fight of the aircraft
- Unfamiliarity with your aircraft
- Time in aircraft, too little or even too much
- Type of flying (e.g., VFR vs IFR)
- Extended downtime (rusty skillset)
- Lack of practice caused by automation
- Slow reaction to technology malfunctions
- Poor and ineffective management styles
- Not applying basic CRM practices or failing to prepare your crew through effective briefings

So, train as though you will need it tomorrow, while hoping you never will.

Pilot in Command (PIC) Responsibilities

FAR 91.3 (Responsibility and authority of the pilot in command):

1. The pilot in command of an aircraft is directly responsible for, and is the final authority as to, the operation of that aircraft.
2. In an in-flight emergency requiring immediate action, the pilot in command may deviate from any rule of this part to the extent required to meet that emergency.
3. Each pilot in command who deviates from a rule under paragraph (b) of this section shall, upon the request of the Administrator, send a written report of that deviation to the Administrator.

Hazardous Materials in Aviation (Will Not Carry)

The FAA has very specific rules relating to carriage of HAZMAT Materials and training requirements. FAR 135.501 (Subpart K-Hazardous Materials Training Program) and AC121-40 (14 CFR Part 121 and Part 135 Dangerous Goods Transportation Operations) outline how to carry dangerous goods (commonly referred to as *will carry operations)*, or alternatively prohibit the transport of dangerous goods (also referred to as *will not carry*) and/or how aircraft operators are authorized to transport passengers and the contents of their baggage.

Helpful information here:

Hazardous Materials carried by Airline Passengers and Crewmember - 49 CFR 175.10 Illustrated
FAA – Pack Safe for Passengers
FAA-Hazardous Materials in Airline Baggage
Marking & Labeling Your Shipment

Handling Spills

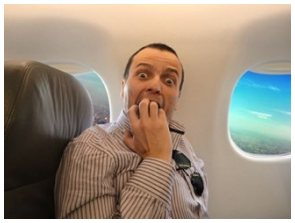
Besides your ops center and local emergency numbers, the American Chemistry Association's CHEMTREC (Emergency Chemical Call Center - 703-527-3887 and (800) 262-8200) is an excellent resource.

Helpful apps

The National Library of Medicine's ERG (Emergency Response Guide) - *The new safety tool provides the nation's emergency responders with fast, easily accessible information to help them manage hazardous material incidents.*

NOAA's CAMEO Chemicals - *CAMEO Chemicals is a database of hazardous chemical datasheets that emergency responders and planners can use to get response recommendations and predict hazards—such as explosions or toxic fumes.* Fact sheet here.

Passenger's Reactions and Roles During Emergencies



Research estimates that 2.5 to 6.5% of the population suffers from a diagnosable fear of flying, a condition called aviophopia or aerophobia. Many, many more simply suffer from an increased anxiety about aviation (we call them nervous flyers). The good news: most of the flying public will readily comply with crew instructions and requests when needed.

For your concerned flyers, you might give them a copy of this excellent 2018 article by Timothy J. Legg, Ph.D., CRNP for Medical News Today: How can I Beat My Fear of Flying?

Moving a passenger mentally from *Victim* to *Survivor.* To combat unhelpful passenger reactions, you can eliminate their feelings of helplessness by giving nervous passengers something helpful to do during an emergency, thereby eliminating part of what causes panic. For example:

- Assign each passenger a buddy to monitor and help during egress
- Specifically, direct someone to help keep other passengers' calm
- Allocate responsibility for retrieving a fire extinguisher or other piece of emergency equipment
- Assign a key role during an evacuation (and explain the importance to them)

REGARDLESS OF THE CIRCUMSTANCES, CLEAR, CALM AND DIRECT COMMUNICATIONS PROVIDES THE BEST WAY TO REACH THE DESIRED BEHAVIOR FROM A NERVOUS PASSENGER DURING AN EMERGENCY.

Checkout this rather risky marriage proposal by faking an airborne emergency. The woman in the video comments on her thought process while completing the checklist. Even though she thought she was going to die, she was focused on accomplishing her task, assigned by the PIC, taking her mind off the potential negative outcome. Quote: "I genuinely did believe that we were going to die," Kennedy told ABC News. "I felt like our lives depended on me making it through that checklist."

Indescent Proposal Video here

Passenger Briefings (Passenger Training)

Cessna Citation Latitude, Dale Earnhardt, Jr & Family – Elizabethton, TN. NTSB Report - ERA19FA248. Kathryn's Report

Pre-flight briefings often end up treated as a necessary evil to many experienced aviators and passengers. However, this requirement serves an extremely important part of keeping aviation a safe form of travel. Consider briefings passenger training and try to make it more effective.

Regardless of how you treat your pre-flight briefings, or how effective you think they are, we set the standard at:

1. Thorough enough to ensure your passengers have the knowledge necessary to save themselves if you can't assist them – which includes opening the main A/C door.
2. And, if you were unconscious or incapacitated, would they be able to save you.

Requirements

FAR PART 91.519 (Passenger briefings)
FAR PART 135.117 (Briefing passenger before flight)

Briefing Cards - an Important Safety Tool

When was the last time you really looked at one? Briefing cards can be very useful "passenger training" tool. They have specific details on the location of safety equipment and how to operate the primary A/C door. Instructions for opening the emergency exits are also included.

See AC 121-24D (Passenger Safety Information Briefing & Briefing Cards) for more details. This publication clearly lays out the requirements of passenger briefings and Appendix 4 covers the latest recommendations for brace positions. These cards must accurately depict the location of your aircraft's safety and emergency gear.

After a very thorough analysis of US Air Flt 1549, the Hudson River Ditching in 2009, the NTSB suggests (Safety Recommendation A-10-63 through-86) companies should try to become more creative and therefore effective, when delivering their briefings.

The following videos illustrate some creative solutions to passenger briefings

- American Airlines Safety Video (2016)
- Air New Zealand – Safety in Paradise (2014)
- Japan Airlines - this one addresses leaving your bags behind (2019)

Video Game Applications

Since 2013, the FAA's Cabin Safety Research Team has been in active collaboration, via grants and correspondence, with the Human Computer Interaction Lab at the University of Udine, Italy. Check these out:

- HCI Lab, Udine Applications - http://hcilab.uniud.it/
- Plane Troubles - http://hcilab.uniud.it/planetroubles/
- Life Vest, Learn to Brace, and Prepare for Impact are also on the site.
- Udine's - Other Creative Apps

Crewmember Creativity When Presenting Mandatory Briefings

Treat it seriously. Ask yourself: what can I do better in briefing passengers? Experiment by involving passengers. Ask questions to test their knowledge and engagement. Point out specific items on the briefing card. For instance, how does the main aircraft door open (this is a particularly important one)? Elicit the help of frequent flyers to encourage people to listen. Get your company's and/or the owner's buy in, if appropriate, and advertise that buy-in to help set expectations.

Cabin Attendants

FAR 135.107 (Flight Attendant Crewmember Requirement) *requires that no certificate holder may operate an aircraft that has a passenger seating configuration, excluding any pilot seat, of more than 19 unless there is a flight attendant crewmember on board the aircraft.*

The value of a Cabin Attendant really shows during an emergency. In fact, for the passengers the attendant acts as the face of the crew in an emergency since the passengers have little access to the flight deck. This leaves the management of the passengers, almost solely, to the attendant. The passengers will look to them in an emergency for how to act, to remain calm and to direct them on exactly what to do.

For those flying without a cabin attendant, the tasks of preparing passengers for an emergency obviously falls on the flight deck crew, who in an emergency focus on flying the aircraft. In addition to preparing passengers for an emergency evacuation, your goal centers on ensuring passengers follow what you want done, not what they think they need to do without any crew input.

G550 Evacuation Specialist

Initially, the FAA wanted Gulfstream to use larger emergency exits to certify the G550. As a compromise, the FAA requires a trained evacuation specialist and a passenger briefing on all flights with 10 to 19 passengers, regardless of the type of operation, even Part 91. Requirements here -Supplement Number G550-OMS-1.

Crew Resource Management

Anyone onboard the aircraft may have the key to recognizing and/or solving a developing problem, so we need a culture which allows even the most junior member of the crew to express what they see. Aviation specialists call this critical area CRM or Crew Resource Management AC 120-51E (Crew Resource Management Training). The concept seeks to give everyone a say in serious situations; however, positive crew interactions in grave scenarios depend equally on a foundation of good CRM all the time. Good CRM overcomes things like dominating personalities, prejudice, intimidation, and routine apathy toward safety of flight issues.

Tenerife Airport Disaster

This is one of two critical disasters impacting the development of CRM:
Apocalypse on the Runway: Revisiting the Tenerife Airport Disaster, buy Admiral Cloudberg, Nov 6, 2021
Wikipedia – Tenerife Airport Disaster
Human Factors Report on the Tenerife Accident - Airline Pilots Association
Remembering the Tenerife Airport Disaster 42 Years Later – This Week in Aviation (Mar 2019)
FAA – Overview to Lesson Learned from Tenerife Accident

United Flt 173, December 28, 1978

This is the major second:
United Airlines 173 – The Need for CRM.
NTSB report here

In both cases, investigation revealed that crew members knew, but could not convince the PIC of the seriousness of the problem with clearly disastrous results.

In response to the investigative results of these accidents and many others, NASA convened a workshop in 1979 on Crew Resource Management within crews on flight decks. The workshop determined that 60 to 80% of accidents involved some form of human error. The FAA introduced new regulations in the 1980s to require CRM training for U.S. flight operations.

Sterile Cockpit Rule

In addition to good communication and making sure everyone has a part to play or even a voice, CRM regs FAR 135.100 (Flight crewmember duties) require what we call the *sterile cockpit rule* to eliminate distractions in the cockpit during critical phases of flight (defined here as all operations below 10,000 ft).

Eastern Airlines Flt 212, September 11, 1974

This is one of the contributing accidents to the Sterile Cockpit rule.
NTSB report here.

Additional info here: Wikipedia Article: Eastern_Air_Lines_Flight_212

CRM Practices – Flight Deck

Encourage and accept feedback and foster an open environment without repercussions when junior crew voice questions or opinions. Train as a crew as often as possible. Brief CRM before every flight and update that brief regularly – resist the hurry up attitude of some crews and aircraft owners.

On the flight deck, institute a final check before taking the active runway. The military calls it the *Last Chance* inspection. As one very experienced pilot commented during class, when he flies with a new crewmember, he always encourages them to tell him when something doesn't seem right. His stated goal is to go home at the end of the day. The encouragement, of course, gives him an additional set of eyes watching out for potential issues.

CRM Practices – Cabin Crew

Passenger safety is always their primary and most important role. The Cabin Attendant provides expertise on the exits, safety equipment locations and use, plus any other relevant procedures for the passengers, in an emergency. Cabin crew should always feel free to ask the pilots about anticipated issues for the flight. Foster the attitude of: *If you see something, say something!* A great example is the appearance of frost on the wings and the critical need for de-icing to maintain safe aircraft operations. *If you see it, say it.*

Perform a "silent review" prior to each takeoff and landing. Pilots often call this technique *chair flying*. In essence, to accomplish this technique, simply review your planned actions and visualize your actions in different situations. Chair flying regularly helps to keep your reactions sharp. According to the Flight Safety Foundation, "by focusing on the relevant procedures and conditions prior to takeoff and landings, cabin attendants increase the probability of responding quickly and correctly to an emergency".

Module 3: Location and Operation of Emergency Equipment

Introduction

Most flight operations use a variety of specialty equipment which always stays on the aircraft. However, layouts and equipment location can vary in every aircraft you fly. We will look at several items, including fire extinguishers, portable oxygen, smoke hoods, flotation and the operation of aircraft exits.

First Aid Equipment

FAR 91.513 (Emergency Equipment) requires the carriage of certain types of emergency equipment onboard any aircraft. Module 11: Medical Issues, covers First Aid Kits, Medical Kits, AEDs, and handling several types of inflight emergencies.

Emergency Oxygen

Protective breathing equipment (PBE). The FAA maintains several regulations covering the types and requirements for PBE, beginning with FAR 25.1439 (Protective breathing equipment).

PBE are usually self-contained and require no connection to any other part of the aircraft. Alternatively, portable devices, commonly called *walk around bottles,* provide a source of oxygen supplied to a paired mask, with a hose. Check their location, condition and that the bottle supply of oxygen remains within acceptable levels.

Pilots' Protective Breathing Equipment

These two regulations cover the relevant requirements for pilot use of oxygen and emergency oxygen in flight.
FAR 135.89 (Pilot requirements: Use of oxygen)
FAR 91.211 (Supplemental oxygen)

Prior to each flight, inspect the oxygen masks for cleanliness and serviceability, emphasizing ease of access and familiarity with how to use them. The standard for deploying emergency oxygen is at 5 seconds (see also TSO-C116a Crewmember Portable Protective Breathing Equipment) for quick don (secured and sealed) using only 1 hand. In equipment configurations with separate goggles, the mask/goggles deployment is 15 seconds. Without practice, pilots will find it difficult to meet these requirements.

Reference in the last section of Order 8900.1:
https://drs.faa.gov/browse/excelExternalWindow/DRSDOCID1689123442202306151217 47.0001

Fire Extinguishers

Part 91.513 (Emergency equipment) requires extinguishers in the crew, passenger and cargo compartments of the aircraft. One extinguisher in the cabin for more than 6 passengers but less than 30, and 2 extinguishers in the cabin for more than 30 passengers.

Part 135.155 (Fire extinguishers: passenger carrying aircraft), when describing fire extinguishers for passenger aircraft, requires an extinguisher on the flight deck for all passenger carrying aircraft, and a second in the passenger compartment if the aircraft contains between 10 and 30 passenger seats.

Finally, check the status of the pressure in the extinguisher and how it is attached to the aircraft for quick removal during an emergency.

Seat Belts

Aircraft employ many different seatbelts and seat belt configurations. FAR 135.128 (Use of safety belts and child restraint systems) and FAR 91.107 (Use of safety belts, shoulder harnesses, and child restraint systems) cover seatbelt use requirements.

The FAA has an excellent pamphlet: Aviation Seat Belts and Shoulder Harnesses.

Personal Flotation Requirements

Part 91.509 (Survival equipment for overwater operations) & Part 135.167 (Emergency equipment: Extended overwater operations). These regs describe requirement for an approved life jacket/personal flotation device (PFD) for each occupant of the aircraft during *any extended over water operation*, defined as more than 50 nautical miles from shore. Crew members should be able to don their life jacket in less than 30 seconds. Red designates crew.

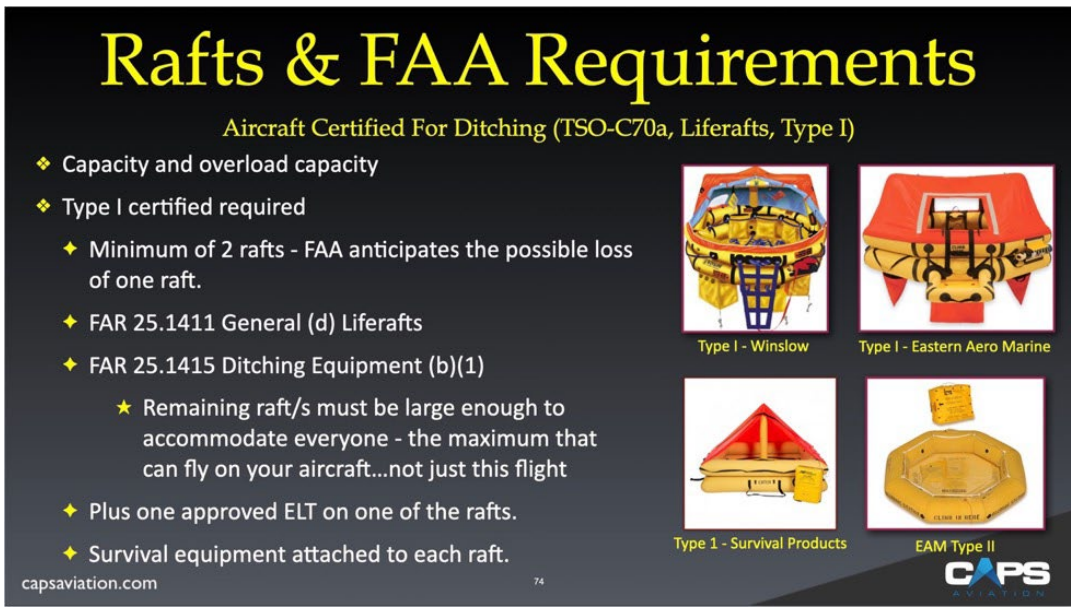
The Technical Standard Orders TSO - C13f & TSO - C13g (Life Preservers) require an adult *approved* PFD to provide 35 pounds of positive buoyancy and also include an 8-hour long survivor locator light TSO-C85b (Survivor locator lights).

Life Rafts

Part 135.167 (Emergency equipment) includes the requirements for life rafts for *extended overwater operations,* along with the required equipment contained within the rafts. This includes any aviation operation, as discussed previously, greater than 50 miles from shore, just like PFDs. In Part 91.509 (Survival equipment for overwater operations) the rules requiring life rafts extends the regime to 100 nautical miles from shore or alternatively, a total of 30 minutes flight time from shore. In 135 Operations, at least one raft needs to include an operable Emergency Locator Transmitter.

TSO-70b (Liferafts), the number of people an aviation life raft will safely carry comes from a combination of terms called rated capacity and overload capacity. The overload capacity is ½ the rated capacity added onto the rated capacity. If you have a 12-person raft, it will accommodate 18 people.

Part 25.1415 (Ditching equipment) outlines the requirements for transport category aircraft. The regulations for the extended overwater regime require two separate Type I rafts onboard. Type I means designed for use in passenger transport aircraft. Alternatively, Type II rafts are designed for non-transport (cargo, etc.) aircraft. If you lose the largest raft, there must be enough space in the remaining raft(s) for all seats aboard the aircraft (not just the passengers on the flight).



Raft Information and Contents

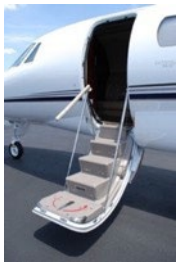
The raft tag describes a Type I, 14-person Winslow raft. The folded FAA 8103-3 (Airworthiness Security Tag) from the pocket shows the detailed inspection and verification for all of the equipment contained within the packed survival kit. If the raft does not have a copy of its contents attached, ask maintenance for a copy.

CRM ACTION: When your crew has some downtime, place the raft (never inflating, of course) on a divan and review the labeling, contents, and options for attaching the mooring line buckle to a hard point inside the aircraft. Great CRM and helps improve reaction time during an emergency.

Securing a Raft to a Hardpoint Inside the Aircraft

On the outside of most aviation life rafts, you will find a lanyard, also called a *mooring line*, *static-line,* or *painter*. These lines are used to secure the raft to the inside of the aircraft, as indicated in the photo. The raft will inflate when 35 feet of the mooring line pays out. To prevent the raft from "going down with the aircraft" the mooring line must automatically break free at or below 500 lbs. of pull force.

Aircraft Exits



Frustratingly, almost every aircraft enjoys its own unique set of equipment and distinct procedures to open the main entry door and the emergency exit or exits. The main door of a Cessna Citation is shown with the internal latch recessed below the last step to the ground. The crew member must push in on the center of the latch then rotate the handle 90 degrees either direction to release the door latch and open the door. Counter rotating handles, lock releases, triggers and secondary controls all form different possibilities for operating an aircraft door. During an emergency, you may not be able to see the instructions or even the controls, but you, or maybe even a passenger, still need to operate them correctly.

CRM ACTION: A minimum standard for all aircrew is to be able to find and open the main A/C door and locate the over wing exits with their eyes closed from their respective crew seats.

Emergency Overwing Exits

How do you open the door and then safely exit through it? To make it easier and faster to locate the exit, place a small piece of self-adhesive Velcro just above or behind the lighting rail above the exit handle.

In most corporate aircraft, the emergency exit falls into the plane and should be kept inside the aircraft. However, many small general aviation aircraft manufacturers recommend propping the door open prior to an emergency landing, since the fuselage tends to crumple on impact.

Crash Axes

Part 91.513 (Emergency equipment) and Part 135.177 (Emergency equipment requirements for aircraft having a passenger seating configuration of more than 19 passengers) both require a crash axe on aircraft which carry greater than 19 passengers, readily accessible by the crewmembers, but not readily accessible by the passengers. A crash axe potentially helps access a hidden fire and aids a crewmember to forcefully create an exit when the normal exits prove unusable. Many corporate aircraft carry them.

Module 4: Inflight Fires, Smoke and Fumes

Introduction

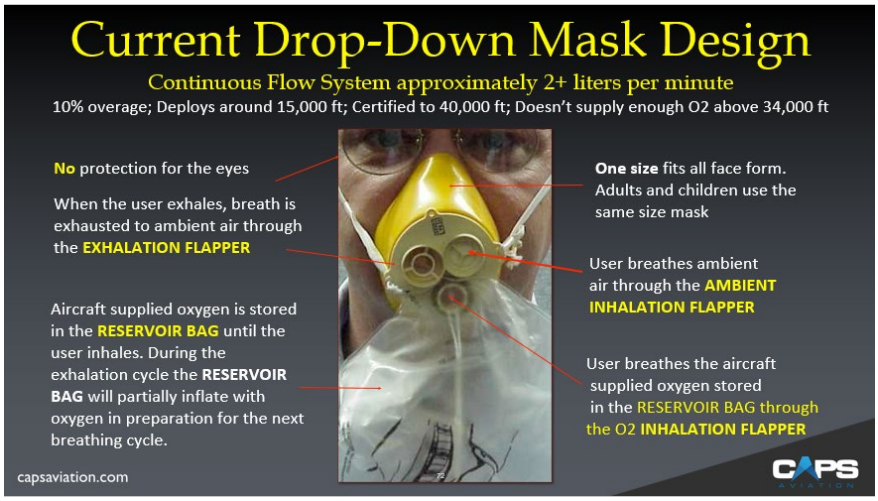
An inflight fire that occurs on an aircraft represents a true emergency of the highest order and needs rapid and decisive action. When indications show a possible hidden cabin fire inflight, declare an emergency and get the aircraft to a safe location on the ground as soon as possible. Avoid trouble shooting and exploratory confirmation of the fire in a holding pattern, in favor of trouble shooting while heading for a safe precautionary emergency landing.

JetBlue A320 Smoke & Fumes Incident

On September 18, 2014, an inflight engine fire compromised the pressurization and cabin air system on a commercial A320 operated by Jet Blue (Aviation Safety Network Summary - ASN Wikibase Occurrence # 169965). Notice that the smoke these passengers experienced was relatively easy to deal with. However, other types of smoke, especially from electrical fires, often presents a much more toxic environment, making it more difficult to breathe and sometimes creates smoke so thick it seriously impairs visibility. In such cases, more immediate and aggressive action may be needed to protect the passengers and crew.

CBS Coverage of Incident JBU1416
NTSB report here

Protective Equipment for Smoke and Fumes



Many incorrectly believe the drop-down oxygen masks provide a source of breathable air during a smoke and fumes event in a pressurized cabin. Instead, these masks protect from hypoxia (a lack of oxygen) by providing a source of oxygen during a loss of cabin pressurization at altitude. The drop-down masks provide a small amount of pure oxygen, from the aircraft through attached tubing, which then mixes with ambient air from the cabin when the user inhales. If the cabin air contains smoke or hazardous fumes, anyone using these emergency masks will breathe it in, along with the oxygen flowing through the system. The overall design of this emergency mask is very effective (Passenger Oxygen Mask Design Study), able to be successfully used by either sex, various ages, face shapes and even facial hair.

Filtering Smoke - Improvised Smoke Filters and Pocket Smoke Hoods

Simply breathing through a piece of cloth, clothing or other material will provide some protection from small particles in the air. Many more substances will be partially blocked by soaking a cloth in water. Several companies offer pocket sized devices like HKMask (not an endorsement), made of heat resistant and transparent material. These hoods seal around the neck and sometimes include chemical *scrubbers* to absorb carbon dioxide from exhaled breaths, while others also provide layered activated charcoal material to breathe through.

Protective Breathing Equipment (PBE)

Within the airworthiness section of the regulations, Part 25.1439 (Protective breathing equipment) requires the installation of fixed breathing equipment for the flight deck crewmembers. It also requires one *portable* PBE for use by the flight crew located on the flight deck and *portable* PBE located in each separate compartment accessible in flight.

Essex Corporation provides two versions of PBE, one variety for passengers called an EPOS or SCU or VRU+ (Emergency Passenger Oxygen System or Self Contained-Unit) which is not required by part 25, and one different variety for use by crewmembers. These Self-Contained Units include a sealed hood made of transparent, heat resistant material, internal Lithium Hydroxide, Carbon Dioxide *scrubber panels* and small continuous flow pressurized oxygen cylinder. The EPOS version provides 17 minutes of resting oxygen while the aircraft transits to the ground, plus 3 minutes of high intensity breathing to escape the aircraft after landing.

The crewmember PBE (Protective Breathing Equipment) version contains two pressurized 18-liter cylinders of oxygen. Users activate the oxygen by simply pulling the bottles apart. Crewmember's PBE provide enough oxygen for 15 min of fire-fighting activity or 60 min of protection at rest.

Both store in a compact, vacuum sealed, foil container with an expected shelf life of 10.6 years (as long as the indicator circle is blue - note the packaged unit image above). These hoods will withstand a temperature of 1,832 degrees F for 5 seconds, or direct contact with dripping melted materials at 390 degrees F without compromising the environment in the hood. Training video here.

Fire Basics – The Fire Triangle

Fire requires three components and a sustained chemical reaction to occur. This triad of components, called the *fire triangle*, consists of Heat, Oxygen, and Fuel combined in a chemical reaction called *combustion*. Interestingly, remove any one of these components, or the chemical reaction, and a fire will simply stop burning. In an aviation context, almost everything installed on an aircraft contains some form of fire resistance. Once a fire starts, the byproducts (smoke and fumes) of the fire often prove toxic. Crewmembers need protection and the ability to react quickly and effectively to counter this inflight threat.

Classes of Fires

The three fire classes aviators are mostly concerned with are Class A (Ordinary Combustibles), Class B (Flammable Liquids), and Class C (Electrical Equipment). Class D and K are usually irrelevant. Each of these fire types stand distinct from the others in how to extinguish them.

A		Ordinary Combustibles	Wood, Paper, Cloth, Etc.
B		Flammable Liquids	Grease, Oil, Paint, Solvents
C		Live Electrical Equipment	Electrical Panel, Motor, Wiring, Etc.
D		Combustible Metal	Magnesium, Aluminum, Etc.
K		Commercial Cooking Equipment	Cooking Oils, Animal Fats, Vegetable Oils

1. **Class A** is the most common and intuitive fire to control. Think campfire, common combustibles burning like wood, paper, cloth, tires, and plastics. Douse them with water or something with water in it or Halon.

2. **Class B** fires come from flammable liquids like oil, diesel, kerosine and gasoline. Water on a class B fire can dangerously spread the fire since oil and water naturally repel each other. Use Halon.

3. **Class C** fires involve energized electronic equipment and free flowing electricity. Use Halon.

Inflight Fires

According to FAA AC 120-80A (In-flight Fires), many fires onboard an aircraft start with malfunctioning electrical equipment. Or in the galley when using microwave or convection ovens. Other examples include heating towels, flammable items in the lavatory trash, portable electronic devices (PEDs), smoking, etc.

Circuit Breakers

In a circuit with a malfunctioning device, if more than a set threshold of current passes through the breaker, it automatically *"pops"* and disconnects that circuit from power, helping to keep the wire's insulation from catching fire. Resetting a popped breaker may result in a fire. FAA's AC 25.1357-1A (Circuit Protective Devices) recommends first understanding why the breaker popped, reset it only if explicitly directed in the aircraft's official operating procedures, or if in the judgement of the PIC, resetting is critical for the safe completion of the flight.

NASCAR In-Flight Fire

The following example illustrates a catastrophic example of a pilot accepting an aircraft with a known unresolved discrepancy, resulted in the death of five people. It's one thing to make a fatal mistake that kills just yourself, its entirely another when your poor judgement leads to the death of others. NTSB Accident Report Number: AAR-09-01 (NTSB Jan 28, 2009, Aircraft Accident Report).

The Signs and Symptoms of an Inflight Fire

The indications of an electrical fire will often start with some form of erratic operation of electrical equipment. Perhaps a flickering or momentary dimmed light, even uncommanded or erratic operation of an instrument. After this initial sign the next indication may be a popped circuit breaker or multiple breakers tied to the same electrical bus. Next comes an unexplained burning odor or even smoke. Hot spots may develop along parts of the cabin exterior or interior panel surfaces. And finally, crew or passengers may observe flames or significant smoke in the compartment.

TAKE IMMEDIATE ACTION!

Locate the source of the fire. Turn off malfunctioning devices, pull individual circuit breakers, then de-energize the associated bus breakers if necessary. Don PBE as soon as needed, use the sensitive back of your hand for locating hot spots, follow the smoke and look for the flames. Once located, gain access to the source of the fire up to and including using a crash axe if available. Be aggressive in locating and accessing the fire quickly, then apply an extinguishing agent, likely your Halon 1211 extinguisher.

Fire Resistant Clothing

We've discussed the location and inspection of fire-fighting equipment like smoke hoods, portable oxygen bottles and fire extinguishers. The inflight fire scenario illustrates the need for inspection, maintenance, and accessibility of this equipment. In addition to the already mentioned equipment, the clothing worn by crew members also provides a layer of protection from the heat of a fire. Unfortunately, many synthetic materials rapidly melt when exposed to the high temperatures generated by a fire. Common workout clothing, synthetic underwear, and nylon stockings tend to melt and drip creating some truly horrific potential for injury in a fire.

Alternately, natural materials offer excellent protection because of their fire-resistant fibers as well as the air trapped between the clothing layers and the skin. Clothing materials like cotton, silk, wool and leather hold up much better than nylon and most other synthetics.

Extinguishers

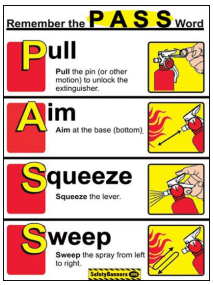
Under Airworthiness FAR 25.851 (Fire Extinguishers) lays out the number of required fire extinguishers for transport aircraft. FAA's AC 20-42D (Hand Fire Extinguishers for use in Aircraft) outlines the current guidelines on what types of fire extinguishers work best in the aviation context.

Water is commonly used in corporate aviation and helps cool and extinguish common combustibles such as wood, paper, tires, clothing, etc. It is also used to cool lithium-ion battery fires.

Halon, which is contained as a compressed gas, continues to be the most effective extinguishing agent and has a relatively low toxicity, especially in comparison to the dangers of inflight fires. Halon works by interfering with the chemical reaction occurring in combustion. Additionally, there are cleaner options available through new materials known as halocarbons, which have yet to be adopted for common use in aviation. This FAA AC also discourages the use of CO2 and dry chemical extinguishers in aviation contexts.

Proper Use of a Fire Extinguisher

Generally, a handheld aviation extinguisher will fully expel its contents in between 8 and 25 seconds depending upon its size. The user needs to hold the device and keep it upright with the handle on top. The hose and nozzle often bend to aid in aiming the extinguishing agent. Try to avoid getting too close to the fire, which helps to avoid splashing and disbursing burning materials from the source. Start at approximately 5 feet away then use the acronym PASS. **Pull** the safety pin; **Aim** the nozzle; **Squeeze** the handle; then **Sweep** side to side as you move closer to the base/source of the fire. Vent the compartment promptly after extinguishing the fire but stay ready to use the extinguisher again as once the agent dissipates, the chemical reaction may start up again.



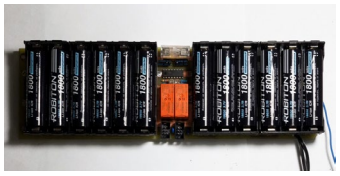
Improvised Extinguishers and Additional Resources

No matter how the fire starts, often the fire spreads to the adjacent materials and surrounding areas in the aircraft, leading to a more generalized Class A fire in the cabin. Within the limits we discussed about the different types of fires, feel free to use things like non-alcohol beverages (Coffee, Soda, Juice, or Bottled Water). Shake up carbonated beverages and spray at the base of a fire. Pillows and blankets might prove useful, and always use every able-bodied person onboard in helping to fight and contain an inflight fire and in communicating an evolving situation with the flight deck.

Lithium-Ion Batteries

A rapidly growing area for inflight fire concerns is the exponential growth in handheld and battery powered devices carried by almost everyone in the United States and throughout the world. Conservative estimates in 2018 put the estimate at least two to three devices containing lithium-Ion batteries per aviation passenger (phones, tablets, computers, headsets, e-cigarettes, etc). The FAA estimates that this puts the total somewhere around 2.3 billion (and climbing every year) lithium-Ion battery powered devices transported in the US airspace system every year.

The FAA's Office of Security and Hazardous Materials Safety often updates their information listing Lithium battery fires in aircraft and airports across the USA. The list describes hundreds of incidents. FAA statistics indicate about one incident occurs every few days. FAA's Specific Lithium Battery Incident Chart here.



The batteries in these devices malfunction in several ways, but the most common comes from what is called a *thermal runaway*. In simple terms, a particular cell in the battery gets too hot, catches fire and then explodes, leading to the same process occurring in the adjacent battery cells as a chain reaction, until it consumes all the batteries in the device. The batteries usually function well as manufactured, but minor damage and bent components from rough handling, dropping the device, getting it stuck in a seat, etc., then sometimes results in explosive problems within the battery pack

Fighting a Battery Fire

If confronted with a lithium-ion battery fire, use Halon or water to extinguish the fire, then use water/non-alcohol liquids to cool the battery down for 10 to 15 minutes if possible. Avoid using crushed ice or snow directly on the device. Use caution initially to avoid getting you or anyone's face close to the device due to the potential for explosions of the affected battery cells. Once the fire is out and the device cooled down, place the device in a container of water or into a fire-proof bag and isolate it from surrounding materials for safety. The FAA continues to remind aviators to extinguish the fire with Halon or water, then cool the device for 10 to 15 minutes before moving it.

- See Safety Alerts for Operators (SAFO - 09013) - Lithium Battery Fires
- Procedures for Fighting In-Flight Fires Associated with Portable Electronic Devices and Lithium Batteries When Using Commercially Marketed Containment Products - N 8900.430
- AC No: 120-80A - In-Flight Fires (A must read-this is another extremely useful AC)

Fire Containment Bags

The FAA has not created a standard for fire containment bags. So, as the FAA recommends, put the fire out and cool the device down for several minutes (10 to 15). Then submerge in a container of water or securely place in a fire containment bag InFO 17021 (Risk Associated with the Use of Fire Containment Products).

Beware of advertising that states a manufacturer's bag is "FAA Certified". Because it likely isn't.

The Need for Immediate Action

The following table illustrates the importance of declaring an emergency quickly and getting on the ground as soon as possible after discovering an inflight fire. Avoid holding to trouble shoot, in favor of getting the aircraft on the ground ASAP and then trouble-shoot the problem on the way. In AC 120-80A (See Appendix 3: Time to Becoming Nonsurvivable) the FAA advises that **with a hidden fire, two thirds of aircraft will not reach an airfield before the fire becomes uncontrollable**…So, be prepared for an off-airfield precautionary landing!

Several of aviation's worst fire disasters

Date	Location	A/C Type	Time from Fire Discovery to Deaths (Minutes)
07-26-69	Biskra, Algeria	Caravelle	26
07-11-73	Paris France	B-707	7
11-03-73	Boston, MA	B-707	35
11-26-79	Saudi Arabia	B-707	17
08-19-80	Saudi Arabia	L-1011 (Flt 163)	29+ Min on ground
	(301 died unnecessarily - no evacuation, everyone likely died of smoke inhalation)		
06-02-83	Cincinnati, OH	DC-9	19 (23 of 64 died)
11-28-87	Indian Ocean	B-747	19
05-11-96	Everglades, FL	DC-9 (ValuJet 592)	10 (110 died)
09-02-98	Nova Scotia	MD-11 (Swiss Air 111)	16 (229 died)
09-03-10	Dubai	747-400F (UPS 6)	27 (2 died)
07-28-11	Asiana Airlines	747-48EF (Flt 991)	18 (2 died)

Airport Firefighting Equipment

The High Reach Extendable Turret AC 150/5210-23 (ARFF Vehicle and High Reach Extendable Turret (HRET) Operation, Training and Qualifications) serves as an example of equipment used for fighting a fire on the ground. These devices usually come mounted on a dedicated truck. They often spray water or aqueous foam over the fuselage and surrounding tarmac, or if necessary, puncture the fuselage to inject fire suppression agents into the cabin directly.

High Reach Extendable Turret's on Will Rogers World Airport fire trucks in Oklahoma City

Asiana Flt 214, SFO, July 06, 2013

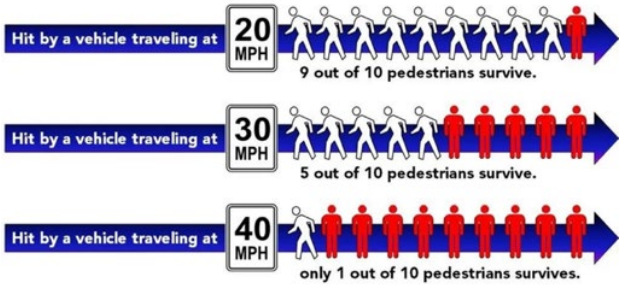
Module 5 - Crash Physics & Off-Field Landing

Introduction

In the following Units we will discuss the energies involved in an emergency off airport landing. We will focus on the design features of aircraft and aircraft systems and how they absorb excess kinetic energy in an emergency landing. We will also discuss the principals involved with safe emergency landings. As always, specific techniques for specific aircraft and individual piloting skill remain subjects for additional training and practice.

Frailty of the Human Body

The human body is relatively frail, especially considering the forces involved with a vehicle weighing thousands, or even tens of thousands of pounds traveling at hundreds of miles per hour.



For instance, consider the energy and results of a person struck by a moving vehicle while crossing the street. According to this The *Urbanist* graphic, nine out of ten pedestrians (90%) struck by a car traveling at 20 mph will survive the encounter. Increase the speed of the vehicle to 30 mph and the survival rate drops to 50%. Increasing the speed to 40 mph, the survival rate drops to just 10%.

Several factors influence the survivability of an unplanned off-airfield landing. Our goal is to reduce the energy absorbed by the weak points of the human body:

- Pilot skills and flying technique to reduce flying airspeed as much as possible, while still maintaining control of the aircraft until it comes to a stop.
- The design of the aircraft structure to absorb energy through crush structures along with the energy required to tear away parts and pieces of the aircraft as it transitions from flying to a stop.
- Aircraft restraint systems to hold the body in an appropriate position while avoiding impacts with the other parts of the aircraft as the aircraft comes to a stop; and finally
- The body position and orientation assumed by the person in the seat – brace positions.

G-Forces

Scientists and engineers call the forces of acceleration and deceleration involved in a crash-landing *G forces*, using the normal pull of the earth's gravity as a reference. One G represents the pull you feel (your weight) from the earth while standing still. Two Gs represent twice and three Gs triple the force etc. According to research conducted by NASA and the U.S. Air Force, our restrained bodies will handle an astonishing 80G for truly short (i.e., *instantaneous*) periods of time in a rear facing seat, 40G in a front facing seat, 9G in a side facing seat (lateral force), and perhaps 20Gs of force head to toe (spinal or axial).

Several resources can help explain this g-force effect:

- FAA Brochure - Acceleration in Aviation: G-Force
- NOVA - All About G Forces
- Wikipedia g-force
- Wikipedia - Col John Stapp

Energy of a moving object is called *kinetic energy*. Normally, that energy dissipates through drag, the landing gear and suspension, and then the brakes on the wheels. In any landing, planned or unplanned, the kinetic energy of the aircraft must be actively dissipated or absorbed by something, until the aircraft eventually stops moving.

Physics describes the total energy of a moving object using a familiar formula:

$$E_k = \frac{1}{2} M \bullet V^2$$

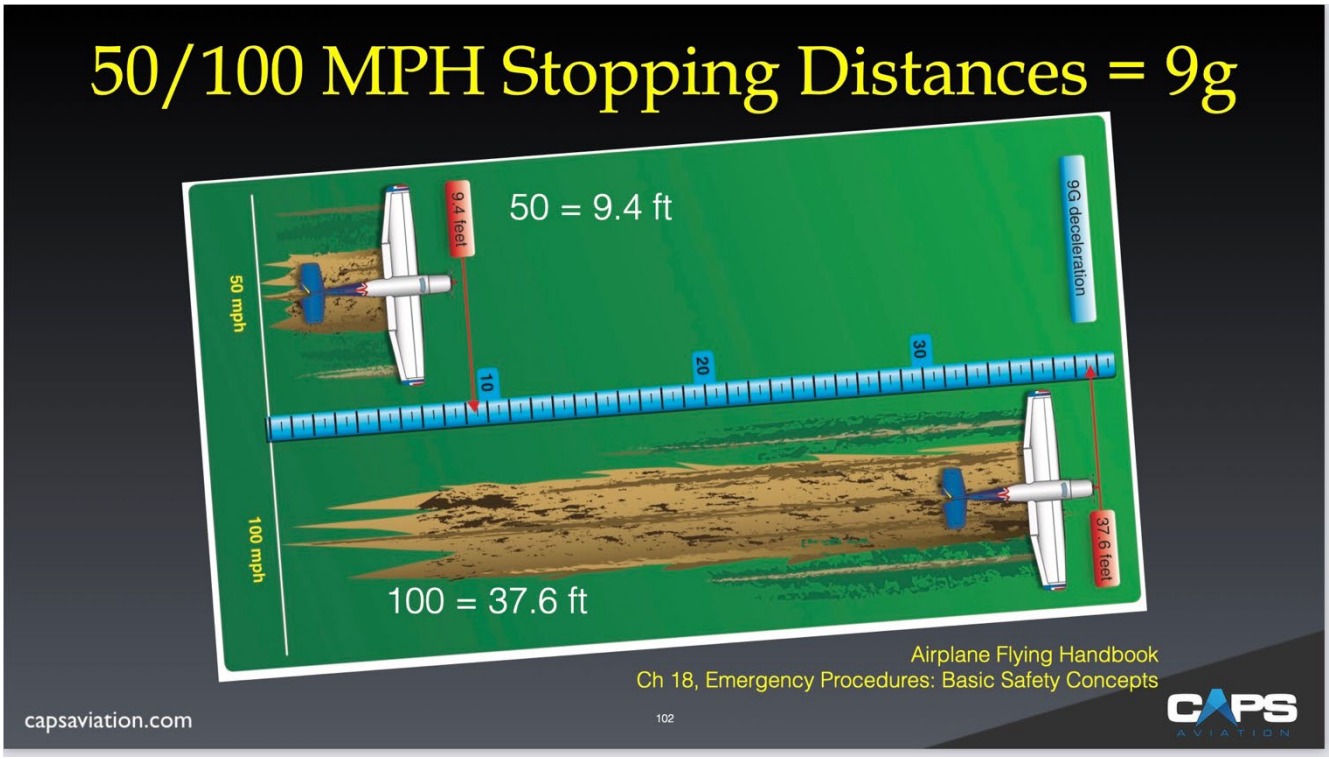
Where M is the mass of an object and V represents that object's velocity.

For our purposes, this equation describes the clear impact of velocity to total energy in a moving object. The total energy relates to the velocity *squared.* If you double the speed of an object, you will in turn quadruple the total kinetic energy in that object, three times the velocity gives nine times the energy and so forth.

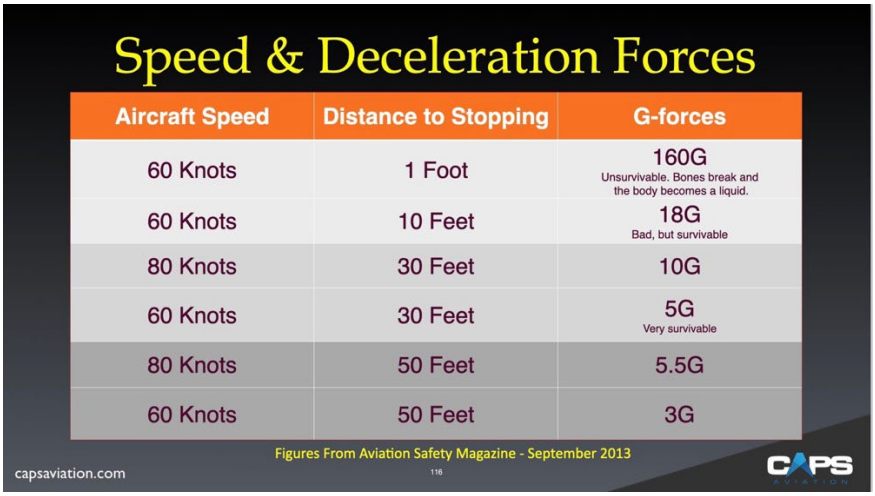
The practical technique for pilots that stems from this Kinetic Energy equation - slow down as much as possible prior to touchdown/impact to reduce your kinetic energy!

Emergency Landing Techniques

The following image from the FAA's *Airplane Flying Handbook* "Emergency Procedures" shows this practical relationship very well. The graphic illustrates the stopping distance of a small aircraft under 9 Gs of deceleration. The first aircraft on the top, starts at 50 mph and takes approximately nine and a half feet to fully stop. The second aircraft starts with double the speed and takes nearly forty feet to stop. Four times the stopping distance!



To illustrate the same concepts from another perspective, examine the chart below based on information published in September of 2013 by *Aviation Safety* magazine. The table provides for an aircraft at differing starting speeds and the different deceleration (G force) and distance required to stop that aircraft. Our takeaway here: lower the initial speed and extend the deceleration over a longer distance, to reduce the forces needed to stop.



The following will help to focus a pilot's efforts to reduce energy prior to touchdown in an emergency off-airfield landing (not an exhaustive or aircraft specific list).

- A precautionary landing produces better results than waiting for a system failure to force an emergency landing
- Reduce groundspeed as much as possible before impact; however, maintain the slowest controllable speed without increasing the sink rate (i.e., do not stall!)
- Point the aircraft into the wind on approach
- Put the flaps down prior to touchdown
- Shallow the angle of contact with the surface as much as possible

Remember: The longer the deceleration, the better. Avoid the obvious immovable faces and objects (cliffs, large rocks, tree trunks, buildings etc.). Small vegetation like brush and thin tree branches, sand, snow, and even water makes a huge difference in dissipating deceleration forces. The kinetic energy of the aircraft transfers into breaking the vegetation and displacing smaller objects and aircraft structures, rather than into the aircraft passengers.

The following incidents and videos illustrate these reductions in forces beautifully. Keep in mind we are not advocating for an attempt of these kinds of landings, rather we focus on the effects of dissipating all or most of the kinetic energy in an emergency landing.

Cirrus SR22 Washington State Olympic Mountain Crash (April 2, 2017)

Our first example involves Cirrus SR22 in the spring of 2017, near the eastern slopes of Olympic National Park in Washington State. The aircraft entered a box canyon and the terrain rose too rapidly for the aircraft to avoid. The pilots attempted to turn around, but the canyon was too narrow. Flight recorder data shows the aircraft, at an indicated airspeed of 81 knots, with a 10 to 11 knot headwind at impact (70 knots groundspeed) and a 30-degree bank turn along the slope of the snow-covered slope. Notice the intact structure of the aircraft cabin and broken empennage and right wing. The aircraft impacted the slope at a shallow angle and the kinetic energy broke the empennage structure and displaced a whole lot of snow while decelerating the aircraft to a stop. Both pilots suffered injury but survived the crash because the kinetic energy dissipated into displacing snow and physical aircraft structures.

More complete details:
NTSB Number: WPR17LA084
Kathryn's Report (photo from Kathryn's)

Cessna 172 Tree Landing (Sep 11, 2017)

Photo 1 – View of wreckage from rear (photo courtesy of the FAA)

Next, a student pilot flying a Cessna 172 out of Plainville, Connecticut fails to execute an effective go-around, which then results in an impact with a tree growing in a nearby parking lot. Notice how the limbs catch the aircraft, bend in response to the kinetic energy and end up almost gently setting the aircraft on the ground with almost no damage.

More info here: NTSB Identification: GAA17CA530
Kathryn's Report
Video Here

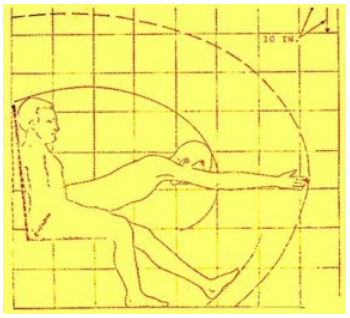
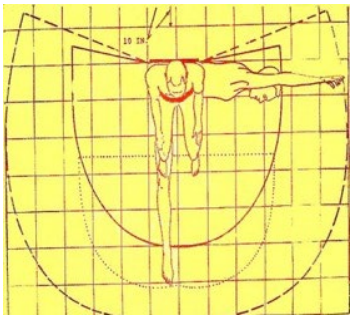
Russian Ural Airlines Flight 178 – Airbus A321 (Aug 15, 2019)

Our final example is Ural Flt 178 which displays the pilot training classic ideal scenario of an emergency off-airport landing in a cornfield, less than 5 miles from Moscow's Zhukovsky Airport. The relatively weak cornstalks provide uniform deceleration over the leading edges of the aircraft eventually bringing the Russian passenger aircraft with 233 people on board to a stop after ingesting birds on climb out. Focus on maximizing energy dissipation rather than a perfect or damage free emergency landing, depending on the location and circumstances.

Photo from Aviation Herald
Aljazeera YouTube Coverage

Occupant Restraint Systems

In addition to managing energy through the landing, crewmembers need an awareness of something called the *strike envelope*. This envelope is based upon sitting position, restraints, and orientation in the cabin while the aircraft decelerates. In simplest terms, the body (and every part of it) will continue in the direction it is already moving, while the aircraft decelerates. We like to think we can control our limbs, head, and neck during a crash, but the high G forces involved inevitably overwhelm our muscles. A passenger facing forward with a lap belt will quickly fold around that lap belt (see diagrams below), with the feet and arms extending as far as they reach. A shoulder strap will prevent the upper torso from continuing forward, while placing the chin on the chest prevents the chin's violent impact with the chest as the aircraft decelerates.

Major studies conducted by the FAA and the NTSB determined that proper use of shoulder harnesses could reduce major injuries in general aviation aircraft accidents by a whopping 88 percent and reduce fatalities by 20 to 50 percent! In March of 2016 the FAA released another of their studies stating that roughly one third of general aviation accidents with fatalities are eventually deemed survivable had there been proper restraints used.

See Seat Belts and Shoulder Harnesses – Smart Protection in Small Airplanes
AOPA's Adding Shoulder Harness Can Increase Safety.

The following video shows a NASA test with two crash test dummies in a Cessna 172. Notice the interaction of the non-shoulder harness wearing dummy (on the left) with the aircraft yoke and instrument console. Meanwhile, the other test dummy suffers no such impacts or issues.

(3-minute video –1:42 to 2:25 shows inside aircraft and value of restraints)

Additional FAA resources:
FAR 135.128 Use of safety belts and child restraint systems
FAR 91.107 Use of safety belts, shoulder harnesses, and child restraint system
FAA 91.521 Shoulder harness

Brace Positions

Brace position do two things:

1. They reduce flailing (limbs that wave or swing around wildly)
2. They reduce secondary impacts

The following are suggested brace positions depending on the seat you are in and direction you are facing. AC 121-45D (Passenger Safety Information Briefing and Briefing Cards) covers bracing (See Appendix 4 – BRACE-FOR-IMPACT POSITIONS) in excellent detail.

First, always wear your seat belt low and tight. Second, place your head against what it is going to hit.

Barring shoulder restraints, forward facing passengers should bend at the waist to wrap their arms around their legs and behind their knees prior to deceleration. Interestingly, the rear facing seats provide even more protection. Passengers in rear facing seats need to place the back of their heads against the headrest rather than on their chest, and place hands under their thighs (or crossed over the chest) with feet flat on the floor. Passengers should avoid side facing seats (divans, beds, etc.) during an emergency landing if possible. Look at the following depictions taken from Transport Canada AC 700-036 and review potential scenarios for crash positions.

Figure 2 – Forward-facing seat, lap strap only, low density seating, arms wrapped behind legs

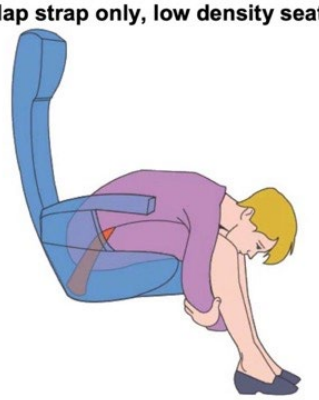


Figure 4 – Forward-facing seat, lap strap only, high density seating, head against seat back, arms at side

Figure 8 – Forward-facing crew member seat, lap strap and shoulder harness with dual upper torso straps

Figure 19 – Aft-facing crew member seat, lap strap and shoulder harness with dual upper torso straps

Figure 16 – Aft-facing seat, lap strap only, high density seating, pregnant passenger

Figure 11 – Forward-facing seat, lap strap only, high density seating, adult holding infant

NOTE: There are more suggested bracing images in both the FAA and Transport Canada's Advisory Circulars.

Interior Challenges – Chairs, Tables, Divans, Bureaus & Beds

FAR 135.331(a) states: *Each training program must provide emergency training under this section for each aircraft type, model, and configuration, each crewmember, and each kind of operation conducted, as appropriate for each crewmember and the certificate holder.*

Be sure to pay particular attention to your aircraft's seating configurations, recommended brace positions for each seat, and how you will likely access and use each aircraft exit when faced with an emergency. If possible, avoid seating passengers in a divan for an emergency landing. If necessary, a younger person is probably more flexible and has a better chance of surviving. Always remember to maintain easy access to emergency exits. However, FAR 25.813 ©(2)(ii) (Emergency Exits), allows minor obstructions in the region of the emergency exits so long as there are compensating factors to maintain their effectiveness.

Module 6 - Ditching and Evacuation Procedures

Introduction

After a successful emergency landing on land or in water, crewmembers need to focus on the next logical step. Assisting passengers and other crewmembers safely from inside the aircraft to a safe environment outside the aircraft. Airlines often use a rule based upon FAR 25.803 Emergency Evacuation. That reg requires aircraft with 44 passengers or more to completely evacuate the aircraft in 90 seconds or less. This rapid timeline acknowledges the extreme importance of a safe evacuation in a short time due to the extreme post landing danger from fire, smoke, fumes, movement, or an aircraft filling with water and sinking. Evacuation training and reviewing procedures several times a year can **"shave seconds"** off an emergency evacuation, possible saving more lives.

Establishing a Reference Point

After decades of conducting practical evacuation labs for aircrews, we have discovered an almost universally helpful technique in getting people out of any aircraft in a host of different situations. We call that technique the ***Reference Point*.**

Human beings primarily use their eyes as a default to navigate in any environment. In a visually compromised or distracting environment (e.g., darkness, smoke, underwater, unusual orientations etc.) we often need assistance to find a safe exit. A reference point provides orientation in the cabin, and even more importantly, helps guide a crewmember from their duty seat directly to an exit.

Focus on finding a good reference point(s) in the cabin before an emergency occurs. Choose an easy to reach location to grip with your hand while remaining seated in your duty station with your harness/seatbelt fastened. Maintain your grip on the reference point with one hand and use the other free hand to release your seatbelt and to clear anything obstructing your egress.

Marking an Exit

Preparing a subtle physical reference marker over emergency exits helps during evacuation in a visually compromised environment. An excellent approach provides a small piece of adhesive Velcro on the trim railing directly above your exit's handle. Crew members slide their fingers along the railing until encountering the Velcro, then access the emergency exit appropriately. Even without an available railing, think of another method of identifying your exit.

Ditching (Water Landing)

Contrary to popular belief, ditching (a controlled landing on the water) statistics clearly indicates a very high survival rate. According to the U.S. Coast Guard and other reliable sources, the general aviation ditching rate with no fatalities is around 88%. This is good news! From our experience, survival rates may even climb higher with a prepared pilot who performs a controlled, precautionary landing. Since most deaths in these situations occur from drowning, the proper use and deployment of flotation (life preservers and rafts) is critical and deserves practice when possible.

Case Study - US Air Flight 1549, January 15, 2009

The commercial flight took off from LaGuardia (LGA) at about 3:25 pm on January 15, 2009, piloted by Chesley "Sully" Sullenberger and Co-Pilot Jeffery Skiles. Approximately two minutes after takeoff the A320 encountered a flock of birds which then caused a loss of almost all thrust from both engines. The PIC (Sullenberger) rapidly determined he could not safely return to LaGuardia, nor safely make any other alternate airfield. Instead, he elected to ditch in the Hudson River.

The aircraft handled the ditching extremely well and though five individuals sustained serious injuries, no one died. In addition to the remarkable performance of the flight deck crew, the NTSB (Accident Report No: DCA09MA026 and (Safety Recommendation A-10-62 through-86 Dated May 21, 2010) credits the crew performance as responsible for the positive

outcome of the accident, citing their training, calm and skill. The aircraft, for the most part, stayed intact. The aircraft did not sink, and all 155 souls onboard were evacuated from the aircraft within 24 minutes of the ditching.

In the third paragraph of this report, the NTSB states these critical factors contributed to the successful ditching and outcome:

1. CRM and decision making of the crew
2. The use of an extended overwater equipped aircraft with slides that helped keep dozens of passengers out of the water
3. Performance of the cabin crew in expediting the evacuation
4. Proximity of first responders and rescue vessels

First Officer Jeff Skiles - Miracle on the Hudson – YouTube – AMO Expo 2014
Commonwealth Club of California - Captain Chesley Sullenberger (11/30/09) Video

Case Study - Puget Sound Cessna Citation Ditching, July 22, 2003

In another example (NTSB Identification: SEA03FA147), we focus on a smaller corporate aircraft. A Citation 525 took off (PIC and one passenger onboard) from Victoria BC to Boise ID in the Pacific Northwest. After approximately 50 miles, the PIC reported complete loss of his primary flight controls, declared an emergency, and eventually ditched the aircraft in Puget Sound's Penn Cove, Washington state, roughly 300 yards off the east shore of Whidbey Island. In the pilot's account to the NTSB, he reported impacting the water at around 100 knots, gear up, wings level, with the flaps down 35 degrees (in landing configuration). The aircraft came to a stop in approximately 50 feet, and water started entering the cabin almost as soon as the forward motion stopped. The pilot and passenger egressed the aircraft and entered the water. The aircraft took about 15 minutes to completely sink. The two spent about 10 minutes in the 47 degrees F water before local boaters pulled them from the sound.

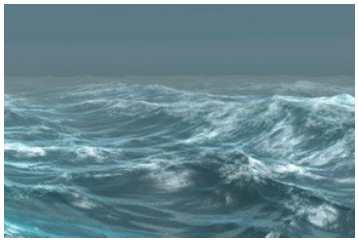
The important take-away from this incident centers on a typical, successful, water landing – stopping a corporate aircraft traveling 100 knots in 50 ft of water with both people easily surviving.

Gulfstream 550 Cabin Familiarization Safety Equipment Video

The following video, produced by Gulfstream to accompany an early G550 purchase, illustrates and locates the emergency equipment features of Gulfstream aircraft, how the emergency exits work, securing and deploying the liferaft, using a lifeline (ditching line), and operating the A/C entry door. Though it makes the process of moving a heavy raft seem easier than it is, the video offers a wealth of important safety information which we will periodically refer to during the course.

Screenshot - G550 Safety Equipment and Evacuation Techniques Video – Many versions exist.

Ditching Preparation



Airworthiness regulations under FAR 25.801 (Ditching) require the aircraft to stay afloat long enough for the passengers and crew to egress and use the appropriate evacuation equipment. Interestingly, the ditching environment generally provides a more uniform surface than a non-maritime off airfield landing. However, pilots often comment on the lack of contrast and fewer landmarks for visual cues indicating proximity to the ground. Descending into darkness, fog, wind, and rain/snow without lights on the surface to guide the pilot's control input, presents added difficulty. Pilots, if able, should land parallel to the major swells and directly into the wind to facilitate a smoother touchdown as is recommended in the FAA's Aeronautical Information Manual which contains several illustrations (Chapter 6, Section 3, Ditching).

Emergency Egress Basics

Knowing the location, type, and how to use each piece of safety gear can shave valuable seconds off your actions when faced with a serious challenge. Make it a habit to check the location and proper use of all emergency gear (rafts, AEDs, smoke hoods, fire extinguishers, PBEs, first aid and medical kits, crash axes, life preservers, walk-around oxygen bottles, etc.) on each aircraft you fly.

Remember "to do the greatest good for the greatest number" of people involved in any emergency. This concept applies directly to aviation accidents as well. You want to *maximize the number of people* who get out of a potentially dangerous situation. Generally, the able-bodied need to egress first, which avoids delays caused by the infirmed or those unable to utilize a particular exit due to some physical issue like obesity, injury, illness, advanced age, etc. Additionally, emergency equipment and or life rafts also deploy with the first passengers to egress. Those with special challenges may have to use a different exit such as the primary aircraft door, or even the baggage compartment door, rather than the emergency exits. NOTE: Some aircraft also have special equipment, or dams, to use when opening an A/C door to slow the inevitable water flow from outside making its way into the cabin.

Overall Considerations

Remember, in the absence of information from you, passengers will likely follow their own beliefs (right or wrong) about their personal survival. This phenomenon then potentially leads passengers to well-intentioned, but sometimes inappropriate behavior. If your flight roster includes no cabin crew, then those on the flight deck still need to prepare the cabin and passengers as time and circumstances allow.

Clear communications and appropriate cabin preparation will help to insure a successful outcome in any off-field landing. In a potential ditching, pilots need to coordinate the flow of information between cabin attendants and the flight deck, focusing on the nature of the emergency and time remaining to prepare the cabin and passengers.

Review these general considerations for emergency water landings (more specific details appear in following units):

1. Communicate to the respective authorities who can offer help
2. If possible, fly to warmer and calmer waters with ships to help with immediate rescue
3. Set-up and apply crash physics for a successful water landing
4. Remind everyone, multiple times, the number of people onboard
5. Coordinate responsibilities and tasks with cabin crew
6. Empower the cabin crew by reminding passengers to follow their directions
7. Brief and review expected commands from the flight deck
8. Review securing and protecting the life rafts
9. Act to accomplish the greatest good for the greatest number of people - able bodied passengers generally exit first
10. Reseat people as necessary to provide helpers and to facilitate a fast and efficient evacuation
11. Assign specific stronger passengers to help those needing assistance
12. Assign everyone a "buddy", including cabin crew
13. Put life jackets on in the aircraft and remind to inflate only outside the aircraft
14. Review the correct brace positions for each seat orientation
15. Remind passengers how to use their seatbelts - might even have them practice

16. Egress order of rafts, passengers, crew, animals, and additional gear
17. Exit commands in the aircraft and at the window
18. Inflating the raft, transitioning to raft, and separating the raft from the aircraft
19. Raft discipline and personal survival

Flight Deck Considerations

Every situation is different, of course, but the following can help make the evacuation quicker and more efficient:

1. Communicate, as conditions permit, your emergency and intentions to anyone who can help – aircraft, ATC, Oceanic Control, Military, Ops Center, ships at sea (Amver System discussed in Module 9), rescue resources, etc.
2. Activate your ELT as soon as the outcome of your flight is in question by switching from "armed" to "on" using the control panel switch.
3. Try to fly to warmer and calmer water with help.
4. Consider ditching with 20 to 30 minutes of fuel remaining, giving yourself additional flight time to set up another approach if something isn't right.
5. In making your landing decision, determine, to the best of your ability (visual references, instruments, ships in area, etc.) the weather conditions, wind speed, direction of the swells, etc.
6. Review issues and instructions with cabin crew and/or passengers:
    - Nature of the emergency, time remaining, and any special circumstances
    - Preparing the passengers, cabin, and survival equipment for quick evacuation
    - Empower the cabin crew by reminding passengers to follow their instructions
    - Review appropriate crew emergency procedures & assignments
    - Remind everyone how many souls are on this flight
    - Discuss the ideal order of egress
    - Emergency exits – The overwing exit/s are the aircraft's primary emergency exit/s, especially during a ditching scenario. The A/C main entry door serves as the secondary emergency exit. The baggage door serves as a third choice if accessible. If a person is unable to use an exit, be ready to quickly select an alternate. Before opening any exit, always **access the outside** conditions for any dangers.
    - Evacuation commands to help avoid confusion. After the aircraft comes to a stop, stay "**Stay Seated", "E-Z" or "EZ Victor"** instead of "evacuate". The cabin crew will tell the passengers to **"stay seated"** so they can move freely to determine a safe exit.
    - If there isn't any cabin crew, tell your passengers to stay seated until you locate the safest exit.
7. Generally, when safe, one pilot should exit the aircraft to secure, protect, deploy the raft, and help ensure a rapid and smooth transition of passengers to the raft
8. Don't forget to check the cabin, lavatory, and baggage compartment for passengers before egressing
9. Pass animals and the extra survival gear out just before the last crewmember exits
10. One crewmember serves as the last to exit the aircraft - likely the flight attendant who initiated the evacuation
11. In Gulfstream aircraft, multiple over-wing exits might be used, so remember to keep track of the numbers exiting each window and avoid creating a tripping hazard with the mooring lines
12. Flight deck announcements
    - Approximately 1000 ft AGL (Stand by for Ditching - 2 min to go)
    - At 500 ft AGL (Brace for impact - 1 min to go)
    - Call out altitudes if possible
    - Finally, "Brace, Brace, Brace" right before impact.
    - After the violent motion stops, communicate Stay Seated, E-Z or E-Z Victor to the flight attendant so she or he can determine a safe exit and initiate the evacuation

Cabin Crew Preparations

After the violent motion stops, the cabin attendant's job starts with assessing the outside. Look for hazards like twisted metal, fire, leaking fuel, running engines, water level, etc., before opening an exit.

To help cabin crew prepare for and execute a successful evacuation, review the following as a sort of checklist:

1. Coordinate with the flight deck:
    - What is likely to happen and who is responsible for which tasks

- Anticipated timeline
- Preparing the cabin and passengers
- Review commands from cockpit used to initiate an evacuation – Stay Seated, E-Z or EZ Victor

2. Review the conditions when the cabin crew should initiate an evacuation without word from the flight deck - structural damage, water entry, fire, and other immediate dangers
3. Life vests on, raft secured and organize passengers and gear
    - **Life vests** - Assist passengers to don them correctly before exiting the aircraft. Remind passengers to only inflate PFDs outside the aircraft. Deploy infant life jackets as needed.
    - **Life rafts** – Keep them secured under a divan or elsewhere inside the aircraft. A loose, 60 to 80-pound raft may cause significant damage on impact. Secure the 35 feet of mooring line to a hard point inside the aircraft – buckled to or double wrapped on a seatbelt, etc. Note the images below. Make sure all cargo strapping on rafts includes a quick release option or reposition the rafts and secure them for quick accessibility.

4. Assign passengers to aid in completing basic evacuation tasks
    - Identify passenger(s) with the ability to help lift (use two people if available) and pass the raft to another person on the wing
    - Make buddy assignments for everyone
    - Place strong swimmers with weak swimmers
    - Assign people to help with disabled or injured passengers
    - Everyone should be tasked with keeping other passengers' calm
    - Reseat injured, infirmed, and pregnant passengers as needed
5. Preparing the passengers
    - Remind everyone the number of people on this flight
    - Review the evacuation process and order
    - Remind passengers to always listen to and follow crew instructions
    - Review brace positions for each passenger
    - Remind passengers how to use their seatbelts - low and tight across the hips. Have the passengers practice opening and closing their seatbelts if time allows
    - Use effective child restraint systems when available. Pictured is AMSAFE's very popular Child Aviation Restraint System (CARES). Image is from their website

    - Secure any animals with a leash, a carrier or in a secure area of the aircraft
    - Wrap or covering a dog's (or other animals) claws to help protect the raft – using dog booties, napkins, duct tape, etc.
    - Secure personal glasses, meds, cell phones, pens, and other items in a zipper (Zip-Lock) bag and place securely in a zippered, buttoned or Velcroed pocket of the owner
    - Encourage people to urinate before impact if needed to avoid the potential of their bladder breaking
    - Tell people not to shed extra clothing which helps retain heat and provide additional insulation after reaching the raft

6. Organize emergency equipment for quick removal from the aircraft
7. If possible, collect and place extra gear (blankets, contractor bags, insulation, water, food, first aid kit, etc.) in a contractor (heavy garbage) bag and store in a secure area like the lavatory
8. Stow loose items that can become projectiles on impact – bottles, cans, trays, carts, phones, bags, etc.
9. Tape sliding doors and cabinets closed as necessary
10. Evacuation process scenario - might look something like this:
    - Remind passengers to follow crewmember instructions
    - Make sure all violent motion has stopped before releasing seat belts
    - Tell passengers to stay seated with seatbelts fastened while the crew assesses the outside conditions to select a safe exit
    - After accessing outside conditions, select the exit, tell the passenger to release their seatbelts, to leave everything behind, and to come to the sound of your voice
    - If an over-wing exit is used, open, remove and stow it, usually inside the aircraft
    - Determine if you want to use the lifeline (ditching line) or leave it stowed – more info below
    - Send an able-bodied passenger or crewmember out the exit first
    - Remove the raft/s with help from other passengers as needed
    - Pass the raft/s out to the person on the wing and instruct them to protect the raft
    - Instruct the outside person to help other passengers evacuate safely
    - One pilot checks the cabin and helps the cabin crew finish the evacuation
    - The other pilot exits onto the wing and takes control of the raft and the evacuation process
    - Keep track of everyone inside and outside the aircraft (cross-check numbers)
    - Make sure life jackets are inflated after exiting the aircraft but before entering the water or raft
11. Deploying the raft - select the edge of the wing offering the best protection for the raft and safest evacuation route
    - Life rafts float, uninflated, in their containers
    - Life rafts contain well-constructed components made from durable material, but sharp edges and items protruding from the wing may easily damage or deflate a raft
    - Consider the dangers of running engines, noise, damage, oil, fire, surfaces that can damage a raft, etc.
    - In very calm water and an undamaged wing surface, consider the leading edge of the wing
    - Otherwise, consider the trailing edge. Be careful to keep the raft from contacting dangerous surfaces - instruct people both inside and outside the raft to help protect the raft from any sharp objects. Warn passengers to avoid the hot engine
    - Inflating the raft - most rafts have two methods of inflation (images below) - when the mooring (retaining/painter) line pays out 35 feet or you pull it out 35 feet. Or instantly by pulling the emergency inflation ring at the end of the raft packaging

    - If you have handed out both rafts (and you should if possible), consider inflating the second raft after everyone has exited the aircraft, made it into the raft and you are clear of the aircraft
    - Boarding the raft – with the raft still secured to the aircraft, select the safest option for entering the raft
        - If there isn't any danger of puncturing the raft, instruct the passengers to climb into the raft directly from the wing
        - When conditions require "swimming" to the raft, ask passengers to slowly slide off the wing into the water while holding the mooring line, then pull themselves hand-over-hand to the raft – NOTE: currents,

wind and inclement weather make unassisted swimming extremely difficult. Therefore, the mooring line becomes indispensable for getting everyone to the raft successfully
    - Another, less desirable option, is to jump into the water while holding or grabbing the mooring line and then pulling yourself into the raft
    - After everyone is in the raft, cut the raft loose from the aircraft with the strap cutting knife located close to the raft boarding entrance
    - Once safely away from the dangers associated with sinking aircraft, begin the process of basic raft survival discussed below

Evacuation Commands

As mentioned and worth repeating, if the aircraft has cabin crew, generally the first command from the flight deck is "Stay Seated, E-Z or E-Z Victor" so the cabin attendant can easily access the best exit. The cabin crews first command is generally "stay seated" so she or he has a clear isle to locate the best possible exit. If no cabin crew, the flight deck crew would normally ask people to "stay seated" so they can find the best exit. The following commands will help execute a relatively smooth evacuation process:

Initial Commands

At the "Stay Seated" or "Easy Victor" command from the flight deck, the cabin attendant or evacuation crewmember needs to use a loud, clear, and commanding voice:

- "STAY SEATED, I'M CHECKING FOR AN EXIT"
    - Accesses the outside conditions to choose the appropriate (safest) exit
    - Open the exit and stow the hatch
- "RELEASE / OPEN SEAT BELTS"
- "EVACUATE NOW, THIS WAY"
- "LEAVE EVERYTHING BEHIND"
- "COME TO THE SOUND OF MY VOICE, TOWARDS THE FLASHLIGHT"
- "LEAVE EVERYTHING, DO NOT BRING LUGGAGE OR CARRY-ONS"

Exit Commands at Window (Ditching)

- FACING EITHER FORWARD OR AFT
- "STEP UP, STEP THROUGH"
- "LEG FIRST, THEN BODY, THEN SECOND LEG THROUGH"
- "INFLATE YOUR LIFE JACKET ONCE CLEAR OF THE EXIT"
- "HEAD FOR THE MOORING LINE"
- "USE THE MOORING LINE TO GET TO THE RAFT"
- "BOARD THE RAFT"

Exit Commands at Window (Land)

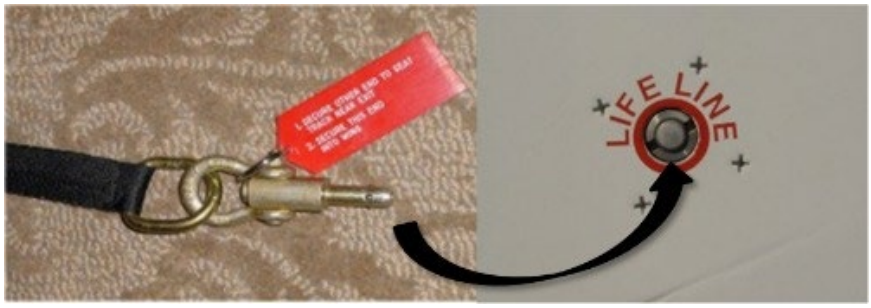
- FACING FORWARD OR AFT
- "STEP UP, STEP THROUGH"
- "LEG FIRST, THEN BODY, THEN SECOND LEG THROUGH"
- "MOVE AWAY FROM THE AIRCRAFT AS DIRECTED (perhaps 2 or 10 o'clock so passengers don't block any rescue vehicles)"
- "WATCH OUT FOR EMERGENCY VEHICLES" (IF AT AN AIRFIELD)

Evacuation Lifelines

As part of the aircraft certification for extended over water operations, FAR 25.1411 (Transport Aircraft Equipment) requires the installation of additional lines (lifelines/ditching lines) to assist passengers and crew in moving from the emergency exit to the wing and/or the life rafts. Manufacturers usually place these lines inside the emergency exit frame, allowing a crewmember to find and deploy them after removal of the exit hatch. The lifelines then typically attach via a special port on the wing or fuselage designed and labeled specifically for this purpose. The lifeline ports include conspicuous labels which usually include a red circle and lettering to help identify them.

Video screenshot of a Gulfstream G550 video (relevant section from 2:50 to 3:05) showing how their lifelines/ditching lines operate.

Notice these lifeline attachment options. Lifelines might be of value to help keep your balance on a moving wing, especially during stormy weather. However, be sure to avoid slowing down an aircraft evacuation or creating a tripping hazard.



Boarding a Life Raft

The mooring line (often referred to as a painter), functions to allow the raft to drift away from the aircraft without floating away completely. The mooring line usually attaches to the raft boarding ladder or ramp and will break away, usually at less than 500 pounds of pull, when the aircraft sinks, if anyone forgets or fails to cut the line once everyone boards the raft.

Ideally passengers and crew will board the raft directly from the wing surface without even getting wet. However, in a real scenario the trailing edges of the wings, engine nacelles or even parts of the fuselage may present twisted metal or sharp edges which prevent direct boarding of the raft without an extreme risk of puncturing the raft. In such a scenario, survivors need to enter the water and use the mooring line to get to the raft boarding system. Remind passengers and crew not to let go of the mooring line once in the water. Wind and current often create a situation where a survivor

cannot overcome their movement away from the raft by swimming. Once in the water, always keep the mooring line in hand!

Once you arrive at the raft, work together to get everyone on board. Since boarding most aviation rafts presents a bit of a challenge, allow a few stronger individuals to enter first and then help others. Make sure to get everyone in the raft and work together to load the injured or incapacitated. Make sure to keep the raft balanced to minimize water entering the raft and prevent a potential capsizing.

Raft Set-Up and Maintenance

After loading everyone into the raft, take a headcount to ensure everyone made it to the raft. Make sure you are detached from the aircraft and determine if any medical issues exist that need immediate attention. At least one of the aircraft's rafts will have an Emergency Locator Transmitter (ELT) attached to it, which may activate when deploying the raft. This beacon, coupled with the activation of your aircraft's ELT, indicates to rescue forces the deployment of a raft.

Take the following actions to ensure everyone remains as healthy and comfortable as possible until rescue:

1. The PIC becomes the raft commander unless incapacitated or he/she designates someone else to take on this role.
2. Hear air escaping? It is usually normal. Note the pressure relief valves on the outside of each buoyancy tube allowing excess gas to escape during initial inflation and when the sun expands the tube's gases (mostly carbon dioxide) during the day.
3. Note that the raft usually contains a survival kit, pump, flashlight, at least one survival locator light, reflective strips, bailing bucket, ELT, sea anchor, 75-foot throwing line, and several organizing pockets for your use.
4. Under the raft you have stabilizing water buckets (ballast buckets) and a strap for righting a raft that inflates upside down or capsizes.
    a. When "righting" an upside-down raft, grab the end of the righting line located at the CO2 bottle to prevent injury by the bottle hitting someone's head.
5. In general, a typical raft survival kit contains several helpful items: water making devices, water containers, rations, signaling items (typically sea dye marker, whistle, one or more flares, a plastic signal mirror, a rescue laser flare, and a streamer), a small compass, first aid items, sun cream, repair plugs for damaged tubes, line, paddles, a knife, a fishing kit, sponges, instructions, pressure relief valve plugs, etc.
6. Keep all the equipment organized and as dry as possible.
7. Most corporate rafts have a yellow instruction card attached to the canopy that will help walk you through several important survival steps.
8. Make sure to deploy the sea anchor – normally this automatically happens when the raft opens. This small parachute will trail underwater behind the raft helping to stabilize the raft by reducing spinning and minimizing the wind's effect. Propper sea anchor deployment also makes predicting the raft's location easier for rescue personnel. For best results, keep the line tight between the raft and sea anchor. In high seas, it helps to increase stability by adding more line to the sea anchor.
9. Immediately assign a person to do nothing but watch for a potential rescue vessel and to let everyone know if they see one. Rotate this task as needed.
    a. Assign the whistle, signal mirror and, if available, the rescue laser flare (discussed in Module 8), to the person on watch. Make sure each item includes a lanyard and is securely attached to the person standing watch.
    b. If possible, designate an experienced person to fire any pyrotechnics in your survival kit.
10. When deploying two rafts, try to tie them together as soon as possible. The 75-foot throwing line (usually located on the raft's top tube) helps to complete this. To pull separated rafts together, assign a strong swimmer from both rafts to hold onto these lines while swimming to each other. The swimmers then lock arms while the occupants of the rafts pull themselves together.
11. Hypothermia (loss of critical body core temperature) will be one of the biggest threats to your survival. The following can help prevent hypothermia:
    a. Use the raft's bailing bucket and sponges to make and keep the raft as dry as possible.
    b. Deflate and sit on part of your life jacket (PFD) to provide additional insulation from a cold raft floor.
    c. When available and needed, inflate the floor of the raft in colder climates – the raft's pump pushes into each tube's inflation valve for easy manual inflation.

d. Get dry and stay as dry as possible by wringing out and drying your clothing.
e. Try not to sit in water for too long, since it makes it difficult to maintain warmth. And if extended long enough, creates the potential for an immersion injury.
f. Use the pump attached to the raft to keep the two buoyancy tubes full, especially when colder air contracts and softens the tubes at night.
g. The raft canopy design likely allows survivors to completely seal off the interior of the raft to offer more protection from cold and wet conditions. However, a sealed canopy increases the risk of the people getting nauseated. Monitor people for seasickness and perhaps provide a small opening in the canopy which allows fresh air and a helpful stomach settling view of the horizon.

12. To better prepare everyone, read out loud the raft instructions on using all the equipment in the raft's survival kit.
13. Be especially careful when using pyrotechnics (flares and smoke signals). Protect these devices from getting wet as much as possible. Unfortunately, these signals often employ cardboard and paper in their construction and sometimes their plastic storage bags develop holes, but almost universally, the lighting mechanism for any of these pyrotechnic devices needs to stay dry. Once activated, these devices also produce extremely hot and volatile material. Before activating any pyrotechnic signals, ensure a clear path and extend them away from the raft and other survivors.
14. Be careful using the knife in the raft kit or anything else sharp. The knife's purpose is for carefully making a small hole in the raft buoyancy tube big enough for a repair plug. The repair plugs are very effective for stopping a leak.
15. Assign specific jobs to the remaining people on the raft. For example: water maker, medical officer, food and water distribution, etc.
16. The "medical officer" is more of an observer, alerting the PIC to any potential injury or illness for follow-up action.

Finally, settle in and create a routine. Bail and get as dry as possible. Try to maintain normal hygiene habits, clean teeth, rinse off regularly, urinate and defecate over the side, etc. Maintain as clean and organized a raft interior as possible to help morale and prevent further discomfort, wound infection, and other unnecessary injuries.

Signaling and rescue will likely arrive shortly (the same or the next day) unless extremely inclement weather prevents immediate access to the area.

Evacuation Considerations on Land

If you perform a landing off-airport terrain, several additional considerations arise. Fire, injuries, and rescue vehicle response near airports or in urban areas, just to name a few. Use the same crash physics techniques discussed in previous Modules. Preparing the cabin and passengers for a quick and efficient evacuation are the same as when performing a water landing, less life jackets and raft preparation.

After touchdown, remind the passengers to stay seated while you assess the outside conditions and determine the best exit to use. Since post landing fire represents an immediate concern, you will want everyone to leave the aircraft immediately, until the threat of fire passes. Be sure to direct the passengers to a definite area about 100 yards from the aircraft. You want to avoid people fleeing in multiple directions for several reasons:

1. The need to keep track of everyone and ensure their safety
2. Passengers need to avoid getting in the way of any rescue vehicles that respond to the incident
3. Rescue personnel will be in the best position to re-enter the aircraft, if necessary

In a remote area after the initial danger of fire passes, the aircraft or parts of the aircraft might prove to be an effective shelter from the sun or colder inclement weather.

Also, the chance of passenger injury is likely higher in off airport emergency landings, so be prepared to treat people with the first aid gear onboard.

Ditching and Emergency Landing Preparation Summary

Remember:

- Do the greatest good for the greatest number of people
- Remind everyone the number of souls onboard
- Prepare the cabin, secure personal and aircraft items so they don't become weapons, reseat passengers as necessary, assign tasks, and prepare the equipment for quick removal
- Remind passenger about their specific brace positions and how to release seat belts
- Over water: Don Life vests (brief do not inflate!) and secure the raft to a hard point
- Remind passengers to follow the crew's voice commands

After the violent motion stops

- First: "STAY SEATED, I'M OPENING AN EXIT" – assess the outside conditions
- Command passengers to assist (be directive),
- Command passengers "LEAVE EVERYTHING BEHIND, EVACUATE, COME THIS WAY, TOWARD THE SOUND OF MY VOICE"
- Over water: Remind passengers to inflate vests once they move outside the aircraft
- Assist incapacitated passengers and crew
- Remove remaining emergency equipment from the aircraft

Post Evacuation Summary (On Land)

- Assess outside conditions
- Assemble passengers at least 100 yards from the aircraft
- Brief to use caution around responding rescue vehicles – airfield
- Direct passengers to avoid blocking rescue vehicle access to the aircraft
- Take a head count
- Do not permit smoking
- Do not allow anyone (except rescue personnel) to re-enter the aircraft
- Treat injuries and administer first aid

CRM ACTION

1. Place a small identifying marker like Velcro to help locate your emergency exit.
2. As a crew, review possible reference points that can be established before releasing a seatbelt.
3. Seatbelt yourself into your normal crew seat. With your eyes closed, locate your reference point, release your seatbelt, then find and safely open the A/C primary door.
4. Then, locate the emergency over wing exit/s and drop the handle without opening the exit. To increase effectiveness, all crewmembers should perform this exercise. Blindfolds help.
5. Pull a raft from under the divan, note the capacity and weight, and the discuss the best options of securing the mooring line to a seatbelt inside the aircraft.
6. If any crewmembers have never lifted a corporate raft, have them, aided by another crewmember, lift it from the floor to the divan. Since a typical 12-person raft weighs around 70#, it is an eye-opener and excellent way to discuss handling a heavy raft.

Module 7: Emergency Communications

Introduction

Effective communication is basic to aviation. Clearly communicating your intentions and needs to ATC, your crew, and passengers helps eliminate confusion. When faced with an emergency, especially an evacuation, carefully delivering the correct message can help shave seconds off the time it takes to get everyone out of an aircraft safely.

Corporate aircraft provide many tools to help make it relatively easy and efficient to communicate – from various radios, phones, intercoms, loud-speakers, mega-phones, pre-recorded messages, and even lighted signs. Obviously, crewmembers should know these aircraft systems and when and how to use them. Think about communicating when wearing an oxygen mask or smoke hood, especially when faced with emergencies such as a decompression, strange odor, smoke, fumes, etc.

CRM ACTION: if you subscribe to an emergency medical service, we suggest encouraging new crewmembers, especially cabin attendants, to make a call to the service before their first flight with you.

Distress Communications

In the event of an emergency, aviators, especially when traveling internationally, need a thorough understanding of the options available for attracting help, including SAR (Search & Rescue) processes. Some onboard systems activate automatically while others require personal initiation.

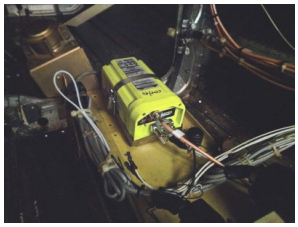
121.5 MHz and 243 MHz Emergency Frequencies

The primary emergency frequency used in civil aviation sits at 121.5 MHz: Aircraft Emergency Frequency. The military companion frequency is 243.0 MHz. Both are line-of-sight range. The FAA monitors these frequencies and uses them during an emergency or when intercepting aircraft. FAA's AIM (Aeronautical Information Manual) also contains a detailed section on distress and emergency procedures. The FAA encourages pilots to monitor 121.5 or 243.0 continuously when flying. (AIM - Section 2, 6-2-4 (d), Emergency Locator Transmitter, Inflight Monitoring and Reporting).

Emergency Locator Beacons (ELB) and Transmitters (ELTs)

Even during WWII, the military utilized transmitting devices to communicate the distress of an aviator or mariner. During the Vietnam war, U.S. aviators used 243.0 MHz (military guard channel) Emergency Locator Beacons carried in their parachutes. These devices automatically deployed when a parachute opened after an aircrew ejection or bailout. Additionally, most aviators also carried a portable radio transceiver in their survival vests, set to 243.0 MHz, for communicating with rescue forces. Beacons and radios were instrumental in rescuing thousands of downed airmen in Southeast Asia.

In late 1972 the FAA began requiring all US civilian aircraft to install g-force activated Emergency Locator Transmitters (ELTs), broadcasting on at least 121.5 MHz. The US Coast Guard followed suit, requiring beacons called Emergency Position Indicating Radio Beacons (EPIRBs) on blue water commercial vessels. The FAA also requires FAR 25.1415 (Ditching equipment) that at least one of the two required aircraft rafts contain an ELT for overwater equipped transport category aircraft.



121.5 MHz and 243.0 MHz both operate as analog frequencies, transmitting a relatively weak signal, easily obstructed by various objects, including tree canopies, hills, and mountains. To make matters worse, these beacons require using cumbersome and time-consuming aircraft or handheld direction finding (DF) equipment.

In 1982 NASA dramatically improved the system by launching the first Search and Rescue Satellite Aided Tracking (SARSAT) satellite to monitor emergency beacons from space. Then, a few years later, new SARSAT satellites upgraded the system again. On Feb 1, 2009, the system changed from monitoring 121.5 or 243.0 MHz analog signals in favor of only monitoring newer and more effective digital 406 MHz signals.

Updating Emergency Beacon Frequencies to Digital 406 MHz

In the late 1990s, several companies began manufacturing beacons that transmitted on 406 MHz, while still retaining a low power 121.5 MHz capability as a homing signal. Most aviators have adopted the 406 MHz technology as it has become widely available and less expensive.

The 406 MHz beacons broadcast a powerful 5-watt signal, enough to usually penetrate tree canopies. Most 406 devices have 48 hours of battery life. Additionally, one clear advantage of 406 MHz devices centers on a unique and repetitive signal. Every 50 seconds they transmit the device's Hex ID or Unique Identifying Number (UIN). And when equipped with a GPS, the device also sends a latitude and longitude coordinate, usually accurate within 100 meters of the beacon's exact location. The beacon's UIN allows the appropriate Rescue Coordination Center to match up with NOAA's beacon registration information, indicating who owns the beacon, contact details, and other valuable particulars for rescue.

All 406 devices require registration with the National Oceanic and Atmospheric Administration (NOAA) every two years, making it much easier for rescue to determine real emergencies, simply by a making a phone call. Most maintenance staff know how to obtain a beacon's Unique Identifying Number. Look for a life raft's ELT UIN number at the bottom of its FAA Form 8130-3 Aircraft's Airworthiness Approval Tag.

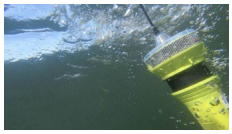
False Activations & Improvising a Broken Antenna

Unfortunately, the US suffers over 2 dozen ELT false beacon activations a day, mostly because of poor installation, carelessness, and hard landings. However, using the NOAA registration system, the authorities usually resolve these false signals within a few minutes via a phone call obtained from the beacon's registration information. Owners and maintenance staff need to take special care when installing, inspecting, and testing an ELT. Avoid accidental activations by following the manufacturer's instructions and this Advisory Circular - (AC No: 91-44A Installation and Inspection Procedures for Emergency Locator Transmitters and Receivers**.**

Additionally, an airplane's instrument panel usually includes an ELT activation toggle allowing you to switch from "Arm" to "On" in an emergency. Even though ELTs activate via g-forces (usually 2.5 g's or greater), seriously consider switching to "on" when faced with an emergency landing or ditching.

ELTs sometimes detach themselves from their aircraft mounting or cabling after a crash. The standard ELT contains a 48-hour internal battery, so they have plenty of power after an emergency landing. If the antenna brakes off (common in many general aviation accidents) the signal fails to transmit to rescuers. However, it is possible to improvise a replacement. Take a 12 to 14-inch piece of wire and place into the center of the antenna hole/attachment point on the device housing, then insulate around it with cloth, wood, or other dry material.

Emergency Position Indicating Radio Beacons (EPIRB)



An EPIRB is required on many commercial vessels. A 406 MHz EPIRB functions either manually or automatically depending upon the unit specifications. EPIRBs generally reside in a special bracket equipped with a hydrostatic release. These mechanisms free the EPIRB at a water depth of about 10 feet. They have been directly responsible for saving many mariners' lives.

Personal Locator Beacon (PLB)

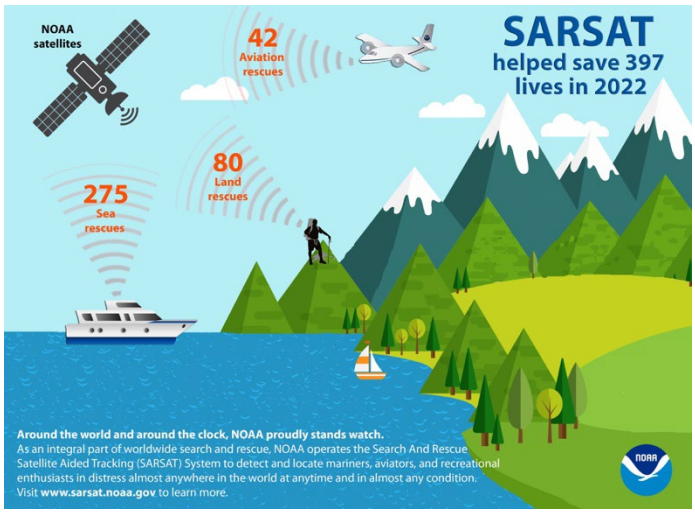
Several companies manufacture Personal Locator Beacons (PLBs). Many pilots, boaters and recreationalist carry these on their various adventures. An operator turns these devices on manually, where ELTs and EPIRBs function automatically. PLB's battery last at least 24-hours after activation and transmits just as powerfully as an ELT or EPIRB.

According to federal response personnel (U.S. Air Force), PLB users should only activate their devices "when in grave and imminent danger." Unfortunately, some outdoor adventurers activate their PLBs because of an inconvenience, rather than a life-threatening circumstance. Non-emergency activation of PLBs carries a $25,000 fine! For instance, a person wouldn't necessarily active a PLB if they fell and broke their arm, especially if they were still capable of walking. However, a hiker immobilized with a broken leg, creates a real need for rescue.

These inexpensive devices are in wide use all over the world and make up a significant percentage of the annual SARSAT Rescues. One of the most experienced manufactures of ELTs, EPIRBs and PLBs in the world is ACR. For added details, checkout this link to ACR's ResQLink 400 PLB. Page down for their helpful information about the function of a PLB, how it works, and reasonable expectations for rescue after activation.

SARSAT System Overview

Since its 1979 founding by the US, Canada, France, and Russia to the launch of its first satellite in 1982, the SARSAT System is continuing to evolve, increasing its accuracy every year. As the diagram below points out, the USA and dozens of nations around the world, have constructed, maintain, and use a very complex and effective satellite-based system to rescue those in distress. The current system enjoys an international governing body created by treaty and called COSPAS-SARSAT.Int. Additional information from Wikipedia is here.



In addition to the NOAA graphic indicating the number of SARSAT rescues in US in 2022, notice the SARSAT system organization and flow after a beacon is activated – for more details, explore this SARSAT website link. This overview describes the process:

1. The owner or responsible person registers the ELT, EPIRB, PLB, etc. with NOAA. Required every two years.
2. An installed device on an aircraft, boat, or personal device activates when faced with a serious emergency.
3. One or more of three types of Search & Rescue Satellites within the system picks up the beacon signal:
    a. Low Earth Orbiting (LEO) satellites – around 500 miles up.
    b. Medium Earth Orbiting (MEO) satellites – around 12,000 to 14,000 miles up.
    c. Geosynchronous (GSO) satellites – about 20,000 miles up.
4. The MEOs represent the newest of the satellites and will eventually consist of over 70 satellites in their constellation. SARSAT's goal to have at least four satellites always looking at every location on the earth.

5. Next, the signal travels to a Local User Terminal (LUT) where computers process it and forward it to the country's appropriate Mission Control Center (MCC). The USA's MCC is in Suitland, MD.
6. The Mission Control Center further processes the signal then forwards the information to the appropriate Rescue Coordination Center (RCC)
    a. USAF is responsible for land SAR and is located at Tyndall AFB, FL.
    b. USCG is responsible for navigable waters worldwide and has several distributed RCCs to cover that responsibility.
7. The RCC pulls up the beacon's NOAA registration information, then calls the list of contacts on the form to see if it is a real emergency and or a false activation.
8. If it is real, the RCC will notify the responsible local SAR authority (Sheriff, National Park Service, State's Aeronautical Division, etc.), who then initiates the search and/or rescue.

NOAA manages the US SARSAT program, NASA launches the satellites, USCG is responsible navigable waterways, and the USAF is responsible for land SAR.

SARSAT Future Communication Options

In a few years, as technology continues to develop, the SARSAT system may allow companies to subscribe to "texting" and other forms of communications. Currently, certain beacons can receive feedback from the SARSAT system indicating the satellites received their signal. A description of the current service is explained by the European Union Agency for the Space Programme (EUSPA):

Additional informational resources:

Wikipedia - International distress frequency
Wikipedia - Emergency locator beacon
AOPA – Emergency Locator Transmitters
FAA Regs – FAR 91.207 Emergency Locator Transmitters
FAA Airman Education Program – Search and Rescue, Rogers Shaw III
FAA TSO – TSO-C126c 406 Emergency Locator Transmitter (ELT)

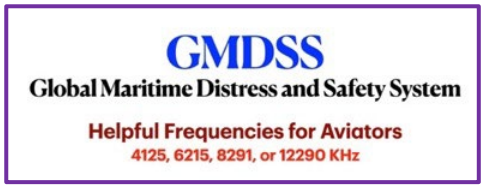
Automatic Dependent Surveillance Broadcast (ADS-B)

As described by the FAA – The Automatic Dependent Surveillance–Broadcast (ADS–B) forms an advanced surveillance technology that combines an aircraft's positioning source, aircraft avionics, and a ground infrastructure to create an accurate monitoring interface between aircraft and ATC. ADS–B is a performance–based surveillance technology that is more precise than radar and consists of two different services: ADS–B Out and ADS–B In. Performance based technology, in simple terms attempts to reduce the allowable deviation from assigned heading and altitude, and to reduce the amount of time between ATC instructions and compliance by operators, allowing more aircraft to safely operate in a given airspace.

ADS-B Out works by broadcasting information about an aircraft's GPS location, altitude, ground speed and other data to ground stations and other aircraft, all of this on a timeline of once per second. ADS-B Out airspace and equipment requirements reside in 14 CFR § 91.225 (Automatic Dependent Surveillance-Broadcast (ADS-B) Out equipment and use) and users may find the equipment performance requirements in 14 CFR §91.227 (Automatic Dependent Surveillance-Broadcast (ADS-B) Out equipment performance requirements). ADS-B In provides operators of equipped aircraft with real time weather and traffic position information delivered directly to the cockpit.

The FAA has a detailed Q&A on these systems and implementation schedules here.
The FAA describes ADS-B Search and Rescue Benefits Here:

GMDSS (Global Maritime Distress and Safety System)



The Global Maritime Distress and Safety System (GMDSS) includes an internationally agreed-upon set of Maritime Safety procedures, types of equipment, and communication protocols used to increase safety and then facilitates the rescue of distressed ships, boats and aircraft. GMDSS, primarily prevents unanswered distress calls and the accompanying delay in Search and Rescue actions when emergencies occur (IMO, Shipping Emergencies - Search and Rescue and the GMDSS, March 1999).

Participants monitor GMDSS frequencies around the world. These frequencies might prove valuable for a corporate aviator in trouble over the world's vast waterways.

1) 2182 kHz Medium Frequency (MF) is monitored on the oceans and has a range of 50 to 100 miles during the day and triple that at night.
2) 4125, 6215, 8291, or 12290 kHz Maritime Distress High Frequency (HF)/Upper Side Band (USB) have similar or even longer ranges. Use these frequencies for distress and safety communications between aircraft and ship stations.

Marine VHF CH 16 (International Distress, Safety and Calling)

Channel 16 VHF (156.8 MHz) serves as a marine VHF radio frequency designated as an international distress frequency with a range of 10 to 60 miles, depending on antenna height. Primarily intended for distress, urgency and safety priority calls. Many coast guards around the world monitor Channel 16 twenty-four hours a day.

GADSS (Global Aeronautical Distress and Safety System)

The following originates from the FAA InFO 19001 dated 2/4/2019 - Global Aeronautical Distress Safety System (GADSS) and Aircraft Tracking (AT). After the Malaysian flight MH370 aircraft disappeared on March 8, 2014, the International Civil Aviation Organization (ICAO) initiated a committee to review and make recommendations for improving AT and GADSS. The committee incorporated their findings into ICAO Annex 6 Part I, with an effective date of November 8, 2018. Implementation was originally schedule for 2021 but has been pushed back to January, 2025, according to an Avionics International article titled The Latest Update in the Global Aeronautical Distress and Safety System (GDASS) Initiative.

When operating in Oceanic areas these recommendations apply to aircraft with a takeoff mass greater than 45,500 kg (100,300 lbs) and a seating capacity greater than 19 seats. The GADSS recommendations will be addressed in future Federal Aviation Administration (FAA) guidance. For Aircraft Tracking the operator should:

1. Establish a 4D (latitude, longitude, altitude, time) AT capability to track airplanes throughout its area of operations.
2. Track the position of the airplane though automated reporting, at least every 15 minutes for that portion of the operation where Air Traffic Services position information is greater than 15-minute intervals, whether in oceanic airspace or over remote continental airspace.
3. Establish procedures approved by the local certificate holding district office, for the retention of tracking data to be used in determining the last known position of the aircraft and assist in search and rescue operations if needed.

GADSS – ICAO - Concept of Operations - Autonomous Distress Tracking Function (Page 14) – The SAR component is described here:

3.2.1 The Autonomous Distress Tracking (ADT) function will be used to identify the location of an aircraft in distress with the aim of establishing, to a reasonable extent, ***the location of an accident site within a 6 NM radius.***

*3.2.2 The ADT function uses on board systems to broadcast aircraft position (latitude and longitude), or distinctive distress signals from which the aircraft position and time can be derived. The aircraft position information will be transmitted, without the need for flight crew action****, at least once every minute, when an aircraft is in a distress condition****. An aircraft is in a distress condition when it is in a state that, if the aircraft behaviour event is left uncorrected, may result in an accident.*

Other descriptive resources:

Orolia - GADSS ELT Video
SKYbrary GADSS description

Additional Communication Options

Travelers use many different options for keeping in touch: cell phones, the internet, landlines, satellite phones, commercial satellite systems, etc. However, what if a disaster makes outside communications difficult or even impossible? Or perhaps the local government shuts down the internet or cell network for political reasons? When traveling to high-risk areas of the world, seriously consider additional options and systems to help maintain contact with your ops-center and family.

Cell Phones

Cell phones make instant communications possible almost everywhere in the world, However, exercise caution when using your phone and other mobile devices overseas. When you consider the amount of personal and business information on your phone, a lost or *hacked* device presents a potential disastrous scenario, and a major security concern. OSAC (Overseas Security Advisory Council) published Traveling Abroad with Mobile Devices: Best Practices for the Private Sector.

Satellite Phones

Corporate aircraft often carry satellite phones, but many can't be removed from the aircraft. When traveling to challenging locations, consider purchasing a portable satellite phone. These relatively inexpensive devices operate well throughout the world. Keep in mind (*and be careful*), some countries restrict their use. OSAC publishes a useful and thorough guide to using Sat-phones in various countries - Guide for Overseas Satellite Phone Usage.

Commercial Communicators – SPOT & Garmin InReach

Two additional options used by outdoor adventurers and aviators, utilize private satellite-based services. These often prove effective for keeping in touch when traveling, especially when faced with an emergency. These devices require a regular subscription fee to operate effectively. Conduct a little research to ensure adequate coverage where you attend to travel. Differing systems contain coverage gaps in their services, mostly over the ocean.

According to their manufacturers:

SPOT X provides 2-way satellite messaging when you're off the grid or beyond reliable cellular coverage. Connect SPOT X to your smart phone via Bluetooth wireless technology through the SPOT X app to access your contacts to communicate easily with family, friends, or directly with Search & Rescue services. SPOT X has its own dedicated U.S. mobile number, so others can message you directly. Also check out their SPOT Gen4. More info here. Image is from Globalstar's website.

Garmin InReach Satellite Communication - With InReach and an active satellite subscription, you can stay in touch globally. You can send and receive messages, navigate your route, track, and share your journey and, if necessary, trigger an SOS to get help from a 24/7 global emergency response coordination center via the 100% global Iridium® satellite network. Also check out their relatively new inReach Mini 2. More info here. Image from Garmin's website

Module 8 - Survival Basics & Signaling

Introduction

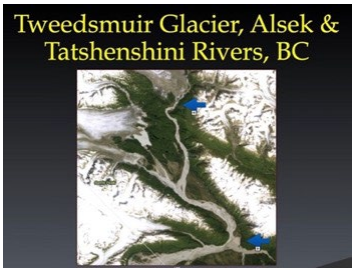
PMA + 98.6 = The Best Chance for Survival

Survival information finds its way into almost all forms of modern media. Unfortunately, much of it misleads the public at best, and some even threatens basic safety and common sense! The two key elements for survival present a relatively straight forward approach: 1). controlling the mind and 2). maintaining body core temperature. Specifically, PMA (Positive Mental Attitude) includes our ability to think rationally and maintain the will to live (a stronger reason to live than to die). After PMA comes shelter – defined as anything that helps maintain normal body core temperature. Maintaining PMA and 98.6° offers a survivor the best chance of survival, regardless of the circumstances.

Because of modern electronics and emergency beacons commonly found in corporate aviation, survival scenarios rarely last longer than 12 to 36 hours. Even when SAR (search and rescue) knows the location of an incident, people still need to survive until rescue forces arrive.

Gary Anderson's 38 Day Post Crash Survival Ordeal

In late June 1971, Ward Anderson and his 22-year-old son Gary (pictured shortly after his rescue with his mom and brother), flew a small aircraft in Northern Canada using a major highway as a navigation aid. After finding themselves surrounded by clouds, running low on fuel, and lost, they decided to land their float equipped plane in a river running next to a glacier. Later investigation identified the river as the Alsek, running past the terminus of the Tweedsmuir Glacier. During the subsequent landing, one of the aircraft floats bore heavy damage, which then led to the aircraft sinking into the frigid and fast-moving water. Gary struggled to shore, barely surviving the intensely cold river. Then, looking back at the remains of the aircraft, he watched as his father disappeared into the cold river rapids, never to be seen again.



With the hope of locating his father alive, Gary decided to walk downriver, while traversing several miles of rugged terrain. After a few days of travel, he arrived at the uncrossable junction of the Alsek and Tatshenshini Rivers, where he managed to build a moss-covered shelter. The shelter protected him from the elements and helped to retain critical body heat. Gary leaned on his education and experience as an engineer, and especially the thermal dynamics courses taken in college. This made him aware of heat transfer mechanics, which then helped him maintain his body core temperature, which in turn preserved his decision-making ability.

Over the next 32 days he continued to improve his shelter. However, he never managed to start a fire and, understandably, never found any source of food. The lack of food led directly to a weight loss of approximately 65 pounds. Gary eventually found a couple of discarded jars left behind by hunters who apparently landed at the site months before Gary's arrival. Gary made sure he drank plenty of river water each day and so remained well hydrated. Near his shelter, he carved out a large, square lettered "SOS" in the sand to signal any potential rescuer flying by.

On Gary's 38th day of the ordeal, Jerry Wells, a charter pilot from Yakutat, AK. decided to fly with a friend to Haines, AK. Jerry, who knew of the Andersen's disappearance the previous month, always theorized the Anderson plane went down in the Alsek River drainage, so he decided to fly that route on their way back to Yakutat, where they spotted the SOS and Gary standing next to it. They landed, and to Gary's astonishment, they rescued him. Within 36 hours, Gary reunited with his mother and brother at the Seattle-Tacoma Airport.

In 1975, Gary, his brother Lee, Tim Kneeland (co-author of this course), a videographer and the adventurer Don McCune (Exploration Northwest TV host) flew to Yakutat to reconstruct Gary's story. Over the next several days they walked his route, discovered a couple of signal arrows he made, and located his survival shelter, as shown in these images. This was a very emotional experience for Gary, offering him closure he would never have been able to achieve without this trip. The experience was documented in a 30-minute television show called One Man's Survival. Gary's extended ordeal illustrate and reinforce the importance of attitude and maintaining the correct body core temperature.

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Left to right: Crash site on the Alsek River; shelter and rescue site; Gary's moss-covered survival shelter

The Critical Basics – PMA

Positive Mental Attitude (PMA), by far represents the most important and critical aspect of survival, anywhere, anytime. Positivity means that a survivor makes decisions and takes actions that directly, **positively,** affect the survivor and/or also productively influences the positive outcome of the situation.

The two primary components of PMA include:

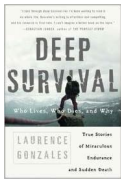
1. Analytical ability
2. Will to live

Analytical Ability

Maintaining an ability to think rationally and the ability to access personal experiences, education, logic, and common sense, sits right at the top of any list of priorities. Survival requires the ability to recognize problems, find resources and use those resources to solve priority problems. When faced with any emergency, the first action is to fully engage the mind. Stop moving and think. Drink some water. Consult with others. Then start giving directions to complete the immediate tasks which mitigate the most pressing threat – making sure to find a physically safe area, provide first aid, build shelter, account for available survival equipment, prepare for signaling distress, etc. These directed actions help restore mental calm and avoid wasting valuable time.

Will to Live

Countless stories demonstrate the importance of never giving up. The will to survive seems obvious at first glance, but



studies by Dr John Leach at the University of Lancaster show that many, when faced with emergency or disaster, simply decide to give up. Focus on living and on your loved ones who need you back home. In emergency after emergency, the desire to stay alive drives the persistence of countless survivors that might have otherwise perished. For further information explore an excellent book about this amazing subject *Deep Survival, Who Lives, Who Dies and Why* by Laurence Gonzales. Available through several sellers including Amazon.

Shelter

Shelter is anything protecting the body from the harsh elements of the natural world (wind, cold, snow, rain, heat, and pesky insects). Shelter also helps retain or dissipate body heat. A poorly protected body in cool wet conditions easily becomes hypothermic. And a poorly protected body exposed to high temperatures, increased humidity, and/or direct hot sunlight easily becomes hyperthermic (high body core temp). Both conditions directly affect human decision making.

The human body functions well within a relatively small, three-degree temperature range, generally from 96° to 102° F. Once we drop below or exceed 6° F from 98.6° F (94° or 105° F), we simply lose the ability to self-help.

95.6° ← 98.6° → 101.6° F
Mental Competence

Surviving in a warm, dry or tropical environment presents a much easier set of problems than facing wet, cold, and windy conditions. When thinking about survival shelters, begin with items offering protection from the elements. Shade from the hot sun. For colder conditions, think wind-proof and waterproof. Creating a windproof, waterproof shelter from nothing but nature often proves impossible, so use human made materials when available. Rafts, plastic sheets, heavy trash bags, commercial shelters, tents, blankets, aircraft parts and, (if on land and it's safe) the aircraft itself.

Conservation of Energy and Resources

A basic and general rule for survival is finding a safe area and staying put, usually close to where the situation occurred, i.e., the crash site. A survivor's energy level and available resources are at maximum levels in the very beginning of the situation. To help with the conservation mind set, consider energy spent as energy lost and gone forever. Replacing valuable energy or lost water from the body sometimes ends up very challenging. So, from the start, take care to conserve your body's internal resources – energy and water. Make sure to weigh every action on the energy scale. Sort out the necessities to accomplish for the desired outcome and avoid actions causing excess water loss, energy loss or even potential injury.

For instance, energy expended providing adequate shelter from the elements along with insulation from the cold ground (using grasses, boughs, blankets, seats, etc.) serves as a high value priority. This energy helps provide protection from the elements and maintaining 98.6° F. On the other hand, forging for food generally provides only a waste of valuable energy.

The Effect of Cold Water on Survivability

Divers consider cold water anything below 70° F. About 70% of humans gasp, or involuntarily breathe in, when quickly entering cold water. This automatic response, called *Cold Shock*, accounts for most drowning deaths in water, rather than the longer process of heat loss through hypothermia. Properly worn flotation helps a person falling into water surface more quickly, allowing them to control their breathing more easily.

The following provide estimates of survival times in cold water. Factors such as health, body mass, fat or lack of it, physical condition, etc., all make a difference. According to the U.S. Coast Guard, when wearing a PFD and submerged in near freezing water, most fall to unconsciousness from hypothermia in about an hour. In 55° F water, that time extends to about 3 hours. Another effect of cold water, as mentioned above, focusses on how quickly the water robs human dexterity. In as little as 15 minutes in 55° F water, many lose the capability of buttoning a button, zipping a closure, or even pulling themselves out of the water when given the opportunity.

Find a detailed description of Cold Shock from the National Center for Cold Water Safety here. The Royal Life Saving Society website also hosts a video by Professor Michael Tipton, one of the world's experts on Cold Water Shock. Dr Tipton co-authored an excellent book called *Essentials of Sea Survival* with Dr Frank Golden.

Insulation, Clothing & Heat Loss

After evacuating an aircraft, clothing usually remains attached (obviously, because you're wearing it). Unfortunately, nothing else enjoys the same guarantee, or even likelihood, of staying with you. Clothing primarily provides *insulation* to help the body cope with less-than-ideal temperatures. The concept of insulation usually encompasses a layer of non-moving air space (dead air), or a void to help prevent heat transfer. A thermos provides an excellent example, an inner bottle separated by only a volume of trapped air to the outer bottle.

A Styrofoam coffee cup provides another excellent example. Even when filled with hot coffee, very little heat escapes through the sides. Most escaping out the top. A lid will then help slow the heat transfer from the coffee cup even more. Similarly, a person wearing clothes often loses most of their heat through an uncovered head.

Dry clothing insulates better than wet clothing. In fact, heat transfers five times more quickly in wet clothing as opposed to dry. When completely submerged in water, heat transfers 25 times more quickly than through dry air at the same temperature. So, regardless of how miserable the feeling, getting out of cold water will extend life expectancy in most situations.

When faced with inclement weather, protecting yourself from the elements forms a critical priority. Always carry some type of shelter. Waterproof material makes staying dry much easier. Raingear, raincoats, ponchos, plastic sheets, pre-packaged survival shelters or even a heavy garbage bag usually makes a big difference in your ability to retain body heat. Thankfully, many corporate aircraft carry rafts, survival gear, and tough trash bags, offering crews significant resources to accomplish this critical goal.

Every year, retailers sell multitudes of fragile, thin mylar “Space Blankets” as emergency shelters. Even though they offer some protection, their serious limitations make them a poor choice as a shelter material for outdoor users. The rectangular shape and relatively small size limit the protection one of these blankets can offer, allowing a large amount of heat to escape. The most serious limitation is how easily they rip into pieces once compromised with a tear or a poked hole. A sturdy heavy plastic bag offers much more protection from the wind & precipitation, holds more heat, reduces evaporate heat lost, and holds together without tearing as easily.

Fire

When on land, the ability to provide an external heat source provides many benefits. A fire offers heat, drying power, cooking, water disinfection, light, security, insect deterrence, and a boost to morale.

Unfortunately, starting fires by friction or rubbing sticks together usually proves extremely difficult, if not impossible, without lots of practice. Matches, ferro-rods (incorrectly called flint and steel), and even signal flares often help to successfully create a controlled fire. Begin by collecting lots of burnable materials, from small (toothpick sized dead wood) to larger pieces but avoid picking up material directly from the wet ground. The best material comes from dry standing dead branches on trees. Build your fire on a dry protective platform. Plus use a brace (a short 2 to 3-inch diameter branch at the end of your platform as shown in the illustrations below) to rest the gathered materials. This prevents collapse and feeds the fire oxygen. Spending the time necessary to gather and prepare the right materials almost always ensures success. Practice this technique the next time you build a fire!

Incidentally, a ferro-rod (metal match) provides a very effective spark. We suggest adding some Vaseline to a cotton ball and experimenting until you create a sustained flame by carefully throwing a spark into a fluffed-up cotton ball.

Fire a building in images:

Upper left to right: First two are splitting wood with a fixed blade knife and baton; Brace & platform and various sizes of wood piles; Vaseline-soaked cotton ball spread out on top of the brace and platform; Burning cotton ball from the spark of a metal match (a Vaseline-soaked cotton ball can burn for several minutes); Carefully placing small to large handfuls of wood against the brace ensuring the fire gets plenty of oxygen; and the resulting fire – build just large enough to take care of your needs. This is a very successful method of building a fire.

The Necessities of Life

Understanding what it takes to survive helps set realistic priorities and direct your actions to accomplish genuine survival requirements.

The six necessities of life in priority order:

1. PMA (Analytical Ability & Will to Survive)
2. Air (Oxygen)
3. Shelter
4. Rest
5. Water
6. Food

PMA, Oxygen and Shelter

As emphasized, survivors need PMA and the shelter necessary to help maintain body core temperature. The need for oxygen speaks for itself when flying above 10,000 feet or in any situation creating a lack of breathable air. This rises to even greater urgency in smokey environments or when submerged in water. Thankfully, these situations (post emergency) only rarely occur.

Rest

Fatigue and exhaustion often affect survivors. Fatigue, or more specifically, getting tired from performing activities, usually gets remedied simply by resting for 10 to 20 minutes, and when possible, eating and drinking to make new fuel available to bodily systems. However, at some point, when we run out of immediately available energy, we reach exhaustion. Before reaching this level, a survivor needs to use their available energy to create a suitable, protective environment (shelter, insulation from the cold ground, possibly a fire) which in turn allows rest for an extended period (sleep), helping the body's systems break down stored energy (or fats) into useable fuel for future activities. If a person collapses on the wet and/or cold ground because of exhaustion and loses the ability to physically continue, they increase their vulnerability to losing body heat and developing hypothermia, not to mention exposure to other environmental hazards. Plan for rest periodically to conserve and recharge. Even resting against a tree in the afternoon sun usually makes a huge difference.

Water

To stay hydrated, the body usually requires 2 to 3 quarts of water every day under normal circumstances and activity. This requirement increases in hot and humid conditions or when exercising or physically working hard. However, the body encompasses a remarkable ability to function for several days when starting with a well hydrated body. Even in hot environments, most of can function for multiple days without adding water to our system. This requires slowing down our activities during the heat of the day, conserving sweat, and protecting ourselves from the sun.

Naturally safe water sources include rain, if collected before hitting the ground. Collecting clean snow and melting it also generates safe water. Never drink seawater or urine because your body removes more water from your system to process the salt and waste than you consume by drinking it. Always treat ground water to make sure it contains no harmful pathogens. In the Temperate regions of the world drinking from streams and lakes often causes intestinal problems due to parasites and other small, microscopic organisms. However, many of the contaminants often take several days before causing symptoms. Doctors can usually treat/cure these issues with medication. In the tropics and around farm animals, be sure to strain and disinfect any water you consume. Otherwise, the resulting diarrhea can lead to severe dehydration.

The best way to reliably disinfect (make potable) water, long term, involves simply boiling it. The CDC recommends boiling for at least one minute. But, in reality, all you have to do is bring the water to a rolling boil according to the Field Guide to Wilderness Medicine. After boiling, feel free to let the water cool to a comfortable level before drinking, or using it for other medical purposes.

A Katadyn's Survivor 06 "water maker" provides an excellent method to treat just about any water source and fills the water-treatment role in many corporate aviation life rafts. The pump filters saltwater (including seawater), viruses, spores, bacteria and other contaminants from water. When pumped continuously, it produces a quart of potable water an hour, or 6 gallons of water in 24 hours. The manufacturer designed it for use in the open ocean (liferafts), not streams and rivers. If in a large body of fresh water, use it anyway.

Food

Even though uncomfortable, many people in emergencies find the ability to go weeks without eating. Most survivors will discover finding food in nature presents a real challenge or even proves impossible. Locating, identifying, and using safe, edible plant life takes training and practice in most environments. Animal life presents no easy answer to corral either. So, generally avoid burning up energy and potential injury trying to find food. Conserve the energy already in your system. Consuming small amounts of food, like candy or energy bars provide more of a PMA boost than in preventing starvation. Most corporate rafts contain at

least 2000 calories of decent tasting survival bars for every person aboard. Even without these rations, few people ever starve to death in survival situations.

Geographical Survival Considerations

The following sections summarize the key techniques associated with survival around the world. Every region experiences different seasons with changing weather conditions and access to resources. However, the following define some key considerations.

Open Water

Human body design favors dry land rather than living in the water, regardless of temperature. So, to survive, begin with a life jacket, then make it to shore, get into a raft or get rescued.

Cold Weather

We define cold weather by cooler temperatures, precipitation (sometimes frozen), and winds. These environments primarily cause heat loss, sometimes severe and often quick. Arrange to have appropriate clothing (think layered insulation), shelter and additional heat sources such as a fire when needed. Keep dry and stay out of the wind.

Deserts & Hot Weather

Heat and direct sunlight often cause substantial sweating which results in significant water loss and dehydration. Survival depends on your ability to conserve the water already in your body. Cactus and other desert plants contain no drinkable water. Most deserts lack any water sources. Digging holes in the desert and covering with plastic (solar stills) will cause a person to lose more water than they will gain. So, create shade and minimizing your activities during the day to conserve water.

Tropics

Heat and humidity define much of the tropical regions around the world. These environments usually lack harsh or deadly weather, so the tropics form a warm, relatively easy place to survive. Moisture, especially during local monsoon seasons, and insects usually create the most difficult challenges. But, if you can choose a place to survive, pick the tropics.

Signaling Tools and Techniques

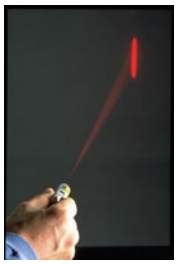
Electronic signals provide the most effective signaling capability on modern aircraft. The ELT in your aircraft and in at least one of your life rafts, sends an electronic signal to a network of satellites usually locating your position within 100 meters square in a couple of minutes. But surviving until rescue arrives presents the critical challenge, as already discussed. A basic working knowledge of how to signal rescue forces, by means other than the ELT, help a survivor in the event of a malfunction or other unforeseen circumstances.

For example, if you find yourself stranded on a raft and an aircraft flies over your location at 42,000 feet, what effective signaling devices send a detectable distress message to that aircraft? Only a signal mirror during the day and a Rescue Laser Flare for nighttime (and within 3 miles during the day). Survivors generally find both in the most common raft survival kits.

Signal Mirror

The best way to use a signal mirror involves placing it tightly against your cheek, under your sighting eye, while placing the aircraft or boat between your out-stretched fingers forming a "V" sign. Move the mirror's reflection across the two "V" fingers (and the sighted vehicle) by moving your entire head back and forth (as shown in the illustration).

Red (or Green) Laser Signal Flares



Winslow rafts usually include Greatland's Red Rescue Laser Flare Magnum with a 72-hour battery life. The red beam visibly shines up to 3 miles during the day and 20 miles at night. At 16 miles, the flare beam stretches out 6000 feet, giving you a wide, effective signal. To avoid loss if dropped, use a lanyard to attach it to the user.

Other Raft Signaling Gear

The following are some additional signaling devices found in many corporate aviation survival kits:

1. Sea-Marker Dye turns water a bright greenish color for 20 minutes or more, unless windy and rugged conditions cause it to dissipate more quickly.

2. Aerial Flare – FAA 91.509 (Survival equipment for overwater operations) requires a life raft to contain at least one pyrotechnic signaling device. Many rafts include one or more Orion SkyBlazers, which shoots a bright red flare reaching a height of 150 to 450 feet. Only shoot flares with a search aircraft (or other vehicle) positioned to see your location.

3. Smoke & flame flares. Some rafts include day/night flares with both ends offering about 20 seconds of signaling. One end produces a bright night fire, and the other end produces dense colored smoke which communicates wind direction for an approaching helicopter. After firing one end, the other remains intact and useable. Pictured at right, a PainsWessex MK8 Day/Night Flare from their website. The second image shows a CAPS Aviation demo of night flare with another flare's day end still smoking.

4. Night flares – Several kits provide one or more Orion Hand-Held Red Flare Signals that burns relatively bright for 3 minutes.

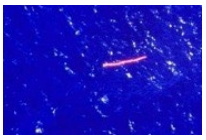
5. 12 Gauge Safety Launcher with Bandolier – Some kits contain a marine flare gun as well. Shown at right, an Orion Alerter Basic 4, 12 Gauge Launcher and Aerial Signal Pack.

6. Whistle – very limited in its use. Even the most well-made whistles' sound travels only a few hundred meters. However, better to use a whistle instead of yelling.

7. SEE/RESCUE Streamer – A 25 foot brightly colored streamer resides in several aviation kits, providing a straight line, highly visible signal from above. The image of the streamer in the water comes from the company's website.

8. Paddles – Coast Guard approved raft kits usually contain two paddles with reflective strips (signaling) on one side. Survivors rarely paddle very far in a round corporate life raft but can find them useful to help keep you away from reefs and other threats.




(Left to Right - 5, 6, 7, & 8): 12 Gauge Launcher, Whistle, SEE/Rescue Streamer (packaged & deployed) and Life Raft Paddles

9. Survivor Locator Lights – These orange or blue water activated lights are found on life vests and rafts, with a battery life of 8 hours or more. Both activate in fresh and salt water. Their purpose is to help locate survivors and rafts at night. Pictured is an ACR blue survival locator light. The EAM Worldwide Life Preserver shows the light and battery (located by the waist strap) configuration.


10. Flashlight – Usually located on the upright raft tubes. Survivors may find spare batteries and a bulb included in the survival kit. Rescuers will often see a bright flashlight miles away.

Basic Principles and Techniques of Signaling

Other effective signals incorporate color, movement, size, and straight lines. Remember, contrast with the surrounding environment. Make yourself visible.

1. Material waving in the wind often helps draw rescuers' attention. Movement catches the eye.

2. Ground to Air Signals commonly used for decades help to draw attention to your location. Use straight lines and right angles ("X", "F", "L" etc.) to contrast with the surrounding environment. Choose your location carefully. Shadows, lichen, vegetation, and shade can reduce the effectiveness of your signal. We recommend 3 feet wide by 18 feet long as good dimensions.

3. Smoke Generators – Collecting a lot of green vegetation and placing it directly on a hot fire often produces an effective smoke signal.



(Left to Right): Smoke generator. A hot fire can help the smoke rise above the trees. Alter the color of the smoke by carefully adding a day flare.

4. Creating white and black smoke depends on what you burn.

Module 9: Search & Rescue

Introduction

This Module looks at when and how to communicate distress. What resources are available to help. And how SAR (Search & Rescue) will likely unfold. Civil aviation has benefitted greatly from the military's wartime experience, especially the Vietnam Conflict. Today, we have extremely accurate beacons, active military participation in locating a downed aircraft, and a multitude of assets available for search and or rescue operations.

Declaring an Emergency (Requesting Assistance & Available Resources)

When should a pilot declare an emergency? What type of help is available? What does rescue need to know from the flight crew? For answers, it is worth quoting the best resource possible: **FAA's** Aeronautical Information Manual **(AIM). This is such a critical tool for guidance and accessing help when faced with an emergency, we decided to include the following sections directly from the AIM.**

Quoting AIM 6-1-2, (Chapter Emergency Condition - Request Assistance Immediately):
AIM 6-1-2 a*: An emergency can be either a distress or urgency condition as defined in the Pilot/Controller Glossary. Pilots do not hesitate to declare an emergency when they are faced with distress conditions such as fire, mechanical failure, or structural damage. However, some are reluctant to report an urgency condition when they encounter situations which may not be immediately perilous but are potentially catastrophic. An aircraft is in at least an urgency condition the moment the pilot becomes doubtful about position, fuel endurance, weather, or any other condition that could adversely affect flight safety. This is the time to ask for help, not after the situation has developed into a distress condition.*

AIM 6-1-2 b*: Pilots who become apprehensive for their safety for any reason should request assistance immediately. Ready and willing help is available in the form of radio, radar, direction finding stations and other aircraft. Delay has caused accidents and cost lives***. *Safety is not a luxury! Take action!***

Emergency Procedures (Chapter 6-3-1: Distress and Urgency Communications)

a) *A pilot who encounters a distress or urgency condition can obtain assistance simply by contacting the air traffic facility or other agency in whose area of responsibility the aircraft is operating, stating the nature of the difficulty, pilot's intentions, and assistance desired. Distress and urgency communications procedures are prescribed by the International Civil Aviation Organization (ICAO), however, and have decided advantages over the informal procedure described above.*

More information at Chapter 6-3-1: Distress and Urgency Communications

Emergency Procedures: (Chapter 6-3-2: Obtaining Emergency Assistance)

a) *A pilot in any distress or urgency condition should immediately take the following action, not necessarily in the order listed, to obtain assistance:*
   1. *Climb, if possible, for improved communications, and better radar and direction-finding detection. However, it must be understood that unauthorized climb or descent under IFR conditions within controlled airspace is prohibited, except as permitted by 14 CFR Section 91.3(b).*

More information at Chapter 6-3-2: Obtaining Emergency Assistance

Unit 3a: Aviation Emergency Frequencies

Emergency frequencies (121.5 and 243 MHz) were discussed in Module 7. As a reminder, whenever you are in doubt about the outcome of a flight or the people on your flight, you should consider declaring an emergency. When you do, ATC will want to know:

- Aircraft identification
- Time, position & altitude
- Ground speed, true course
- Fuel remaining (in hours) & souls on board
- Description of emergency & intentions
- Assistance requested

More detailed information (AIM Section 2. Emergency Services Available to Pilots)

Emergency Procedures (AIM 6-2-3: Intercept and Escort)

As described in the AIM: The concept of airborne intercept and escort is based on the Search and Rescue (SAR) aircraft establishing visual and/or electronic contact with an aircraft in difficulty, providing in-flight assistance, and escorting it to a safe landing. If bailout, crash landing or ditching becomes necessary, SAR operations can be conducted without delay. For most incidents, particularly those occurring at night and/or during instrument flight conditions, the availability of intercept and escort services will depend on the proximity of SAR units with suitable aircraft on alert for immediate dispatch. In limited circumstances, other aircraft flying in the vicinity of an aircraft in difficulty can provide these services.

AMVER (Automated Mutual Assistance Vessel Rescue System)

AMVER (Automated Mutual Assistance Vessel Rescue System) is dedicate to search and rescue on the high seas. It is a computer-based voluntary global ship reporting system used worldwide by search and rescue authorities to arrange for assistance to persons in distress, sponsored by the United States Coast Guard.

Amver become a reality until 1958, when computers were gaining the capacity to quickly update ship locations at sea. AMVER vessels, which number in the tens of thousands, have volunteered to respond to calls for rescue or assistance from distressed ships, aircraft or people traveling the world's waterways. Prior to sailing, participating ships send a sail plan to the Amver computer center. Vessels then report their locations every 48 hours until arriving at their port of call.

Search and rescue controllers can predict the position of each ship at any point during its voyage. The position of each participating ship is displayed in an Amver surface picture or SURPIC (A surface picture of an Area of the Ocean). In an emergency, any rescue coordination center can request this SURPIC to determine the relative position of Amver ships near the distress location and divert the best suited ship or ships to respond.

Search & Rescue (SAR) Operations

SAR operations are very well established in the United States and in many countries around the work. These dedicated government, private and non-profit organizations save thousands of lives every year. Wikipedia has an informative page describing SAR operations around the world.

Even though every country has different SAR resources, most will act quickly to help aviators, mariners, and adventuring people in distress. If SAR operations are activated anywhere in the world, the US military, civilian resources, and local government agencies will begin providing resources and coordination. For US carriers and aircraft flying over USA territory, the USCG is responsible for worldwide navigable waters. The USAF (United States Air Force) takes the lead for land operations, usually heavily augmented by local resources.

SARSAT and SAR

As discussed, once a GPS equipped ELT is activated (same for EPIRB and PLB), your latitude and longitude are transmitted through the SARSAT satellites, processed, and quickly forwarded to the appropriate USCG or USAF Rescue Coordination Center (RCC) for confirmation and deployment of resources. The RCC accesses the NOAA ELT registration database to determine who is responsible for the aircraft and contact information. The RCC makes a phone call to verify if it is a real emergency or false activation. If it is real, SAR is activated.

United State Coast Guard

One of the reasons the USCG was founded in 1790 was to provide maritime security for our new country. Eventually, emergency search and rescue operations for distressed recreational and professional mariners became one of their most important and common functions.

Over 56,000 members of the Coast Guard operate a multi-mission, interoperable fleet of 243 Cutters, 201 fixed and rotary-wing aircraft, and over 1,600 boats. GoCoastGuard.com describes what the USCG does on Average every day, including 45 search and rescue cases.

United States Air Force

The USAF has been involved in search and rescue since its establishment in 1947. Even as part of the United States Army Air Corp they were active in finding many aviators after being shot down. Besides their responsibility for land search operations under SARSAT, they are involved in search and rescue operations in several ways.

Local SAR authorities can ask them to provide resources such as:

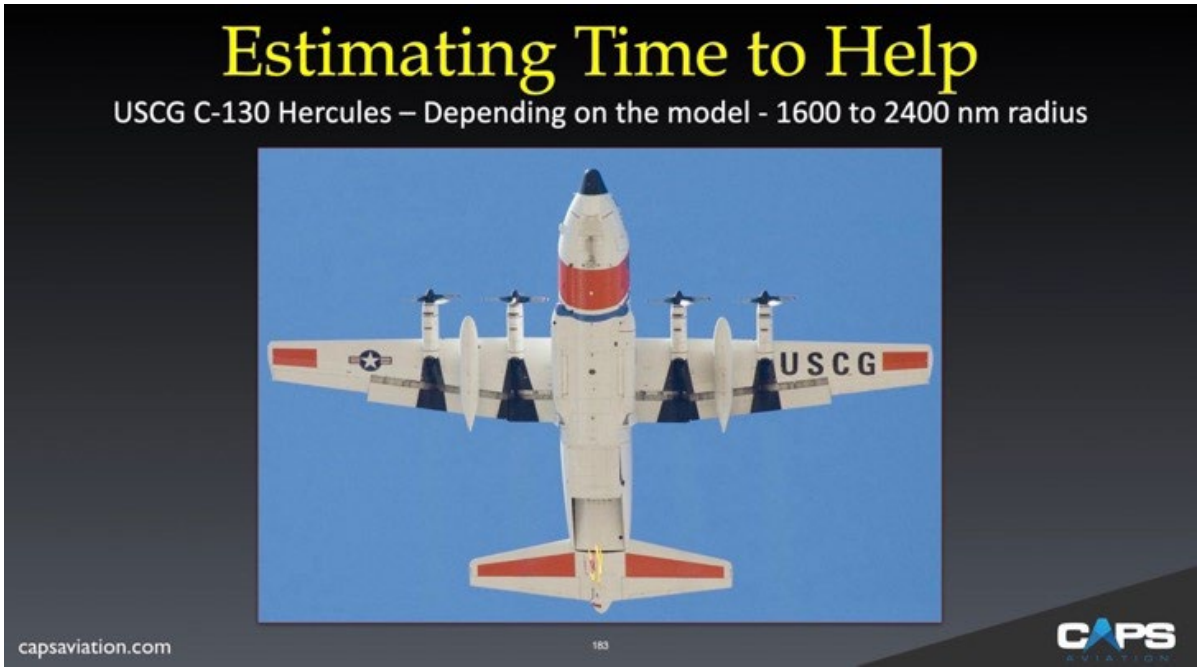
1. Providing local SAR organization flight and location data
2. Activate local Civil Air Patrol (CAP) to assist in searches and rescue efforts
3. Mobilize pararescue forces for rescue ops (PJs)

Unit 6: Rescue Resources Available to SAR Coordinators

Once your location has been determined, SAR coordinators will review and analyze your situation, your experience, current and anticipated weather, terrain challenges or sea conditions, and assets available for rescue. Then, they will organize and commit the appropriate resources. Dozens exist, including fixed wing aircraft, civilian and military helicopters, local Good-Samaritan ships, USCG auxiliary, Civil Air Patrol, AMVER System, and local resources such as Mountain Rescue, County Sheriff Department's SAR teams, Explorer Search And Rescue, Rescue Dogs, etc.

Unit 7: Rescue at Sea

After a water landing, it is likely you will be picked up by a large ocean-going ship. A helicopter might be used if you are close enough to shore, or within 200 or so miles of a military vessel with helicopter assets. After your location is determined, the USCG will likely launch a C-130 Hercules aircraft to fly above your location and take on-sight command of the rescue. A USCG C-130 can drop survival gear, linger a long time and provide excellent support services.

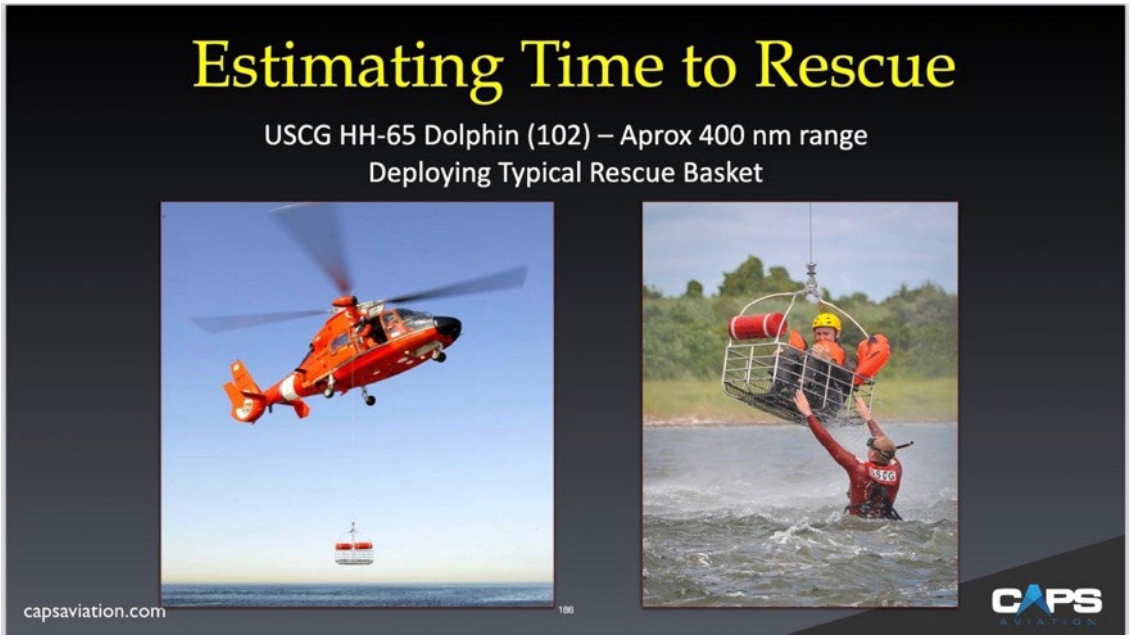


USCG C-130's usually carry rafts and survival gear that can be parachuted to aid survivors. A portable radio can also be dropped to establish communications with SAR forces. Note the picture (L to R): a USCG Aviation Survival Technician (AST – aka Rescue Swimmer) unfurling a message streamer; rafts and survival gear; droppable containers with a radio and high-speed pump. The bottom image shows a C-130 dropping a streamer.

Rescue Pickup Devices

There are many rescue pick-up devices used by military, government, and civilian agencies. However, the USCG will normally only use the Rescue Basket for civilian pickups (pictured below) since it is relatively easy to get into and can handle a very large person or an adult with a small child.

Rescue devices under a helicopter can generate static electricity. To be safe, it is best to let any device contact the ground or water before touching it.



PIC & SAR

With current and future flight following (time, latitude, longitude, and altitude) instrumentation, ELTS, SARSAT, Military Assets, and other distress tools, it is making it relatively easy to find an aircraft in distress, anywhere in the world. Once located, a very sophisticated and efficient SAR system is deployed, made up of thousands of dedicated and trained professionals and volunteers. The PIC responsibility, of course, is to:

1. Recognize and react to a serious emergency ASAP
2. Signal rescue forces using your radios, ELT, and other resources
3. Prepare the crew and aircraft for a fast and successful evacuation
4. Land the plane successfully on land or water employing solid crash physics
5. Evacuate everyone safely from the aircraft with as much of the survival gear as possible
6. Insure everyone's survival using the proven survival techniques discussed earlier
7. Facilitate a successful rescue

A review of the various Modules in this handout will remind you of the specific information needed to accomplish each of these goals.

Module 10 – Aviation Physiology - Hypoxia

Introduction

The FAA defines high altitude ops as any operation above 25,000 feet above mean sea level or any speeds at Mach numbers greater than .75. After defining this operational regime, FAR 135.331 and AC 61-107B describe the required ground training and general knowledge required for pilots to obtain and maintain certification to legally fly in these regimes.

The required subject matter includes:

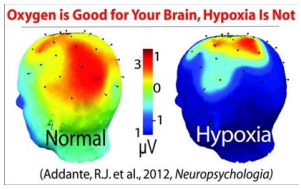
- Human O2 Requirements, Human Physiology of Respiration, Oxygen Use and Hypoxia
- Environmental Characteristics at Altitude
- Duration of Consciousness Without Supplemental Oxygen
  - Effective Performance Time (EPT)
  - Time of Useful Consciousness (TUC)
- Decompression, Gas Expansion, and Gas Bubble Formation
- Physical Phenomena & Actual Physiological Incidents

As discussed an adequate supply of oxygen to the brain is critical to safe flight, therefore the FAA maintains specific requirements when a crew member must use supplemental oxygen - FAR 135.89 (Pilot requirements: Use of oxygen) and FAR 91.211 (Supplemental oxygen). Checkout the FAA's brochure: Oxygen Equipment Use in General Aviation Operations for a detailed discussion on oxygen equipment.

Unit 1: Human Oxygen Requirements

Earth's atmosphere contains approximately 21 percent Oxygen, 78 percent Nitrogen and 1 percent other inert gasses. The oxygen we consume fuels the chemical reactions driving almost all cellular function within the body. Interestingly, we exhale about 15% oxygen with every breath.

The composition of the atmosphere changes little with altitude. The higher an aircraft travels, the lower the atmospheric pressure around that aircraft, and in practical terms, this means that more distance separates each gas molecule. This, in turn, means at higher altitudes it takes more volume of air (breaths) to get the same amount of oxygen into your bloodstream via the lungs. Amazingly, as an aircraft climbs through 10,000 ft MSL, one third of the atmosphere (and pressure) lies below it. Climbing through 18,000 ft MSL an aircraft leaves half the atmospheric pressure below it, and an aviator's lungs need to work twice as hard to deliver the same O2. At 62 miles (1000 kilometers up), considered the Karman Line, measurable atmosphere vanishes completely as we enter space.



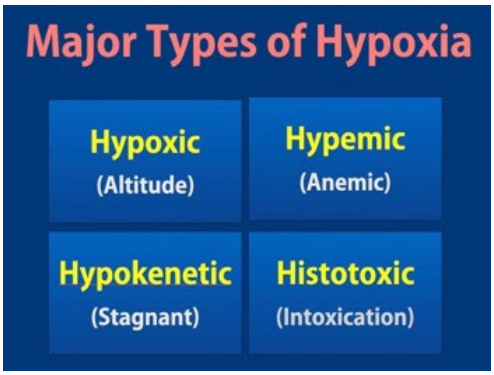
Humans need Oxygen to function, but the brain and the eyes feel any reduction in available oxygen first. At 12,000 ft MSL human performance can easily drop to 87% of normal. Additionally, certain activities (like smoking) even further reduce the body's tolerance for lack of oxygen. The FAA conducted research in 1997 on the effects of smoking on hypoxia in aviation. They determined that smoking a pack of cigarettes everyday increases a pilot's effective altitude by at least 5,000 ft. More specifically, this means a smoker flying unpressurized at 6,000 ft MSL feels the effects of a non-smoker flying at 10,000 ft MSL.

Hypoxia

Medical professionals call a lack of adequate oxygen in the body's cells and tissues Hypoxia. This inadequate oxygen supply divides further into four distinct subsets of Hypoxia based on the cause. As a reminder, AC 61-107B (Aircraft Operations at Altitudes Above 25,000 Feet Mean Sea Level or Mach Numbers Greater Than .75), details and builds on the information covered here.

One "hypoxia" exercise we suggest trying annually: After an hour of flight at 6000 feet or higher at night, place an oxygen mask with 100% oxygen flowing against your face. After a few breaths your eyes will recover from a lack of oxygen, making the dash bright and colorful again. Invite cabin attendants to do the same. It shows the effects a lack of oxygen causes on your eyesight, even at relatively low altitudes. Checkout the FAA's Hypoxia brochure for additional information.

Types of Hypoxia



Though several types of Hypoxia exist, these four present the most common types faced by aviators:

***Hypoxic* Hypoxia**, also commonly called *Altitude* Hypoxia, comes from the reduced partial pressure of oxygen in the atmosphere, as one climbs higher in altitude into "thinner air."

***Hypemic* Hypoxia**, also called *Anemic* Hypoxia, occurs when conditions affect the oxygen carrying capacity of the blood. This type commonly stems from breathing carbon monoxide, poor nutrition, and some drugs which react chemically and bond with hemoglobin, which normally carries the oxygen. Carbon monoxide (CO) is a particular concern for people flying piston driven aircraft. CO is 240 times more efficient at connecting to the body's hemoglobin as oxygen.

***Hypokinetic* Hypoxia**, also called *Stagnant* Hypoxia, refers to a circulatory problem or impediment to the circulation of the blood to the body's tissues such as during heart failure. Also, pilots and crewmembers involved in high performance aircraft sometimes experience a pooling of the blood in the extremities (away from the brain) under high "G" maneuvers.

***Histotoxic* Hypoxia**, commonly called *Intoxication*, occurs when conditions interfere with the body tissues absorbing the oxygen delivered to the cells by the blood stream. Alcohol, narcotics, and certain poisons all affect the cells in the body/brain in this way.

The FAA's Larry Boshers wrote an excellent summary about hypoxia called Beware of Hypoxia.

Signs and Symptoms of Hypoxia - Case Study – Kalitta 66, July 26, 2008, Learjet 25 Cargo, FL 320

The Kalitta 66 audio clip below illustrates what hypoxia sounds like in this affected pilot. Notice the slurred speech and difficulty communicating exhibited by the Pilot in Command. The aviator almost sounds drunk and shows the impairment in function and awareness created by the lack of oxygen to his brain. An altitude audio warning horn can be heard as well.

Listen to a YouTube audio narrative of the incident here - Kalitta 66 July 26, 2008. Learjet 25 Cargo. Notice the lack of capability to solve the problem. The pilot describes in detail what he can't do, without understanding the necessity of putting on an oxygen mask, without the help of others.

Reactions to Hypoxia

Every aviator reacts in a unique way to hypoxia. Each of us show our own set of signs and feel a unique set of symptoms. Pay close attention inflight to yourself, and your fellow crewmembers. Look for:

- Impaired judgement and coordination (out of the ordinary)
- Increased heart rate and labored breathing
- Possible flushing in the face
- Unusual sensations like numbness, tingling, and coldness in the extremities
- Cyanosis (bluing) in the fingers (nailbeds) and lips
- Slurred speech, euphoria, or trouble concentrating

When something seems out of place or not quite right, take protective action immediately (100% oxygen) and then ask questions.

Hypoxia Training Options

Take every opportunity for hypoxia training when available. The FAA offers free altitude chamber training at their facility, the Civil Aerospace Medical Institute (CAMI), in Oklahoma City. Additionally, devices like the Reduced Oxygen Breathing Devices (ROBD) and the FAA's Portable Reduced Oxygen Training Enclosure (PROTE) deploy at several locations each year. Each of these training tools give aviators an opportunity to experience hypoxia and recognize their own unique signs and symptoms. In all cases where you experience hypoxia inflight, use 100% oxygen immediately and descend to an altitude below 10,000 feet.

Decompression Descriptions

Three types of decompressions describe the way an aircraft loses pressurization: explosive, rapid, and slow. An additional concern results from "failing to pressurize" an aircraft. This situation describes one of the most insidious and dangerous inflight emergencies, simply because aviators often miss the early signs.

Explosive Decompression – Case Study - Aloha Airlines Flt 243, Boeing 737, April 28, 1988

Explosive decompression involves an extremely violent reduction in pressure, often occurring in less than 1 second, making it difficult to safely let rapidly expanding air escape the lungs. Fortunately, this type of incident rarely ever occurs! The most famous example being an Aloha Airline's 737 on April 28th, 1988, at FL 240 on a routine inter-island flight. Excessive metal fatigue in the fuselage over time, caused a large section of the cabin roof to depart the aircraft, exposing the 89 passengers and 6 crewmembers to outside conditions inflight. Thirteen minutes after the explosive decompression, the aircraft landed safely on the island of Maui. One crewmember (a flight attendant) was killed when the force of the depressurization pushed her from the aircraft, along with the roof of the cabin. Wikipedia coverage here. NTSB report here.

Rapid decompression

A rapid decompression also occurs quickly but allows the lungs time to safely vent. These types of incidents also happen very rarely, but like the explosive decompression described above, leave very little question as to the nature of the issue. Interestingly, *Business and Commercial Aviation* magazine found in 2013, that only two business jet explosive decompression incidents occurred in the previous 50 years.

Slow or Gradual Decompression or a Failure to Pressurize

The slow or gradual decompression, or even a failure to pressurize at all, presents a more insidious problem for aircrew and passengers. This issue occurs much more frequently, and the first indication may include hypoxia in the crew or passengers.

Case Study - Payne Stewart, October 25, 1999

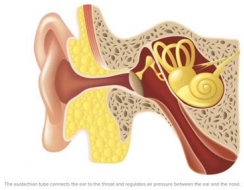
In a relatively famous example of how a **failure to pressurize** an aircraft leads to a tragic result, take the Learjet 35 chartered by professional golfer Payne Stewart. According to the NTSB, ATC lost all communication with the crew within 14 minutes after takeoff from Orlando, Florida. The aircraft continued a straight path for approximately 4 hours, covering approximately 1,500 miles before running out of fuel and crashing near Aberdeen, South Dakota. Three sets of fighter aircraft intercepted the Lear to make sure it posed no threat to civillian or military installations.

The NTSB determined the probable cause of this accident was incapacitation of the flight crewmembers because they failed to receive supplemental oxygen following a loss of cabin pressurization, for undetermined reasons.
Read the full NTSB report on the incident here. Wikipedia page here.

Case Study - Helios Airways Flt 522, August 14, 2005

Helios 522 provides a classic example of a failure of the flight crew to make sure the aircraft pressurized normally in flight. This accident is the worst aviation disaster in Greek history. It also stands as the most discussed preventable example of "hypoxia" which, unfortunately, resulted in the deaths of 121 people, including 5 flight crew. After a pressurization check in Cyprus, the maintenance crew failed to set the Boeing 737 – 300 aircraft to automatically pressurize. It also went unnoticed by the flight crew during walkaround inspections. This oversight, along with the flight deck crew's failure to recognize the aircraft failure to pressurize on climb-out, resulted in a tragic outcome. One flight attendant, with a modest amount of flying experience and supported by a walkaround oxygen bottle, tried to fly the aircraft after the flight deck crew was incapacitated, but ultimately proved unsuccessful. He likely remained the only person conscious when the aircraft ran out of fuel 33 km from Athens International Airport. View the very detailed official report by the Hellenic Republic Ministry of Transport & Communications Air Accident Investigation & Aviation Safety Board found here. Find *a summary article in Alchetron – Updated on November 19, 2022.*

Decompression Issues – Trapped Gases (Gas Bubble Expansion)

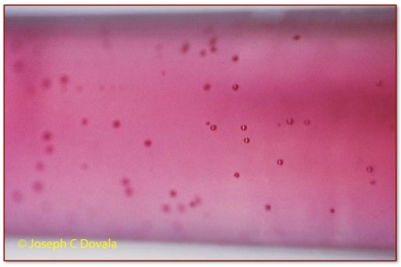


Trapped gasses often rapidly expand in volume, causing a sense of fullness, pressure and sometimes even pain. Commonly, the areas of the body prone to trapped gasses include the ear canals (inside the ear drum), sinus cavities, the gastro-intestinal tract (primarily the abdomen) and surprisingly, sometimes teeth (cavities etc.).

Techniques to relieve the discomfort for the ears and sinuses include Valsalva and rapid jaw movement. The best method for equalizing pressure is by rapid jaw movement. If not, try to accomplish a Valsalva. Pinch the nose shut, close the mouth and forcefully exhale against the closed nose and mouth (without letting any air escape).

Avoid using over the counter medications to treat sinus congestion symptoms before flight, medications such as nasal spray and other decongestants tend to temporarily mask symptoms, leading to potential discomfort later, if not a full-blown physiological incident or trapped gas scenario inflight.

Decompression Issues – Evolved Gases (Gas Bubble Formation)



After trapped gas, a potential problem from rapid pressure changes comes from a condition called decompression sickness, also commonly called *the bends*. Given the high concentrations of Nitrogen in the atmosphere (78%), some of that Nitrogen dissolves into the blood through the lungs. Under normal atmospheric pressures, that Nitrogen stays dissolved and circulates harmlessly throughout the blood stream. However, when the surrounding pressure drops rapidly, dissolved Nitrogen sometimes spontaneously forms small gas bubbles, which then circulate and sometimes cause obstructions in the small arteries and capillaries throughout the body's tissues. This gas bubble formation mimics what happens in a carbonated beverage when someone pops the seal on an aluminum can or unscrews the sealed cap of a plastic carbonated beverage container. When the pressure drops, the bubbles come out of the solution and rise in the liquid.

The negative effects of this process in the body vary from shortness of breath, dizziness, seeing spots/flashes, headaches and as cases increase in severity, sometimes pain in the large joints and even the lungs. Treatment requires a return to a pressurized environment (usually a hyperbaric chamber at a hospital) to force the bubbles back into dissolved form in the blood stream, while breathing 100% oxygen to get rid of the Nitrogen.

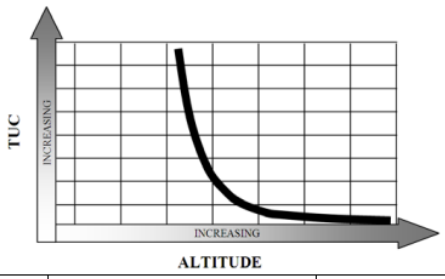
Decompression sickness rarely occurs in corporate aviation but presents a much more common problem for SCUBA (Self-Contained Underwater Breathing Apparatus) divers, since they breath compressed air under water. To avoid complications, allow at least 24 hours to pass between diving (breathing compressed air) and flying on a pressurized aircraft. Pass this information to your passengers as well, to avoid the same issues with them.

Time of Useful Consciousness (TUC) and Effective Performance Time (EPT)

In 2015 the FAA, in conjunction with the NTSB, published the most recent changes to Advisory Circular 61-107B on Operations above 25,000 ft MSL and at Mach numbers above .75. The latest change specifically defined the terms TUC and EPT (interchangeably) as "The period of time from interruption of the oxygen supply, or exposure to an oxygen-poor environment, to the time when an individual is no longer capable of taking proper corrective and protective action."

The following chart from the Advisory Circular illustrates the decreasing TUC with increasing altitude. These values represent averages and real-world values may be different (even shorter) based upon the specifics of the situation and individual physiology! Rates of ascent, activity, physical fitness, health, illness, diet, rest, smoking, medications, alcohol, and drugs all have an effect as well.

FIGURE 2-3. TIMES OF USEFUL CONSCIOUSNESS VERSUS ALTITUDE



ALTITUDE	TUC/EPT	Following Rapid Decompression
18,000	20–30 min	10–15 min
22,000	10 min	5–6 min
25,000	3–5 min	1.5–2.5 min
28,000	2.5–3 min	1–1.5 min
30,000	1–2 min	30 s–1 min
35,000	30 s–1 min	15–30 s
40,000	15–20 s	Nominal
43,000	9–12 s	Nominal
50,000	9–12 s	Nominal

Summary Thoughts

1. Review Module 3 and the links at the beginning of this Module for the specific altitudes when oxygen masks are required for part 91 and 135 operations.
2. Your oxygen mask serves as an important tool in the event of an emergency. Practice putting your O2 mask on in 5 seconds or less and your O2 mask and goggles on in 15 seconds or less. See the FAA Brochure Oxygen Equipment.
3. If you notice a strange smell or something doesn't seem right, put your mask on and breathe 100% oxygen, then troubleshoot.
4. Seek out hypoxia training for yourself and other crewmembers.

Further Information

FAA – Aeronautical Information Manual – Chapter 8 Medical Facts for Pilots – Section 1 Fitness for Flight, 8-1-2 Effects of Altitude
AOPA October 18, 2014, Article and Video – Hypoxia: Insidious Emergency
CFI Notebook - Aeromedical and Human Factors - Hypoxia
FAA – Altitude Induced Decompression Sickness Brochure

Module 11 – Inflight Medical Issues

Introduction

This section is intended to help aircrews identify life-threatening emergencies and then, if appropriate, transport the passenger to more advanced medical help. As a reminder, this section does not replace recognized first aid or medical training. The FAA maintains a section covering several medical issues in the Aeronautical Information Manual under Medical Facts for Pilots, Section 1 - Fitness for Flight 8-1-1.

First Aid Kits, Medical Kits & AEDs

Part 91 (FAR 91.513 Emergency Equipment) requires the carriage of several pieces of emergency equipment onboard any aircraft. This list includes a first aid kit, with equipment suitable to handle the types of injuries likely to occur inflight, or in other minor accidents. This Part 91 requirement stands, regardless of numbers of seats on the aircraft. Within Part 135 operations, (Part 135.117 Emergency equipment requirements for aircraft having a passenger seating configuration of more than 19 passengers) requires a specific set of first aid equipment on all aircraft.

Asking to Help

Many countries create Good Samaritan Laws that allow people to provide aid to someone in need without fear of lawsuits. First, ask the person for permission to help them. Tell them about your training in first aid. If the patient fails to respond, the medical emergency itself implies they want your help.

PPE (Personal Protective Equipment)

First responders rarely catch diseases when providing aid to someone. However, almost all medical training emphasizes the need to use appropriate personal protection from potential blood borne or body fluid pathogens. Personal Protective Equipment (PPE) often includes protective gloves, goggles, a mask, and a barrier for giving rescue breaths, etc. Consider gloves and CPR barriers as minimum PPE for aviators.

As stressed in Blood Borne Pathogens programs, remember the acronym P.A.C.T.: **Protect** yourself; **Act** to help; **Clean** up; and **Tell** someone (i.e. make a report to the appropriate authority as soon as practical). For more information see Bloodborne Pathogens and Needlestick Prevention from the US Department of Labor's OSHA and the American Heart Association.

First Aid Training

Regular First Aid, CPR and AED training serve as the best tools for immediately reacting to a medical emergency. Obviously, we highly recommended taking basic first aid, CPR (Cardiopulmonary Resuscitation) and AED (Automated External Defibrillator) training. Your local American Heart Association, American Red Cross, commercial vendors, government agencies, and other educators offer several excellent programs. Certification typically last for two years.

Part 121 emphasizes FAA AC 121-34B (Emergency Medical Equipment Training) the importance of cabin crew renewing their first aid training every two years.

Utility Drawer

We suggest designating a utility drawer for common expendable supplies and the over-the-counter medications you decide to carry e.g., Band-Aids, pain medications, antihistamines, motion sickness relief, Narcan (opioid drug overdoses), medical gloves, a CPR barrier, etc. This makes for easier access and helps keep your first aid kit intact and ready.

First Aid Kits

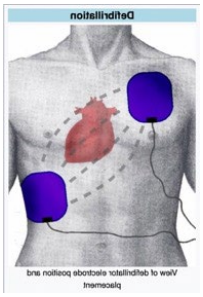
Regardless of your skill and experience, placing a priority on learning more about first aid and practicing or training regularly will pay dividends in any emergency requiring medical skills. Note the location of the first aid kit on each aircraft; often, you will find it in a closet, behind cargo netting, in a drawer or even under a divan. Before flight, check the physical integrity of the kit and inspect it for contamination, expiration dates, missing supplies, etc. We suggest placing the first aid kit in a secure but readily accessible location and letting everyone know (passengers included) where to find it.

Subscription Medical Kits

Another option provides a well-quipped medical kit, with a paid service allowing clients to call an on-call medical practitioner for permission and guidance in using the kit contents. In some cases, these kits and services enable the use of prescription level medications and even techniques requiring medical supervision. Medaire, for instance, provides a very popular service to corporate aviation. We also suggest encouraging all crewmembers to make a practice call to your chosen service provider, to gain familiarity with the exact process on your aircraft.

Automated External Defibrillator (AED)

An Automated External Defibrillator (AED) serves as an easy to use, self-contained, quick and efficient potential life-saving device for certain types of life-threatening irregular heartbeats. AEDs now commonly appear on corporate aircraft and are required on most FAR 121 operations FAA AC 121-33B (Emergency Medical Equipment).



These machines quickly analyze the electrical activity of the heart, searching for a particular abnormal heart rhythm, indicating the heart may respond to an electric shock and re-establish normal heart activity. Interestingly, an AED does not shock a stopped heart.

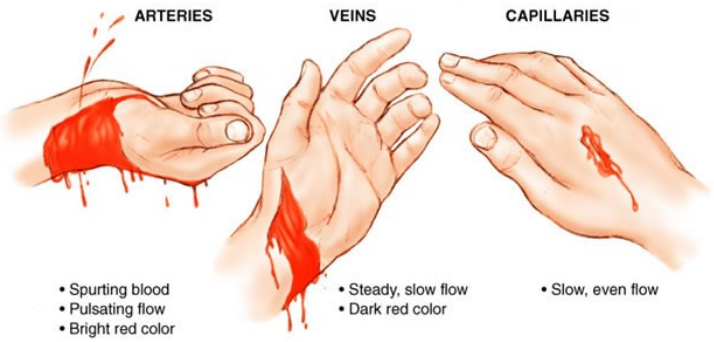
The user simply powers on the device, attaches the device's pads, and applies the pads as pictured to a naked chest. Then, you simply follow the verbal instructions given by the machine. Basically, the AED directs a responder's actions. Make sure all flight crewmembers know the AED location, how to turn it on, how to connect the pads, and where to place them on the patient.

Serious Medical Issues Inflight

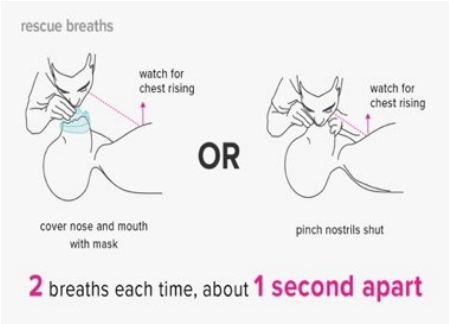
Very few flights face life and death medical emergencies. However, certain emergencies need immediate recognition and actions taken to get that person to competent help. If in doubt about the outcome for a passenger (or crewmember) in distress, get the aircraft on the ground and to an appropriate facility as quickly as possible.

Bleeding

Though rare on flights, most bleeding stops by covering the wound and placing direct pressure on the area for a few minutes. If blood comes through the cloth or dressing, put more material and pressure over the wound. Most first aid kits have plenty of material intended to control bleeding. However, with severe bleeding and spurting bright red blood, use a tourniquet to control the bleeding. More information can be found here: Mayo Clinic & Stop the Bleed.



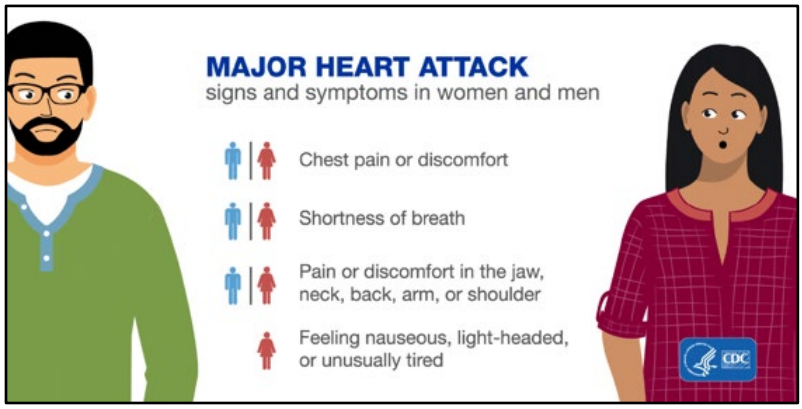
Breathing



If a person stops breathing for any reason, brain damage often begins in as little as 3 or 4 minutes. Permanent brain damage in 4 or 5. And death soon after. Even though parts of your body might survive for up to an hour without oxygen, your brain cells simply need oxygen much more quickly to survive. So, immediately begin breathing for an individual who stops breathing. Quick action, even by an uncomfortable bystander, provides a life-saving opportunity. Just extend the neck, plug the nose, and breathe into the person's mouth for about one second.

Heart attack (Reduced Supply of Blood to the Heart)

Heart attacks often start with a blockage in an artery supplying blood to part of the heart muscle itself. This condition also sometimes causes significant apprehension and pain. If serious enough, these blockages sometimes lead to cardiogenic shock, meaning an insufficient amount of blood (oxygen) flowing to the body's cells.



The Mayo Clinic defines cardiogenic shock as a life-threatening condition in which your heart suddenly can't pump enough blood to meet your body's needs. The condition is most often caused by a severe heart attack, but not everyone who has a heart attack has cardiogenic shock.

The chemicals in Aspirin (acetylsalicylic acid - chewable 150 to 325 mg) provide an effective initial treatment for most heart attacks. They rapidly dissolve into the blood stream helping to break down or dissolve the *clotting agents* contained in the blood stream. A heart attack presents a life-threatening emergency, even if the Aspirin relieves all or part of the symptoms. Always consider this a serious emergency and get the passenger to medical help as quickly as possible.

Some patients already suffer from other conditions where aspirin might complicate their situation, especially those taking blood thinners. Always ask the passenger about allergies to aspirin, if their doctor told them not to take aspirin, or if they take blood-thinners. If so, steer clear of aspirin.

Sudden Cardiac Arrest (Stopped Heart)

According to the Sudden Cardiac Arrest Foundation, over 350,000 people die from out-of-hospital cardiac arrests in the United States every year, with 70% occurring in people's homes. Since too few citizens pursue training in CPR (Cardiopulmonary resuscitation) or simply avoid getting involved, too many die unnecessarily.

Even without formal training, which we always encourage, the effort of simply trying sometimes saves a life. For instance, the AHA's info on Hands-Only CPR (more here) provides an effective response in many cases.

Every five years, the AHA, ARC, and their European equivalents review the science surrounding CPR, AED use, and first aid. After extensive collaboration, they incorporate any warranted changes for more effective emergency care.

The following form the current steps from the AHA, for giving CPR to an unresponsive person:

1. Make sure the scene is safe – you want to go home at the end of the day.
2. Check to see if they are responsive - ask them if they are okay as you pinch their ears, tap their shoulder, or rub their chest's sternum.
3. If no response, activate EMS (Emergency Medical Services). If someone is there to help, direct a bystander to call 911 (or their country's emergency number) and find an AED. Ideally, ask them to call on a cell phone and place it next to you while you work on the victim. If translation is needed, ask them to stay with you.
4. After sending someone to activate EMS and get an AED, take another look at the victim for 5 seconds, but no more than 10 seconds, to see if any breathing or movement exists.
5. If no movement, remove the clothing from the victim's chest so an AED can be attached to bare skin.
6. Then:
    a. Make sure they are on a hard surface like a floor.
    b. Place your hand on the lower third of the chest – likely between the nipple line.
    c. Press down at least 2 inches to empty the heart.
    d. Let your hand come all the way back up so the heart can refill with blood.
    e. Compress the chest 30 times at a rate of 100 to 120 times a minute, or about twice a second.
    f. After 30 compressions, lift the chin up to extend the neck and give two breathes.
    g. Then continue to repeat 30 compressions and 2 breaths until the AED arrives.
    h. Once the AED arrives, use it immediately – ideally ask the person who brought it to open it, turn it on, connect the pads, then place the pads on the victim as you continue compressions and breaths. Remember, don't stop giving compressions if possible.
    i. Keep giving compressions and breaths until the AED tells you to stop, giving it a chance to assess whether a shock is advisable. While assessing, make sure no one is touching the patient, so the AED reads only the victim's heart signals.
    j. Once the AED begins giving instructions, follow them.
    k. If the AED determines the person has a shockable rhythm, it will tell you that. Then instruct everyone to stay back so the shock doesn't get diluted.
    l. Once the shock is delivered, or if a shock isn't advised, the AED will tell you it is okay to begin CPR.
    m. Usually after five sets of 30 and 2, the AED will likely tell you to stay back as it checks if a shock is warranted.
    n. If someone is capable of helping you, switch giving CPR with them after every five sets of compressions and breaths, which takes about two minutes.
    o. Most hearts don't start beating again without the use of an AED. However, victims of drownings, lightning strikes and electrocutions might.

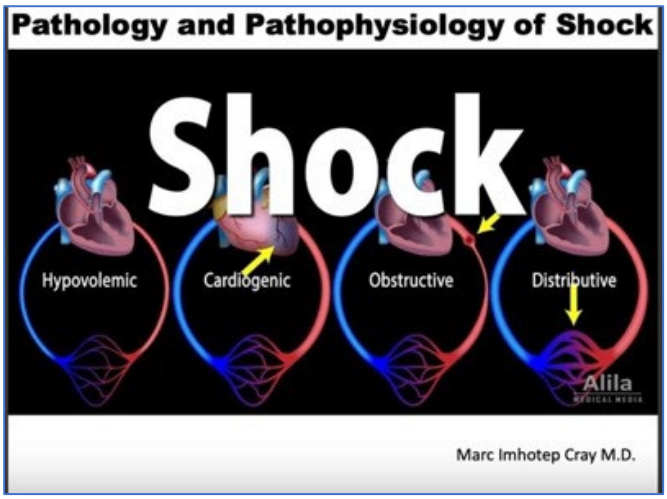
7. It is okay to stop performing CPR when you get tired, the victim responds, you are relieved by a capable rescuer, or a medical authority pronounces them dead.

As mentioned, these general instructions can't replace competent training, especially when using a manikin for practice. The AHA and ARC both offer training in First Aid, CPR and AED use and provide two-year certifications.

1. The American Heart Association
2. The American Red Cross
3. CPR instructions from the Mayo Clinic
4. WebMD offers additional background information here

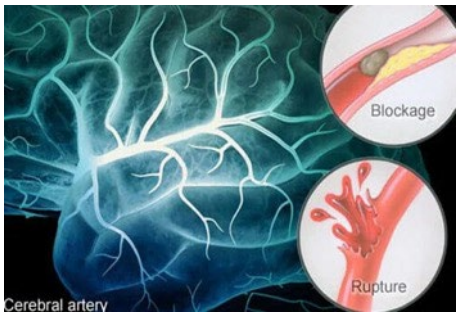
Shock

The Mayo Clinic offers this concise definition: *Shock is a critical condition brought on by the sudden drop in blood flow through the body. Shock may result from trauma, heatstroke, blood loss, an allergic reaction, severe infection, poisoning, severe burns, or other causes. When a person is in shock, his or her organs aren't getting enough blood or oxygen. If untreated, this can lead to permanent organ damage or even death.*



Suffering a heart attack, sustaining a serious injury causing excessive external or internal bleeding, or losing too many fluids because of vomiting, sweating heavily, or diarrhea happens only rarely during fight. If something like this occurs, treat the victim with your available resources and get help from others. Since shock presents the possibility of a life and death emergency, get the aircraft on the ground, to competent medical help, as soon as possible.

Stroke



Doctors call a sudden interruption to the blood supply of the brain (often leading to permanent damage), a stroke. With rapid intervention medical responders often employ an array of drugs capable of treating the interrupted blood flow and restoring normal function, but only if employed relatively quickly. If you suspect a stroke, get the patient on the ground and into the hands of medical professionals as soon as possible.

In 1998 medical professionals introduced the Acronym F.A.S.T. in the UK. Since then, the American Stroke Association and the American Heart Association, among others, use the acronym to increase public stroke awareness and proper response.

Look for the signs of a stroke:

- Face – one side of the face is drooping
- Arms – arm weakness, on one side or the other
- Speech – difficulty speaking or slurring of words
- Time – call an ambulance as soon as possible (immediately!)

Allergies and Anaphylaxis (Serious Allergic Reaction)

A severe reaction to an insect bite/sting or even an unexpected food allergy may rapidly affect the victim's ability to breathe, as the soft tissues of the throat swell inside the relatively rigid trachea (windpipe).

People with known allergies often carry a medication called epinephrine (Epi-Pens) with them. Ask passengers if they carry one and then assist them to administer it, if needed. As mentioned earlier, some subscription medical kits offer medical advice from on-duty medical professionals. Theses kits (e.g., MedAire) will often contain Epi-Pens as well, which can be administered by the cabin crew under the on-call physician's direction. A small percentage of people might need a second injection if improvement doesn't come within a few minutes.

Over the counter diphenhydramine (Benadryl) also effectively treats allergic reactions. However, keep in mind that oral medications like Benadryl take from 15 to 20 minutes after ingestion to become fully effective. In the meantime, try to keep the passenger calm and remind them to breathe slowly and as deeply as possible.

WebMD maintains an interesting video and information here.

Drug Overdose

The Opioid epidemic continues to rage across the Americas. So, depending upon the passenger, aircrew sometimes face a potential for encountering an overdose. Consider this high-profile example. In the month leading up to his death from an opiate overdose, the singer Prince was taken to a hospital after an emergency landing when he became unresponsive mid-flight on a charter aircraft. He was successfully treated with Narcan (the drug Naloxone) and recovered. However, he died of an additional and unrelated overdose 6 days later.

Currently, the United States are seeing well over 110,000 deaths a year from drug overdoses. Commonly available opiates include the brand named Oxycontin, Vicodin, Percocet, and Codeine. Unfortunately, many of these types of drugs find their way into users' hands for the purpose of recreation, and therefore potentially in the hands of your passengers. These drugs also include Heroin and its synthetic derivatives Fentanyl (50 times stronger than heroin).

In the case of an Opioid overdose onboard, Naloxone (branded Narcan and Evzio) serves as the emergency treatment of choice. The individual nasal spray pack contains the correct dose, easily administered by a lay person. A few people may need a second dose, so monitor them carefully.

Diabetic Issues

Controlling medical issues for all diabetics is all about blood sugar levels. Either too much sugar or not enough often creates serious problems. Diabetics usually monitor their glucose levels carefully. If something seems off, ask them, or those that know them, about their condition. If a person needs sugar and remain conscious, give them sugary drinks, not zero calorie sodas. Orange juice is great, as with sugary foods. Eating something with sugar also easily takes the crankiness out of someone suffering from low blood sugar (hypoglycemia). The America Heart Association, Mayo Clinic, and many others provide helpful information about handling diabetic emergencies.

Other Medical Issues

Other medical issues sometimes also require quick attention by flight crew members. The following rarely turn out as life-threatening, but some eventually grow serious enough to require getting the person to medical help as soon as possible. If in doubt about the potential outcome of a situation, get the aircraft on the ground ASAP.

Motion Sickness

For passengers who suffer motion sickness, Dramamine or other brand anti-nausea medications offer a relatively safe way to calm the stomach. The drug takes approximately 20 to 30 minutes to become effective when taken orally and generally needs administration prior to feelings of nausea to work well. We also recommend taking these meds 20 to 30 min prior to a planned ditching to help alleviate nausea in a post-ditching life raft scenario. In fact, many life raft survival kits contain motion sickness pills as well.

Pregnancy

Births and the birthing process remain a normal part of human existence since we first walked the earth. However, the odds of a passenger giving birth on any flight are exceedingly rare, even during late term pregnancies. With a premature birth, more complications occasionally occur. So, the more professional medical advice you can access, will benefit the baby's long-term survival. If you allow a pregnant person to fly in the very late stages of pregnancy (your company likely maintains a policy), and she goes into labor, the birth will usually end up normal.

If are faced with an inflight birth, the following tips will help:

1. Remain calm for everyone's comfort.
2. Contact outside help if available – passengers, paid medical service, local 911 operators, your ops center, etc.
3. Locate the most comfortable place possible for the expectant mother and soon-to-arrive baby
4. Put a blanket under the mother where the birth is going to happen.
5. Prepare a wrap for the newborn as well.
6. Help, but let nature take its course.

Two interesting resources: The New York Times – How to Deliver a Baby (April 29, 2016). The Flight Safety Foundation published an excellent, detailed article in May 2009 - Special Delivery (Expanded Version).

Broken Bones

Intensifying weather events, turbulence, lifting heavy bags, falling luggage, tripping, etc. usually categorize as not serious events. However, if an accident leads to a serious injury or even broken bones, discomfort for the injured will likely continue until the person reaches medical care. If someone breaks a bone or bones, try to avoid causing more harm, especially if you suspect a neck or spinal injury. Immobilize the affected area as much as possible to minimize pain and further damage. The Mayo Clinic provides a summary of helpful actions.

Psychological Balancing Act

The survival story of Gary Anderson (Module 8 - pictured here) represents a case in handling tough mental issues. When asked by one of our students how he dealt with the disappearance of his father in the Alsek River, Gary said he decided to mentally avoid the subject during his survival situation. Instead, he successfully "compartmentalized" the fate of his father until after rescue and his return home. He said it would have been much harder to concentrate on staying alive while contemplating his father's likely death.

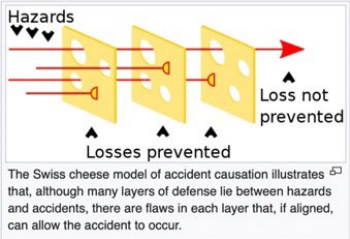
Dealing with serious personal and family issues remains a tough problem. If these issues overwhelm a crewmember, avoid flying for the safety of your passengers and crew until developing a better mental state.

Self-Imposed Crew Stress

As discussed, conflicts at home, financial difficulty, marital issues, job challenges, legal issues, and extended flying schedules create a complicated web of opposing influences aircrew need to navigate, while still completing crew duties. While flying, aviators should "compartmentalize" their personal issues - keeping them in perspective and/or tucking away for later consideration. But at some point enough distractions will overwhelm anyone.

Next comes minor illnesses like a cold or the seasonal flu, combine these with maintenance delays, dehydration, extended duty hours and a poor night's sleep, and a situation might easily spiral out of control. None of these issues usually cause an accident by themselves, but they add up in a long list of contributory links that U.S. Air Force accident investigators often call an *accident chain of events*.

Accident Cycle



The Swiss cheese model of accident causation illustrates that, although many layers of defense lie between hazards and accidents, there are flaws in each layer that, if aligned, can allow the accident to occur.

This chain of events, also referred to as the Swiss Cheese Model of accident causation illustrates that, although many layers of defense lie between hazards and accidents, if the flaws in each layer align, it allows the accident to occur. The University of Manchester forwarded this model decades ago, but not without some controversy.

Regardless of how we visualize the chain of events leading to an accident, we want to identify these links as early as possible and break the chain before they all work together to cause an accident or worse.

Remember situational awareness and CRM – the more eyes watching for potential problems, the more likely you will be able to break the chain before a catastrophic event occurs.

Over the Counter (OTC) Medications

In 2011 the FAA toxicology lab conducted a study and found that 570 pilots (42%) of 1,353 aviation fatalities tested positive for drugs/medications of some sort in their bloodstream at the time of an aviation incident. The most common medications found consist of sedatives used generally for antihistamine purposes. The FAA's CAMI lab compiled a "Do not Fly" list of Over The Counter medications with the helpful moniker *unaware of impair* effect of the medication. OTC medications also interact unexpectedly with each other and with prescription medications. When combined these medications sometimes generate side effects and behave differently than intended, not to mention how they react with illicit drugs or alcohol.

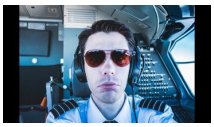
According to the FAA avoid flying while using:

- Allergy medications & sleep aids
- Muscle relaxants & OTC dietary supplements (diet pills)
- Pain medications & Pre-medication or pre-procedure drugs
- Any OTC drug with a warning label "May cause drowsiness" or "Be careful when driving a motor vehicle or operating heavy machinery"

As a rule, the FAA recommends waiting a certain period for the *impair* effect to wear off after taking any of the above OTC medications. To calculate the wait time, read the directions for use and then multiply the maximum dose interval by 5. For example: if the directions state "take two pills every 4 to 6 hrs.," the maximum dose interval is 6 hrs. Multiply that interval by 5 and our general rule states a pilot should wait 30 hrs. after taking the medication before a flight.

FAA - What Over-the-Counter (OTC) medications can I take and still be safe to fly?
FAA Info - Over-the-Counter (OTC) Medication (Updated June 28, 2023)
FAA Brochure – Medications and Flying
Flight Med website - Benadryl and Flying: A Deadly Cocktail

Colds, Flu, and Illness

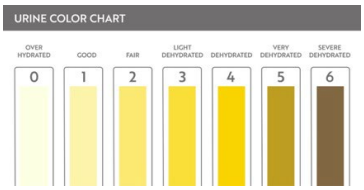


Sick Pilot - Flying Witha Cold

Remember how you felt the last time you came down with an illness? Certain colds and other illnesses often impact performance and personal comfort when flying. So, flying healthy usually forms the best approach. Check out the FAA materials listed above (Over the Counter (OTC) Medications) to see if certain medications might help you feel better while performing flight duties when a little under the weather. The best choice, as already mentioned, centers on getting well before flying.

Dehydration

Dehydration (hypohydration) also gives rise to a serious medical issue which easily impacts a pilot's judgement. In fact, all too often dehydration plays a negative role during preventable accidents.



Aviators often practice "tactical dehydration" when they wish to limit the number of trips to the facilities during a flight. When using the toilet presents a hassle, he or she might cut their fluid intake to a less than a healthy level. This, coupled with higher altitudes, dryer air and long flights can cause the body's water level to drop to dangerous levels. So, plan to drink enough water to see clear or light-yellow urine when urinating, a sign of good hydration.

These articles provide interesting hydration details:

1. Here is a very relevant article by the FAA's Roger's Shaw, III - Dehydration and the Pilot
2. The Flight Safety Foundation published Dehydration Presents Unique Risk for Pilots
3. Aviation Medicine published Dry and High – Dehydration causes an insidious degradation of pilot performance that must not be lightly regarded.

Fatigue & Mitigation Strategies

Many organizations continue to study fatigue and its impact on aviation. Knowing how long-flights and back-to-back trips generate fatigue, the link to the accident rate obviously stands out when crews fail to get the required rest. For FAA specific information: browse the webpage devoted to Fatigue Risk Management and an informative brochure called Fatigue in Aviation. See also AC 120-103A (Fatigue Risk Management Systems for Aviation Safety).

The Australian Civil Aviation Safety Authority published an interesting 8-part strategy for mitigating fatigue over time:

1. Plan for at least 7 hours per night of uninterrupted sleep.
2. Use 10-to-15-minute power naps during the day (a nap often allows for another 1-2 hours of alertness).
3. Regular aerobic exercise increases brain function, helps better regulate sleep, and increases alertness.
4. Stay hydrated by drinking at least 2 liters or more of pure water every day. Dehydration results in a significant decreases in physical and cognitive performance.
5. Eat a balanced diet consisting of multiple small meals rather than only once per day.
6. Begin the day with breakfast consisting of protein and complex carbohydrates (rather than simple carbs and sugar).
7. Use caffeine strategically. When used occasionally and in moderation, caffeine helps with alertness but overused it works as a diuretic (causes dehydration) and interferes with sleep cycles.
8. And finally sleep at night rather than in the day, or at least limit exposure to daylight and keep it dark and quiet where you sleep when working a nighttime flight schedule.

Acute Stress Reaction & Hyperventilation

After experiencing a traumatic event, human beings sometimes suffer with what medical professionals refer to as an acute stress reactions (ASR) or acute stress disorder (ASD), commonly called panic or a panic attack.

According to the World Health Organization, the symptoms of an ASR show a typically mixed and changing picture and include an initial state of 'daze' with some constriction of the field of consciousness and narrowing of attention, inability to comprehend stimuli, and disorientation.

In plain terms, the traumatic event sometimes triggers a fight or flight reaction for the survivor, after the fact, causing an increase in breathing, heart rate and adrenalin in the blood stream plus a flushed or sweaty appearance. This increase in physiology without a physical outlet sometimes leads to an over-breathing called *hyperventilation*. This over-breathing reduces CO2 from the bloodstream and may trigger even more discomfort with feelings of not getting enough air, intensifying feelings of panic and even nausea. Left unchecked, someone suffering from ASR and hyperventilation might present a worsening situation and extra burden in a critical situation.

According to Web MD, treat hyperventilation by controlling breathing, purse the lips (like blowing out a candle) and visualize deep and slow breaths, perhaps even holding each breath in for 10 seconds as the sufferer calms down. Visualize breathing into the diaphragm rather than filling the chest. In extreme cases the best method directs a caregiver to ask the victim to mimic the actions of the caregiver while they control their breathing as described above.

Seeking Medical Assistance

In most cases a serious inflight medical emergency requires immediate action for the safety of passengers and crewmembers. That action often takes the form of a precautionary landing, or even a declared emergency. Contact Air Traffic Control (ATC) as soon as possible. ATC personnel provide access to additional resources and usually offer suggestions to help with the situation. Declare the emergency, then request a discreet frequency to help keep the main frequency clear for other traffic. ATC will help by making 911 calls (Wikipedia's list of international emergency numbers here) alerting medical professionals to meet the aircraft at the nearest suitable landing field.

Many commercial aviation operators consider a subscription to an inflight medical service and kits as mentioned. MedAire offers such a kit and subscription service.

Module 12 – Handling Emergency Situations

Introduction

Once an aircraft leaves the ground, aircrew sometimes encounter a wide array of situations not normally expected and rarely experienced during routine flights. Inflight options for how to handle an unusual situation directly affect the safety of everyone on board. With limited options available, the FAA gives wide ranging authority to safeguard the well-being of the passengers, crew, and the aircraft itself. This authority, vested with the PIC, includes almost any reasonable action to safely handle the situation and to land as soon as conditions permit.

PIC Authority and Emergencies Actions

FAR 135.109 (Pilot in command or second in command: Designation required) requires the designation of Pilot in Command and 2nd in command for every flight without exception. As stated before, Part 91.3 (Responsibility and authority of the pilot in command) describes direct responsibility and final authority to the Pilot in Command for the operation of the aircraft in flight. Further it clearly states that the PIC may deviate from any rule necessary to meet the threat of an emergency.

This final authority and capability to deviate from the rules as necessary, illustrate the importance of communicating with the flight deck in an emergency. Crewmembers need to inform the PIC of anything abnormal in the passenger cabin and likewise the PIC needs to communicate directly to the passengers, or through designated members of the crew (first officer, flight attendant, etc.).

Additionally, many flight operations and certificate holders designate certain protocols for specific situations. Often, these protocols serve to assist flight crews when handling emergencies based on previous incidents and risk mitigation as determined by the corporation. Follow these procedures, but realize the PIC still retains ultimate responsibility and authority to take any necessary actions to handle any emergency.

Distress Signals

As discussed in more detail in Module 9, chapter 6 of the Aeronautical Information Manual (AIM, Emergency Procedures) sections 1 (General), 2 (Emergency Services Available to Pilots), and 3 (Distress and Urgency Procedures) address the standard process to declare a *distress* or *urgent* situation. As a reminder:

- In the United States (and the rest of the world), the terms MAYDAY, MAYDAY, MAYDAY spoken over an active radio channel, immediately conveys *distress* or an emergency - A condition of being threatened by serious and/or imminent danger and of requiring immediate assistance.

- A less commonly used phrase, PAN, PAN, PAN similarly spoken over an active channel, conveys *urgency* - A condition of being concerned about safety and of requiring timely but not immediate assistance, a potential distress condition.

The AIM procedures referenced above also direct transponder equipped aircraft to transmit Mode 3/A (4-digit code on query) and Mode 3/C (pressure altitude on query) with a manually set transponder codes of 7700 to help identify the distress aircraft on air traffic control systems.

Outside of radio and transponder operations, early aviators developed a host of signals to show emergency and urgency conditions:

- For emergency situations morse code SOS (… --- …) or red lights or red flares one at a time in short intervals.
- For urgency situations Landing Lights repeatedly turned on and off or Navigation lights turned on and off.

Remember, many different scenarios lend themselves to declaring an emergency. Try to avoid hesitation or an over-analysis about whether to declare an emergency. Utilize all resources to help ensure a safe resolution to whatever unusual situation develops inflight or associated with flying.

Crewmember and Passenger Incapacitation

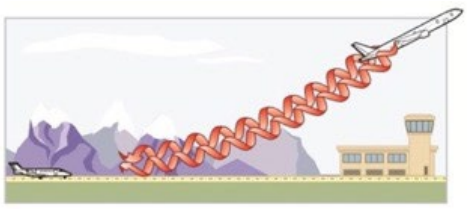
According to a study conducted in 1987 by the Civil Aerospace Medical Institute (CAMI), most inflight deaths of crewmembers come from heart attacks, but the most common cause of crewmember incapacitation inflight stems from gastroenteritis (inflammation of the digestive system e.g. food poisoning etc.), at just over 58% of cases.

The following link provides some information on dealing with food poisoning from the US National Institute of Diabetes and Digestive Diseases. The FAA's Incapacitation Data Registry Evolution offers some interesting data about aviator incapacitation.

Turbulence

Another primary threat to crewmembers while inflight comes from the atmosphere itself. We call the phenomenon turbulence. NOAA's National Weather Service defines turbulence on a scale ranging from *Light*, to *Moderate*, to *Severe*, and finally *Extreme*.

According to Dr. Paul D. Williams, Professor of Atmospheric Science at the of the University of Reading in the UK, about one tenth of one percent of the atmosphere at cruising altitude for commercial aviation contains severe turbulence at any given time. Of course, the location of this turbulent air varies with time, appearing and disappearing with the weather conditions that spawn it. One of his interesting articles on climate change and turbulence is here.



Much more commonly, aircraft encounter the moderate to severe turbulence generated by the passage of other aircraft. The bigger (and heavier) the aircraft, the larger and more severe the disturbance of spinning air coming off the tip of each wing. The closer to the ground, the more impactful the effect of encountering this turbulence on smaller aircraft. The FAA calls these vortexes of rapidly spinning air *wake turbulence* and limits the timing of take-offs and landings to allow these disturbances time to dissipate before allowing other aircraft to arrive or depart. More detail can be found in FAA's AC 90-23G (Aircraft Wake Turbulence).

Whether the turbulence comes from weather events or passing aircraft, sudden changes in altitude and airspeed leave unprepared cabin crew and passengers subject to injury and even death. The forces involved exceed the strength of most humans to prevent them flying around the cabin without seat belts etc. Direct passengers to keep their seatbelts fastened while seated and keep cabin crew informed as to changing conditions along the route of flight.

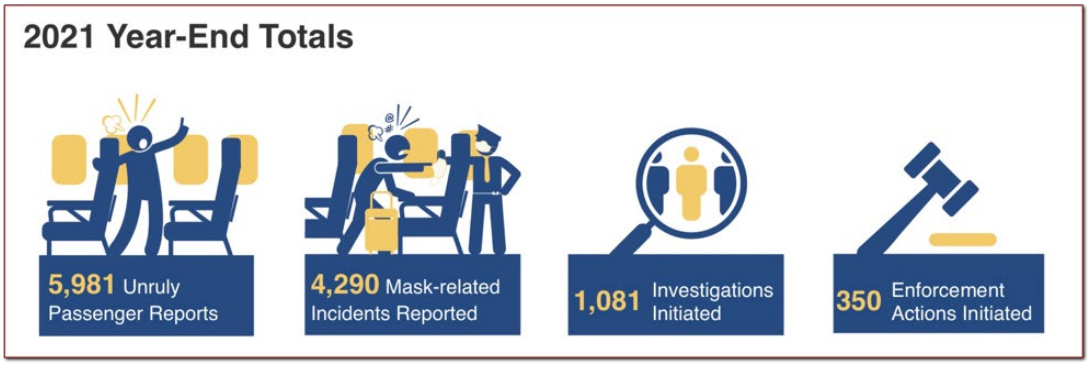
These links offer additional information:
FAA's Turbulence
AC No: 120-88A Preventing Injuries Caused by Turbulence
AC No: 00-30C Clear Air Turbulence Avoidance
Air Carrier Turbulence-Related Injuries Can be Reduced, NTSB Finds

Unruly Passengers

Federal Aviation Regulations 91.11, 121.580 and 135.120 state that "no person may assault, threaten, intimidate, or interfere with a crewmember in the performance of the crewmember's duties aboard an aircraft being operated." Couple the prohibition of interfering with crewmembers with the broad authority of the PIC to deal with emergencies, then many of the creative improvised solutions taken by crewmembers suddenly make more sense. In essence, crewmembers should mitigate and de-escalate, when at all possible, actively engage in self-defense if necessary, and exercise creative restraint to ensure the safety of all the passengers onboard the aircraft.

Tough and unruly passengers, though rare in corporate and charter aviation, sometimes show their nature given alcohol and/or stress in their lives etc. In 2016, prior to the pandemic, only a few dozen (worldwide) passengers ended up restrained inflight. Subsequently, mask wearing, and other COVID-19 precautions only added to the stress of flying commercial for some.

Before COVID-19 became a reality for the world, the US would experience about 160 to 250 unruly passenger chargeable incidents annually. Many of these passengers were released without punishment. Some were fined and several jailed. However, with the disruption of COVID-19, unruly passenger events in 2021 weighed in at an astonishing 5981 people. Many of these passengers paid hefty fines (about a million dollars total) and hundreds faced enforcement actions. The FAA's current statistics on passenger interactions can be found here.



Miscellaneous Medical Issues

Besides turbulence, a dozen or so incidents occur every year due to medical conditions, drugs and excessive fatigue. Aircrew also occasionally suffer heart attacks, alcoholism, etc. But food poisoning remains the biggest factor affecting flight. FAA's Incapacitation Data Registry Evolution offers some interesting data about aviator incapacitation.

Bird Strikes and Wildlife Issues

G550, University Park (Penn State). It happened over the outer marker on final. Landing west at sunset.

Although incidents occur with a range of animal life, according to the FAA's Wildlife Mitigation webpage resources, 97% involve birds. Pilots and officials reported about 227,005 wildlife strikes with civil aircraft in the USA between 1990 and 2019. About 17,228 strikes occurred at 753 U.S. airports in 2019. An additional 4,275 strikes were reported by U.S. Air Carriers at foreign airports over the same period (1990 – 2019).

Mitigation efforts at airfields include electronics and signs, noise makers, drones and even modifications to the local environment to make airports less hospitable. Birds represent a serious threat during critical phases of flight, especially during the takeoff/departure (39%) and Approach/Landing (69%) phases, while only 3% of strikes occur enroute. Bird strikes threaten the fuselage, control surfaces, cockpit integrity, and even engine function. Make every attempt to see and avoid birds, remembering that when startled, birds inflight tend to tuck their wings and dive. Plan accordingly and keep your awareness high during operations close to the ground. Other animals present a threat in some situations, for example deer (white tail are the most common) or even moose, but far less frequently than birds.
The following image is the result of a deer running out of the woods and struck a Cessna Citation II that had just landed, rupturing a fuel cell (Flight Safety Foundation January 6, 2016, article Entering the Wild Kingdom). The crew escaped but the airplane was destroyed by fire. It happened on Nov 17, 2012, in Greenwood County, South Carolina. Thankfully, this type of damage is very rare.

A deer ran out of the woods and struck a Cessna Citation II that had just landed, rupturing a fuel cell. The crew escaped but the airplane was destroyed by fire.

More info:
FAA: Wildlife Strikes to Civil Aircraft in the United States, 1990-2022.
Report wildlife strikes here.
AC No: 150/5200-32B Reporting Wildlife Aircraft Strikes

Drones

A relative newcomer to the aviation scene, unmanned aircraft (UA) also commonly called drones and various systems, present a rapidly growing part of controlled airspace. Thousands of drones, purchased as toys and by hobbyists now provide stunning views of property, events and in some cases breaking news. Drones are quickly becoming an increasingly important part of our lives.

https://www.pcmag.com/news/us-navy-drone-refuels-a-fighter-jet-in-midair-for-the-first-time

The FAA continues to publish operational rules for these devices. The rules specified in Part 107 addresses Small Unmanned Aircraft Systems. These rules apply to drones under 55 lbs. in gross weight down to .55 lbs. They further subdivide Drone Operations Over People into 4 categories based on potential for injury to the people under them should they fall. Title 18 of the US Code section 39B (Unsafe operation of unmanned aircraft) also makes it a crime to operate a UA in a way that threatens other aircraft.

UA's over 55 lbs. require an airworthiness certificate under part 25, and regular registration and pilot certification for operations just like other aircraft. This explosion in growth of small UA's operating in the airspace also leads to more interactions with commercial aircraft. According to the FAA, 1820 drone sightings were reported by aircraft in 2022. Drones present just as much danger, potentially even more, than birds. Expect more drones in urban areas as companies expand into areas such as delivery of goods, medical response, SAR, and even short-haul transportation.

The most common defenses around aircraft now employ electronic interference with drone control systems, like the Anti-UAV Defense Systems (AUDS). There are dozens of such systems in various phases of development. Even the Japanese have experimented with drone carrying and catching drone nets. The FAA continues to research the best methods of disabling drones near airports.

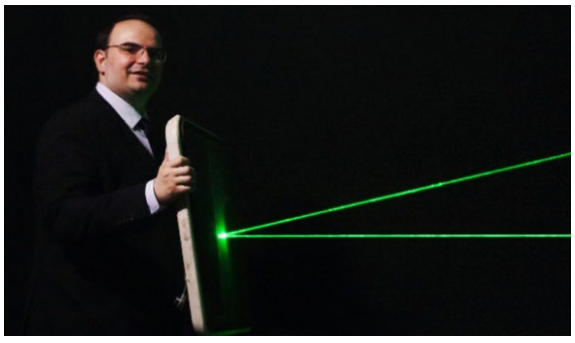
Anti-UAV Defence System's

Japan Plans Defenses Against Drone

Laser Strikes

Another relatively new threat comes from individuals shining lasers at aircraft. In 2012 Title 18 of the US Code added section 39A, making shining a laser device in the path of an aircraft a Federal crime. There are a few exceptions for official and emergency uses of lasers.

The FAA reported 9457 laser strikes in 2022, over 2500 more than the 6852 reported in 2020. The vast majority (over 90%) come from green lasers, but other colors exist. When operating in a known laser threat area, consider specialized glasses designed for the task of protecting eyes from harmful laser light and the ultimate protection of infused windscreens with laser deflection and/or diffusion material built right in. The FAA publishes an interesting brochure called Laser Eye Protection (LEP) Perceptual Effects on Aviation about products and eyewear.



Windscreen Laser Protection for Pilots.

Teledyne Scientific & Imaging

The following link provides information on reporting laser strikes - FAA's Report a Laser Incident

Module 13 – Security & Terrorism

Introduction

FAR 135.331 and Order 8900.1 (Volume 3, Chapter 19, Section 4 - Safety Assurance System: Emergency Training Curriculum Segments) offers several topics to be covered during training: Hijack procedures; Bomb threat procedures; Security coordinator responsibilities; and In-flight intercept signals and procedures. We also emphasize travel security and personal safety information. The following sections present a far from complete picture, so the more you travel internationally, especially to higher risk areas, the more personal research required.

Situational Awareness (Don't Let Your Guard Down)

Let's start with one of the best tools an aviator has in his or her toolkit, Situational Awareness (SA). Knowing and keeping track of others and surroundings, whether flying or walking to a restaurant, helps keep you tuned into the local environment as well as potential threats to your survival. Practicing situational awareness can provide early threat recognition and added time to respond to emergencies.

In May 2017 (updated in Dec 2019) Aviation Safety Magazine published Situational Awareness? by A. Bartlett, to help aviators understand situational awareness in an aviation environment. Bartlett offers several techniques for maintaining and improving SA:

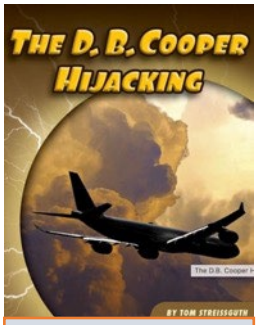
1. Predict The Future
2. Identify Threats
3. Trust Your Gut
4. Minimize Task Overload
5. Avoid Complacency
6. Fight Fatigue
7. Perform Constant SA Assessments

Rane's Stratfor.com provides another excellent resource (subscription required) emphasizing SA. It describes itself: *As the world's leading geopolitical intelligence platform, Stratfor brings global events into valuable perspective, empowering businesses, governments, and individuals to more confidently navigate their way through an increasingly complex international environment. Their goal is to empower members to understand and successfully navigate an ever-changing and complex global environment.*

The authors maintain a subscription to Stratfor, and feel they excel in analyzing and presenting factual and useful information about international travel, security, and terrorism. This chart comes from an article Stratfor published 2013: The Value of Situational Awareness.

Two additional Stratfor articles (they usually ask for a sign-in for limited free access) of interest: A Practical Guide to Situational Awareness & Building Blocks of Personal Security: Situational Awareness

Hijackings



Tom Striessguth's audio book cover.

Since Sep 12, 2001, less than 2 dozen documented hijackings of commercial aircraft have occurred worldwide. Wikipedia maintains a general information page on Aircraft Hijacking, also called air piracy, and another page offers a detailed list of aircraft hijackings since 1919. Interestingly, the first hijacking occurred only 16 years after the Wright Brothers made their first controlled, sustained flight. Only one hijacking has occurred in the United States since Sep 12, 2001, and it happened to a Ryan Air Services Cessna 208 Caravan with five people on board in Alaska on July 7, 2021.

The Aeronautical Information Manual (Section 3. Distress and Urgency Procedures) contains guidance on the procedures to follow in 6-3-4. Special Emergency (Air Piracy). When hijacked, try to accomplish the following:

1. Communicate your emergency as practical under the circumstances
2. Squawk 7500 which literally means "I am being hijacked/forced to a new destination"
3. If possible, maintain true airspeed less than 400 knots
4. Fly a course to where the hijacker instructs you to go

The establishment of the TSA after 9/11 created a relatively effective deterrent to dissuade people trying to hijack a US carrier for nefarious purposes. Even though far from perfect, the TSA protects air travel in the U.S. The TSA Year In Review: 2022 outlines the firearms discovered made by TSA in 2022. In fact, in 2022 alone, they found over 6542 guns in traveler's bags, 88% loaded, at USA airports.

Bomb Treat Procedures

Bomb threats generally turn out as only threats, called in or otherwise communicated to the airline, crew or passengers. Worldwide, less than a handful of aircraft bombings have occurred since 2000. The following regulation covers threat basics FAR 1544.303 (Bomb or Air Piracy Threats).

Since the first in 1933, an estimated 86 bombings have occurred, with at least 53 resulting in fatalities. Reasons include revenge, suicide, assassinations, insurance payouts, and terrorism. More recently, less that 10 incidents have occurred after Sep 11, 2001. The worst was Russia's Metrojet Flight 9268 bombing that took place in the Sinai Peninsula in 2015, killing all 224 on board.

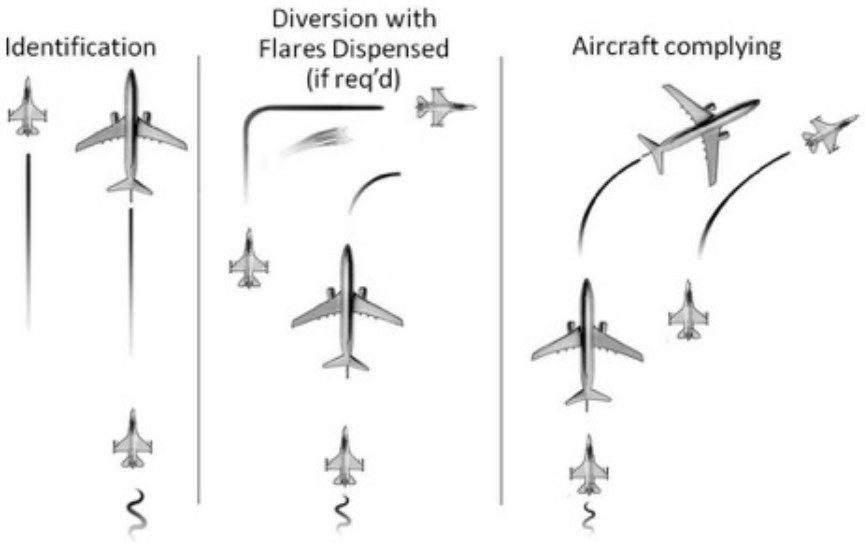
The FAA maintains procedures for Air Traffic Control and criteria when designing larger aircraft, but little applies directly for corporate aviation. Check with your aircraft manufacturer for any recommendations offered on the best location for placing a suspected bomb and any wrapping techniques for maximum protection of the aircraft and passengers. FAR 25.795 (Security considerations) and AC No: 25.795-6 - Least Risk Bomb Location contain interesting background information.

Will corporate aircraft constitute a potential threat in the future? Potentially used as a 9/11 style bomb? Unfortunately, the possibility stands as non-zero. Since corporate aviators operate with far fewer restrictions than Part 121, pilots and crew need to stay tuned into their "gut feelings." Remember, an uneasy gut feeling or standing hairs on the back of your neck come from something you sense or observe, without indicating paranoid or profiling behavior. It sometimes means you sense something is not quite right. In such cases, take the necessary steps to make yourself comfortable – watch passenger behavior, ask questions, look around, inspect bags, etc.

Interceptions

According to North American Aerospace Defense Command (NORAD), the number one reason for aircraft interceptions centers on "entering restricted airspace and not talking to ATC." This surprising result happens even though accessing information on Temporary Flight Restrictions (TFRs) ends up as trivial with even moderate mobile/internet access. Find TFR guidance here from the National Business Aviation Association (NBAA). The FAA also published the very helpful AC-91-63D (Temporary Flight Restrictions (TFR) and Flight Limitations).

The FAA maintains very specific guidance for aviators when intercepted by a military or government aircraft. See the Aeronautical Information Manual (Section 6. National Security and Interception Procedures: 5-6-13 to 5-6-15). Specifically: 5-6-13 Interception Procedures, 5-6-14 Law Enforcement Operations by Civil and Military Organizations, and 5-6-15 Interception Signals. The following AIM graphic depicts the intercept process.



FAA's In-flight Intercept Procedures is very helpful as well.

Experienced intercept pilots from Customs and Border Protection offer this advice to corporate pilots:

1. If you see a CBP or military aircraft – know that they want to speak to you.
2. Hold a steady line (remain on autopilot).
3. Tune to 121.5.
4. Use your registration number and say something like this: "This is King Air N1234. I have apparently been intercepted. What do you want?".
5. Then the interceptors will tell you where to go and what to do. Normally it includes something like: "N1234, this is the U.S. Dept. of Homeland Security (or the U.S. Air Force/Navy/etc..), you have entered a restricted area (entered U.S. airspace, etc…), turn right to approximately 120 degrees, proceed to _____ airport and land. We will follow you there and talk to you on the ground."
6. Your negotiating power is minimal at this point. However, ask for an alternative airport if you are low on fuel, the runway is short or there are other mitigating circumstances.
7. Failure to comply comes with very serious repercussions, including violation, or in extreme circumstances air-to-air weapon deployment.

Avoid interceptions by staying informed about TFRs and other restricted airspace on planned routes of flight and make sure to communicate appropriately.

Kidnappings

The Overseas Security Advisory Council (OSAC) publication – Kidnapping: The Basics, lists several types of kidnappings. Kidnapping Americans for ransom occur relatively infrequently considering the 90 million Americans who travel internationally every year. Unfortunately, many, if not most kidnapping for ransom go unreported. According to Hostage US, (501c3 non-profit hostage support group) about 200 to 300 American fall victim as hostages annually.

In 2015 the White House established the Hostage Recovery Fusion Cell (HRFC) at FBI Headquarters. An FBI-led network of experienced investigators, negotiators, and foreign liaisons now respond when someone kidnaps and holds any American overseas. Find more information here.

Some of the most common techniques to avoid kidnapping include:

1. Stay as unpredictable as possible
2. Stay particularly careful at choke points where travel/exit options narrow
3. Stay situationally aware
4. Pay attention to your gut feelings

If kidnapped:

1. Cooperate with your captors
2. Encourage negotiations for a reasonable amount of money
3. Befriend captors – humanize yourself wherever possible
4. Allow pictures for proof of life
5. Don't help or pick up a weapon during rescue

Express Kidnappings make up a much more common practice and develop as a crime of opportunity. Assailants force the victim to withdraw as much money from their bank account as possible. These usually end up without harm to the victim, except, of course, for the money stollen. When possible, use well-lit ATM machines and always maintain situational awareness. Find additional information on Virtual, Tiger, and Political Kidnappings in OSAC's Kidnapping: The Basics. The Overseas Advisory Council in 2019 published another excellent resource called Active Shooter and Kidnapping Response Tips.

Terrorism

Terrorism is a very public part our lives, especially since 9/11. Terrorism usually attempts some type of influential gain or even recognition by the perpetrators. One of the FBI's stated purpose centers on protecting the United States from terrorism and terrorist related activities. The FBI's Joint Task Force also plays a large, coordinated role in successfully resolving national and international terrorism threats.

The FBI's definition of terrorism:
International terrorism: Violent, criminal acts committed by individuals and/or groups who are inspired by, or associated with, designated foreign terrorist organizations or nations (state-sponsored).

Domestic terrorism: Violent, criminal acts committed by individuals and/or groups to further ideological goals stemming from domestic influences, such as those of a political, religious, social, racial, or environmental nature.

Oklahoma Federal Building Bombing – From FBI Files:

On the morning of April 19, 1995, an ex-Army soldier and security guard named Timothy McVeigh parked a rented Ryder truck in front of the Alfred P. Murrah Federal Building in downtown Oklahoma City. He was about to commit mass murder.

Inside the vehicle was a powerful bomb made from a deadly cocktail of agricultural fertilizer, diesel fuel, and other chemicals. McVeigh got out, locked the door, and headed towards his getaway car. He ignited one timed fuse, then another. At precisely 9:02 a.m., the bomb exploded.

Within moments, the surrounding area looked like a war zone. A third of the building had been reduced to rubble, with many floors flattened like pancakes. Dozens of cars were incinerated, and more than 300 nearby buildings were damaged or destroyed. The human toll was still more devastating: 168 souls lost, including 19 children, with several hundred more injured. It was the worst act of homegrown terrorism in the nation's history.

Find more specific information from Wikipedia. Another well-known terrorist act on American soil includes the Boston Marathon Bombing in 2013.

What Can You Do?

The FBI suggests the following:

- Remain aware of your surroundings.
- Refrain from oversharing personal information.
- Say something if you see something. The insular nature of today's violent extremists makes them difficult for law enforcement to identify and disrupt before an attack. Many times, a person's family or friends end up as the first to notice a concerning change in behavior that may indicate a person's mobilization to violence.

Security Resources

Every flight requires the necessary planning to make sure the crew, passengers, and aircraft stay safe for the entire trip. Crewmembers need credible information about potential destination challenges before any trip begins. Corporate aviation security professionals play a critical role. However, they might be full-time, part-time, or nonexistent depending on the organization. Regardless, security officers, trip planners, ground handlers, FBOs, and pilots from previous trips to the area all offer valuable insight. The following resources offer readily accessible and current information to any corporate aviator.

Understanding the Risk of Corporate Travel

The Medaire map of the world (below), shows specific travel risks around the globe. Risky areas around the globe shift unpredictably and constantly, so due diligence requires regular efforts by the crew to review health and security issues before and even during each trip. For larger operations with regular varied international flights, we recommend a *Security Coordinator* to monitor flight operations and destinations for developing risks, and then strategies to mitigate those risks for each crew and client.

MedAire (International SOS) risk map below:

International SOS usually publishes an annual Travel Risk Map. Designed by medical and security experts, the map gives organizations a comprehensive understanding of the risks related to the markets in which they operate and travel to. It displays each country's respective up-to-date medical, security, and road safety risk ratings, resulting in a thorough overview of risks by destination

This International SOS Risk Map 2022 can be found here.

International SOS' Health and security risk interactive maps can be found here. Another excellent resource may be your insurance company.

CIA World Factbook

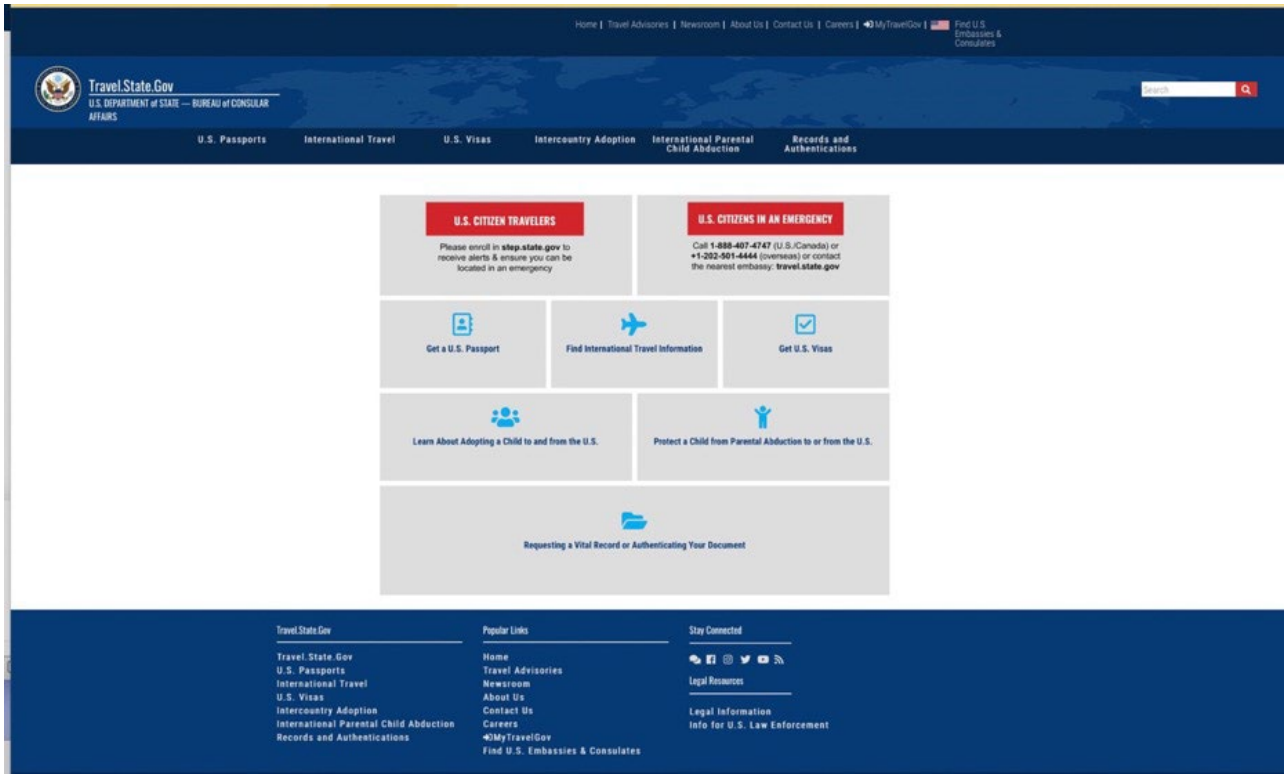
In 1950 the world consisted of only 89 independent Nations. Today we count 195, plus 72 territories and other entities. The U.S. Central Intelligence Agency (CIA) helped shape the world over the last 70 years. To share their vast knowledge, they produce an excellent public resource known as the CIA The World Factbook. This informative work, also available for free on the web, covers every country and territorial entity in the world in terms of demographics, history, relationships with their neighbors, etc. This provides a very helpful reference and foundation for the international corporate aviator.

The CIA's description: *The World Factbook is one of the US Government's most accessed publications.*

The World Factbook, produced for US policymakers and coordinated throughout the US Intelligence Community, presents the basic realities about the world in which we live. We share these facts with the people of all nations in the belief that knowledge of the truth underpins the functioning of free societies.

US Department of State Resources

One of the best sources of information is the U.S. State Department. It maintains and regularly updates online resources specifically designed to inform U.S. citizens about potential issues if they decide to travel abroad. We strongly recommend aircrew familiarize themselves with all the State Department has to offer and make checking their site part of your preparations for every international flight. The website at http://www.travel.state.gov provides an easy access portal.



To start simply click on "Find International Travel Information", which is loaded with relevant and helpful details about global travel. From here, select "Country Information" for more specific and detailed material on your selected destination.

Besides country specific information, access to more important alerts and broad initiatives may also independently displayed at the top of each of the state department website pages. Selecting Travel Advisories, will present a list of over 210 countries that can be sorted several ways, alphabetically, date updated, and by Travel Advisory Level.

Travel Advisory Levels display on a 1 through 4 scale, with 1 (blue) representing "normal" low risk travel while 4 (red) representing the highest and most serious threat. The website's alphabetized searchable list of countries provides a quick reference to the State Departments analysis of the country's threat level.

In addition to the alerts and threat levels, this State Department website also provides basic knowledge about general demographics, geography, religious groups, and politics.

NOTE: During pandemic times, such as COVID-19, the State Department considers the impact of health concerns when calculating ratings, likely increasing the threat level. During COVID much of Europe was raised to a level 3 or 4, when normally Europe is considered level 2.

Smart Traveler Enrollment Program (STEP)

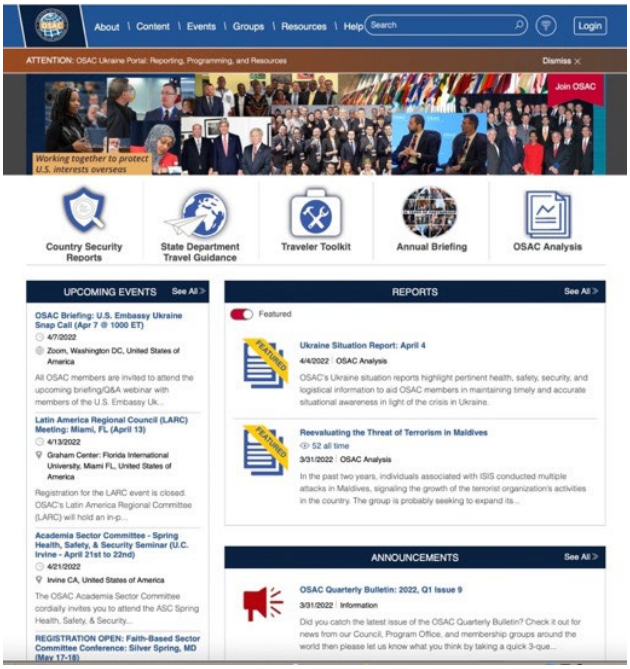
The State Department also maintains a free App called STEP (Smart Traveler Enrollment Program). The App serves to automatically update travelers on changing conditions and threat levels as well as providing contact information for US Government resources in all the countries around the world. In certain emergency situations the registration process within the app also allows embassy staff to contact and/or communicate with U.S. citizens directly. This App should be downloaded and used by every pilot and cabin attendant. The program works equally well for business and personal travel. Point it out and recommend it to passengers and crew!

US State Department's OSAC (Overseas Security Advisory Council)

The U.S. State Department offers additional security and informational resources by maintaining a separate website at www.osac.gov through an organization called the Overseas Security Advisory Council (OSAC). The OSAC was created in 1985 to foster diplomacy around the world and to encourage cooperation between private companies and the State Department in pursuing positive business environments and markets for U.S. companies and interests. Like travel.state.gov, the OSAC's website provides organized reports, alerts, articles, and other resources for travelers overseas.

One excellent resource OSAC offers is their Traveler Toolkit which contains over 80 links to all types of helpful articles for business travelers, especially when traveling to high risk areas of the word. Examples of the dozens of articles they produce include, Guide to Overseas Satellite Phone Usage, OSAC Risk Matrix, Traveling Abroad with Mobile Devices: Best Practices for the Private Sector, Adventure Travel: Know Before You Go, The American Liaison Network: A Resource and Model for Crisis Communication, Road Safety Abroad, Best Practices for Maximizing Security on Public Wi-Fi, Watch Your Step, The Overseas Traveler's Guide to ATM Skimmers & Fraud, All That You Should Leave Behind, and Kidnapping: The Basics.

In addition to reporting about events in various countries, OSAC produces a recurring Daily Newsletter emphasizing terrorism, health concerns and cybersecurity. The newsletters consist of collated articles from the US State Department and other news media outlets that OSAC analysts consider relevant to US travelers. You can apply to receive OSAC's Daily Newsletter by signing up here: https://www.osac.gov/About/JoinUs and follow their free registration process.



Curt Lewis's Flight Safety Information

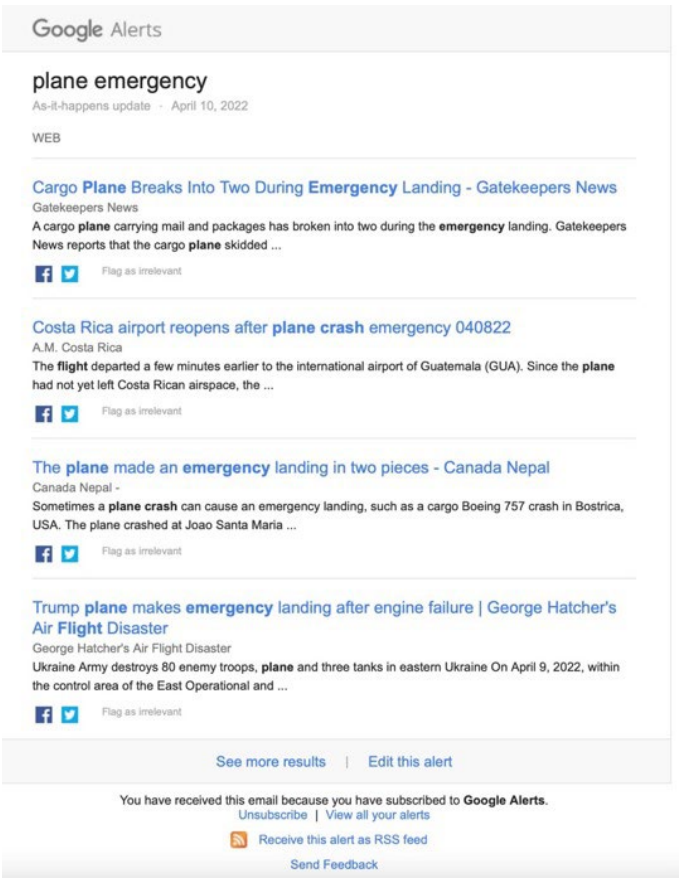
Like the OSAC, Curt Lewis and Associates, through their site at www.fsinfo.org, provides a daily newsletter of collated flight safety articles from media all over the world. Each reference also links back to the original source.

FLIGHT SAFETY INFORMATION
FSINFO.ORG
YOUR SOURCE FOR AVIATION NEWS

Flight Safety Information - April 8, 2022 No.070

In This Issue

: ARGUS International is the answer to all your aviation consulting needs
: Accident: DHL B752 at San Jose on Apr 7th 2022, hydraulic failure results in runway excursion
: ProDIGIQ | ProSafeT : Product Spotlight
: Incident: Calm AT42 at Rankin Inlet on Apr 4th 2022, hydraulic failure
: 2022 Aircraft Cabin Air Conference
: Incident: United B738 at Denver on Apr 6th 2022, flaps disagree
: OmniSMS: Your NextGen Safety Management System
: Regulator calls for complete flight safety (China)
: ACSF Adding Programs To Cast Wider Safety Net
: BIS Takes Enforcement Actions Against Three Russian Airlines Operating Aircraft in Violation of U.S. Export Controls
: Russian Pilots Protest EASA's Blanket Flight Ban
: Russian-owned Jumbo Jet Stuck at German Airport over Sanctions
: Frontier Airlines wants to ditch jet bridges in Denver and board by stairs
: Call for Nominations For 2022 Laura Taber Barbour Air Safety Award
: Aviation Safety Community
: Book - Plan B - Why Pilots Crash
:Today's Photo



Google Alerts

plane emergency
As-it-happens update · April 10, 2022
WEB

Cargo **Plane** Breaks Into Two During **Emergency** Landing - Gatekeepers News
Gatekeepers News
A cargo **plane** carrying mail and packages has broken into two during the **emergency** landing. Gatekeepers News reports that the cargo **plane** skidded ...
Flag as irrelevant

Costa Rica airport reopens after **plane crash** emergency 040822
A.M. Costa Rica
The **flight** departed a few minutes earlier to the international airport of Guatemala (GUA). Since the **plane** had not yet left Costa Rican airspace, the ...
Flag as irrelevant

The **plane** made an **emergency** landing in two pieces - Canada Nepal
Canada Nepal -
Sometimes a **plane crash** can cause an emergency landing, such as a cargo Boeing 757 crash in Bostrica, USA. The plane crashed at Joao Santa Maria ...
Flag as irrelevant

Trump **plane** makes **emergency** landing after engine failure | George Hatcher's Air **Flight** Disaster
George Hatcher's Air Flight Disaster
Ukraine Army destroys 80 enemy troops, **plane** and three tanks in eastern Ukraine On April 9, 2022, within the control area of the East Operational and ...
Flag as irrelevant

See more results | Edit this alert

You have received this email because you have subscribed to **Google Alerts**.
Unsubscribe | View all your alerts
Receive this alert as RSS feed
Send Feedback

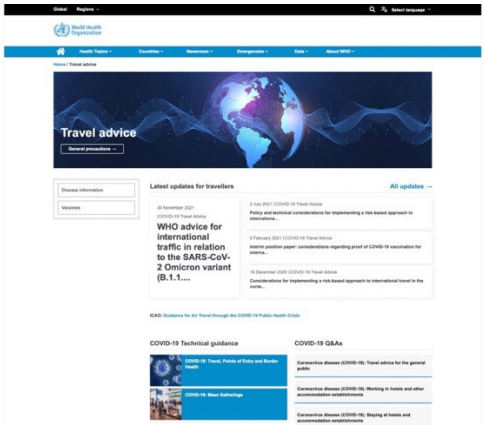
Google Alerts

If aircrew want to search for information from third party outlets, Google searches for media articles based upon terms placed in search parameters (word pairs, for instance). Users may then change these search terms at will to better refine the results. As an example: execute a Google search here (https://www.google.com/alerts) then place the two words "plane" and "emergency" in the alert box provided. If Google finds these two words in an article, anywhere on the web, you will get a link to the original article in your Google inbox. If you receive too many articles, you can easily cancel any alert you set up or refine it to be more specific.

The World Health Organization (WHO)

World Health Organization

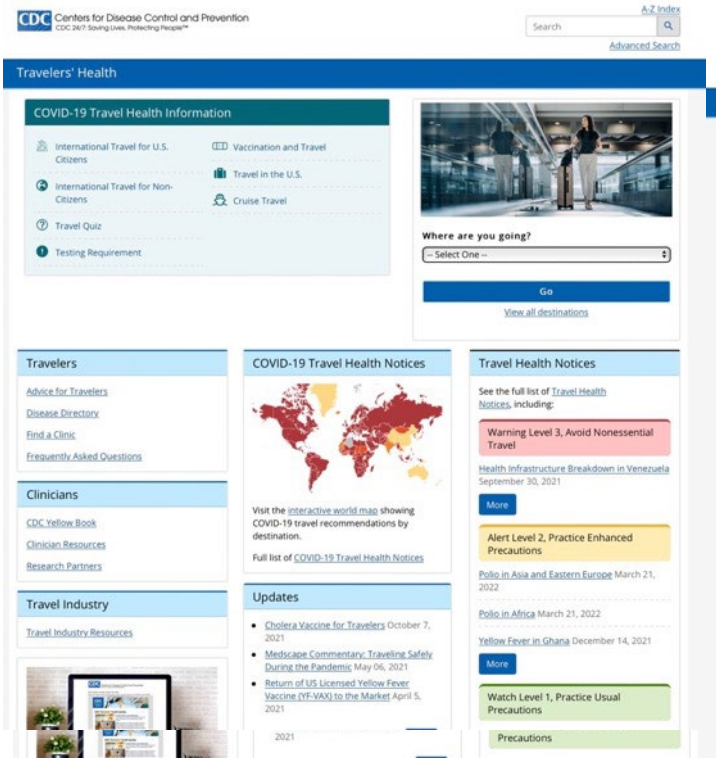
The World Health Organization provides postings on health updates describing potential medical risks all over the world. They identify pandemics and provide health related travel tips and advisories for travelers. It is also available for free online.

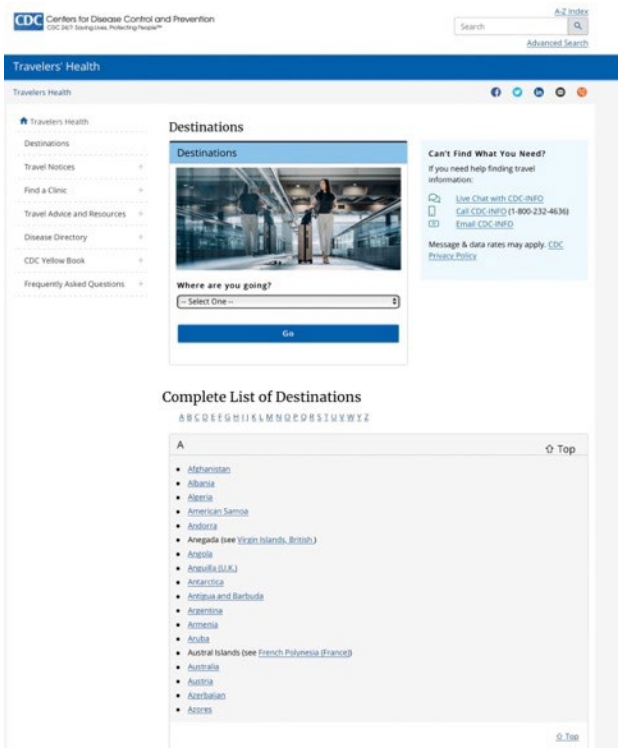


Download WHO's 2012 international Travel and Health publication here. Updated in 2019.

U.S. Center for Disease Control & Prevention (CDC)

Like WHO, the CDC website at www.cdc.gov/Travel, under traveler's health, provides posted health updates on potential epidemic outbreaks, pandemics, plus health-related travel tips and advisories designed for U.S. citizens traveling abroad, or returning to the U.S.



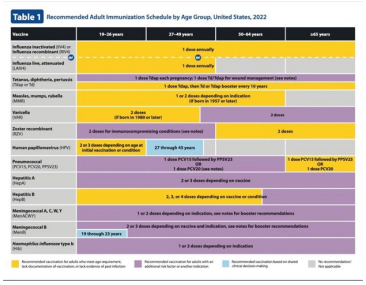


From Instructor Brett Stoffel

Brett contracted a case of Dengue fever while traveling/teaching in Puerto Rico. We spent two weeks training during an epidemic on the island. After the fact, we discovered the alert and mitigation strategies for the outbreak were posted on the CDC and WHO websites for the entire time of the coursework. Dengue, a mosquito-borne virus, generates a severe fever (103-104 F). Brett spent 1 week incapacitated and lost 25 pounds while the disease ran its course.

CDC Recommended Vaccine Schedules

The CDC updates and maintains a recommended list of vaccinations for all age groups in the United States. As travelers know, many places in the world suffer from poor hygiene and disease control. We strongly recommend making sure your immunizations are up to date before traveling abroad. And, as always, maintain optimum health by practicing excellent hygiene, especially in countries with non-potable tap water and a lack of sanitation facilities!



CDC Apps for Apple & Android

The CDC developed a free app to track the schedules for vaccinations. In case of a pop-up flight or a revised destination, you can quickly checkout vaccination suggestions and other local health concerns at your new destination. These Apps are available at: IOS From Apple Store and Android from Google Play.

Travel Security

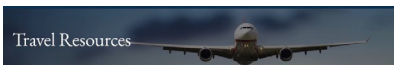
Generally, international travel provides a safe and rewarding experience. However, the world is always evolving, and local conditions can deteriorate quickly. The following information may prove invaluable for any traveler, especially when visiting less developed or politically unstable areas of the world. Spend more time developing security and safety protocols when heading to high-risk countries. Proper research and thoughtful planning help ensure a safe and productive flight. The following, though not complete, touches on several key components of aviation travel security.

General Considerations

Most people throughout the world behave in a friendly and usually very helpful manner. However, we know crooks exist everywhere and make their living from other's hard-earned resources. So, keep your guard up, even in the world's most popular destinations.

Petty crime (taking an unattended phone, pickpocketing, purse snatching, etc.) stands far more likely to occur than more serious crimes such as muggings or kidnappings. However, if faced with a serious crime, the outcome usually is better if you follow the criminals' instructions. Every situation varies, of course, but threatening or scaring your attacker can lead to devastating results.

All country's laws and rules work differently along with their creative interpretation by local law enforcement. What you might consider an injustice (like paying a small bribe) needs careful handling and thought. If your travels take you to a notoriously corrupt area, study the best practices for that area.



The **US State Department** maintains a presence or representative in almost every country of the world. However, they lack the legal or physical ability to immediately rescue US citizens when detained in another country. As hard as they work, but their efforts run up against the laws of that country.

As discussed, use these State Department resources for current information:

1. Travel Resources
2. High-Risk Area Travels
3. Smart Travelers Enrollment Program (STEP)
4. Overseas Advisory Security Council (OSAC)

The U.S. FBI offers these tips as well - Safety and Security for the Business Professional Traveling Abroad.

Business travelers should take measures to ensure not only the safety and security of themselves but also their business information while traveling outside the United States.

Precautions and Preparation

OSAC also publishes several relevant documents worth reviewing in their Traveler's Toolkit:

1. The Importance of Being Prepared
2. Travel Security Form
3. Security In Transit: Airplanes, Public Transport, and Overnights

Research the area and keep up with changing conditions. Always tell someone trustworthy your travel plans and how to contact you if necessary. Strive for minimalism…take only what you need. Leave behind unneeded valuables such as jewelry, expensive watches, credit cards, personal items, etc. Take only the cash, credit cards, ATM cards and personal information you need for the trip. Informing your credit card company and bank when traveling will help avoid personal funds being cut off because of suspicious (in the bank's eyes) international activity. Make sure you keep your shots up to date. Update your cell phone plan to avoid excessive local charges. Make sure to check for strong passwords or passcodes to lock your phone. A passport is very valuable on the black market, so treat it like gold. Take a picture of your passport and store it in a secure area on your phone – this often makes it easier to replace if lost or stolen. Make sure you update (or create) a will or trust, otherwise you will put an undue strain on your family. Without a will or trust, the state generally divides up your assets according to a generic will statute.

Pre-planning - Money

Determine how much cash, if any, will cover anticipated expenses and how to safely carry it with you. Also consider contingency expenses if forced to travel to another destination because of a weather delay, illness, extended business needs, political unrest or even a natural disaster. Understand and practice how to access additional funds while traveling outside the country.

Transportation to and from Lodging

Every airport presents different challenges: weather, hanger space, security, lighting, law enforcement, accessibility, etc. In addition to company procedures, locks, and other aircraft security devices, strategically placing tape on a door helps to give warning if someone tampers with your aircraft.

Local Transportation

This is usually a straightforward process. However, in high-risk areas, take additional precautions to insure you are using the safest option possible. Like someone you know. Or trustworthy hotel transportation. Even Uber or Lift can be a safer choice than a local cab.

Hotel Considerations

We normally live our lives without facing a hotel fire or terrorist threat. However, in riskier and/or less developed environs take more care. Stay on the lower floors and make sure you review evacuation options in case of an emergency. To start with, read this excellent list of suggestions from OSAC - **Hotels: The Inns and Outs**.

In areas of political unrest, large demonstrations, or potential terrorist activities, always take additional precautions. For instance, the distance from the aircraft to the hotel, transportation, lodging, general safety, hotel floor, and even dining options. No guarantees on anything, but in high-risk areas (even with low-risk hotels), the following points often prove helpful:

1. Don't broadcast your room numbers when checking in.
2. Consider writing room numbers on a hotel business card – that way everyone in your party knows everyone's room number along with the hotel's contact information.
3. Switching rooms with female crewmember might help prevent someone targeting her.
4. Selecting the third floor makes it harder to access from outside but still possible to get out.
5. The back and end of a hotel is usually safer when, for example, a truck bomb explodes. These devices are usually placed in front of the building so News trucks have better access.
6. Count the number of doors between your room and the stairwell.
7. Walk down the stairs for familiarity and to ensure chains aren't locking the exit to keep unwanted guests out.
8. Repeat the walk before you go to bed to make sure you have a useable exit.
9. By selecting adjoining rooms, you might have another possible escape option.
10. A small door wedge can help slow entry into your room.
11. Some stack glasses next to their room door to make a rattle in case someone tries to enter while you sleep.
12. Consider wetting a cloth for extra breathing protection if forced to escape a burning building.
13. Consider where to place your shoes, clothes, and valuables for quick access in the event of an emergency.
14. Always remember that loose lips sink ships. Guard important personal or company information when enjoying after-hour libations.
15. Know your crewmembers' basic schedules for easier recognition of a potential problem.
16. Know how to contact crewmember families in the event of an emergency.
17. Consider how you will communicate to your family and company after losing local communication services for any reason.

Leaving the Security of a Hotel

Unless in a high-risk area, you will likely leave the confines of the hotel for business, meals, exercise, and recreational pursuits. Obviously, personal vulnerability increases, from cab scams to becoming a victim of crime.

To avoid problems with cabs in some of South America's largest cities, one airline instructed their crews to ask the front desk to call a cab for them. Even if with a line of cabs outside the hotel waiting. Then when you want to return to the hotel, call the desk to again arrange a taxi.

Food always presents an adventure. Eating unfamiliar food often leads to very uncomfortable nights. Always use caution, especially when eating or drinking on the streets and restaurants in developing nations.

When walking around, these tips help avoid trouble:

1. Walk in a group.
2. Though not necessarily, consider including a man in each group. This might help dissuade someone from choosing women as a target.
3. Avoid drawing attention to yourself, especially after drinking.
4. Dress to blend in as much as possible.
5. Avoid carrying fancy cameras, jewelry, and gifts.
6. Remind yourself of the importance of maintaining situational awareness.
    a. Turn around often to see what's happening behind you – one of the best techniques of counter-surveillance. Most criminals lack sophisticated skills when surveilling their potential victims. If someone scopes you out but thinks you spotted them, they might choose someone else.
    b. If you see the same person twice, or more often, increase your level of awareness and be ready to quickly alter your plans.
7. Carry a throw-away wallet - put some cash in it, an old credit card and other materials to hopefully satisfy a robber and give you time to get away.
8. Criminals love ATM machines for committing crimes. So, act carefully around then. Use well-lit machines with no one around. Whenever possible, bring someone with you to increase your footprint.
9. Driving also presents a unique set of challenges. Local laws and the way people drive varies widely from country to country. Locals often maintain their own beliefs on how to conduct themselves on the road. In addition to carrying your driver's license, consider getting an International Driving Permit. And, of course, know the country's rules of the road. For more information, checkout these publications from OSAC:
    a. Evasive Driving Techniques
    b. Driving Overseas
    c. Road Safety Abroad

As experienced international travelers, most of us regularly see parts of the world most only dream about and meet incredible people along the way. Nothing in this discussion should dampen enthusiasm for travel or make us paranoid. But, as always, we want to come home at the end of the day, with memories, finances, and our health intact.

Module 14 – Reporting Incidents

Introduction

The many government organizations responsible for various aspects of commercial aviation describe a daunting and overwhelming picture. The FAA, NTSB, NASA, Airport Authorities, FCC, Law Enforcement, etc., all play different roles. In addition, every company requires certain types of reporting and record keeping. Understanding the requirements for reporting an accident or emergency and then directing it to the appropriate agency makes for a much smoother process in the event of an emergency. This section covers many of the major requirements and resources for reporting, but always check the specifics with your organization for additional requirements or changes to the rules.

FAA (Federal Aviation Administration)

According to the FAA themselves, "The Federal Aviation Administration is responsible for ensuring the safe, efficient, and secure use of the Nation's airspace, by military as well as civil aviation, for promoting safety in air commerce, for encouraging and developing civil aeronautics, including new aviation technology, and for supporting the requirements of national defense."

Relevant regulations
FAR 135.19 Emergency Operations.
FAR 135.67 Reporting Potentially Hazardous Meteorological Conditions and Irregularities of Ground Facilities or Navigation Aids.
FAR 91.25 Aviation Safety Reporting Program: Prohibition Against Use of Reports for Enforcement Purposes. (Program details below)
The FAA also maintains an excellent Accident & Incident Database found here.

FAA's AIM (Aeronautical Information Manual)

With updates on a regular basis, The Aeronautical Information Manual represents the FAA's "Official Guide to Basic Flight Information and ATC Procedures" and weighs in at over 750 pages. This manual provides the aviation community with a reference for basic flight information and ATC procedures for use in the National Airspace System (NAS) of the United States. An international version called the Aeronautical Information Publication contains parallel information, as well as specific information on the international airports for use by the international community.

Chapter 6 covers Emergency Procedures. Chapter 7 covers Safety of Flight, which also contains a section on Safety, Accident, and Hazard Reports

PIC Responsibilities

FAR 91.3 (Pilot's Responsibility and Authority of the Pilot in Command). As discussed in other Modules, a quick review of this regulation clearly outlines the expectations and responsibilities of the pilot in command:

(a) The pilot in command of an aircraft is directly responsible for, and is the final authority as to, the operation of that aircraft.

(b) In an in-flight emergency requiring immediate action, the pilot in command may deviate from any rule of this part to the extent required to meet that emergency.

(c) Each pilot in command who deviates from a rule under paragraph (b) of this section shall, upon the request of the Administrator, send a written report of that deviation to the Administrator.

Forbes 2018 Article – What's It Like To Be A Female Pilot? Captain Danielle Stoney Reveals

(d) FAR 91.123(d) (Compliance with ATC Clearances and Instructions) states: Each pilot in command who (though not deviating from a rule of this subpart) is given priority by ATC in an emergency, shall submit a detailed report of that emergency within 48 hours to the manager of that ATC facility, if requested by ATC.

For additional clarity see AIM 6-1-1 (Pilot Responsibility and Authority).

PIC Causes of Accidents

What accidents stand as the most common caused by PICs? AIM 7-6-1 (Accident Cause Factors) offers some valuable insight**:** The 10 most frequent cause factors for general aviation accidents involving the **pilot-in-command** are:

1. Inadequate preflight preparation and/or planning.
2. Failure to obtain and/or maintain flying speed.
3. Failure to maintain direction control.
4. Improper level off.
5. Failure to see and avoid objects or obstructions.
6. Mismanagement of fuel.
7. Improper inflight decisions or planning.
8. Misjudgment of distance and speed.
9. Selection of unsuitable terrain.
10. Improper operation of flight controls.

NTSB (National Transportation Safety Board)

According to the NTSB the purpose of their organization is to: "Make transportation safer by conducting independent accident investigations, advocating safety improvements, and deciding pilots' and mariners' certification appeals." The NTSB's website is here.

"The Office of Aviation Safety maintains the responsibility for investigating domestic aviation accidents and incidents (about 1,750 annually) and for proposing probable cause for the Board's approval. In conjunction with other offices within the NTSB, the office also works to formulate recommendations to prevent the recurrence of similar accidents and incidents, and to otherwise improve aviation safety. Visit the NTSB's excellent Aviation Information Resources page at ntsb.gov/air.

NTSB's Reporting Requirements, 49 CFR Part 830:

49 CFR PART 830 (NOTIFICATION AND REPORTING OF AIRCRAFT ACCIDENTS OR INCIDENTS AND OVERDUE AIRCRAFT, AND PRESERVATION OF AIRCRAFT WRECKAGE, MAIL, CARGO, AND RECORDS).
This regulation contains rules pertaining to:

(a) Initial notification and later reporting of aircraft incidents and accidents and certain other occurrences in the operation of aircraft, wherever they occur, when they involve civil aircraft of the United States; when they involve certain public aircraft, as specified in this part, wherever they occur; and when they involve foreign civil aircraft where the events occur in the United States, its territories, or its possessions.

(b) Preservation of aircraft wreckage, mail, cargo, and records involving all civil and certain public aircraft accidents, as specified in this part, in the United States and its territories or possessions.

Under Subpart B, 830.5 these regulations include a list of what the NTSB considers a reportable incident, including:

Flight control malfunction, Injury or illness precluding crew duties inflight, Dropped engine components debris inflight, Inflight Fire, Aircraft Collision (inflight), $25,000 or more in property damage, Inflight electrical failure, Inflight hydraulic failure, Dual engine failure (or worse), Aircraft egress using emergency egress systems, Dropped propellers, Complete loss of 50% or more of displayed electronic information (EFIS, EICAS,ECAM, PFD and PND displays), ACAS advisories, Main rotor or tail rotor damage in helicopters, Landing on a taxiway, Incorrect runway landing, Evasive action to avoid collision (near miss), Aircraft overdue and Suspected of accident involvement.

The regulation also contains the requirement to report as soon as reasonably possible, where to make it and what to include in the report. It also contains directives of preservation of the wreckage, public safety and anything contained onboard the aircraft or pertinent to the incident.

NASA's ASRS (Aviation Safety Reporting System)

The ASRS system works on a voluntary basis and hopes to stimulate the free and unrestricted flow of information concerning deficiencies and discrepancies in the national aviation system. It also essentially offers immunity from enforcement restrictions, except for illegal (criminal) activities or accidents.

The ASRS identifies system deficiencies, and issues alerting messages to persons in a position to correct them. It educates through its newsletter CALLBACK, its journal ASRS Directline and through its research studies. Its database provides a public repository which serves the FAA and NASA's needs and those of other organizations world-wide which are engaged in research and the promotion of safe flight.

CALLBACK

Sign-up Here

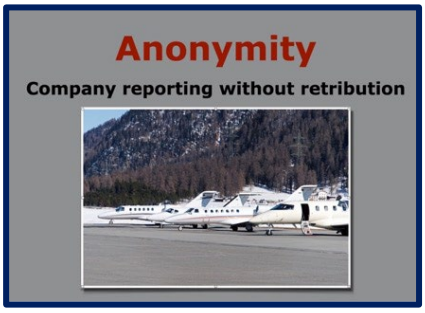
ASRS's award winning publication CALLBACK provides a monthly safety newsletter, which includes de-identified ASRS report excerpts with supporting commentary in a popular "lessons learned" format. In addition, *CALLBACK* sometimes contains features on ASRS research studies and related aviation safety information. The FAA encourages editorial use and reproduction of *CALLBACK* articles with attribution to the source of the information to encourage others to use it as well.

Resources:

1. See 7-7-1 (AIM) Aviation Safety Reporting Program as described in the Aeronautical Information Manual AIM (how & why the program was established)
2. ASRS Homepage: https://asrs.arc.nasa.gov/index.html
3. Submitting a Report: https://asrs.arc.nasa.gov/report/faq.html
4. AC 0046F, Aviation Safety Reporting Program Advisory Circular.
5. ASRS Program Briefing PDF Here
6. Fact Sheet – FAA's Aviation Voluntary Reporting Requirements - https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=23034

Company Procedures & Review of Certificate Holders Accidents and Incidents

Policies and procedures often vary dramatically between organizations and become established from hard earned experiences. Having a clear understanding of your company's requirements and what's expected of crewmembers endures as a necessity to avoid confusion and missed expectations.



FAR 91-1021 (Internal Safety Reporting and Incident/Accident Response) states:

(a) Each program manager must establish an internal anonymous safety reporting procedure that fosters an environment of safety without any potential for retribution for filing the report.

(b) Each program manager must establish procedures to respond to an aviation incident/accident.

FAR 135.331 (b)(4). Crewmember Emergency Training includes:

"Review of the certificate holder's previous aircraft accidents and incidents involving actual emergency situations."

Module 15: Course Evaluation & Critique

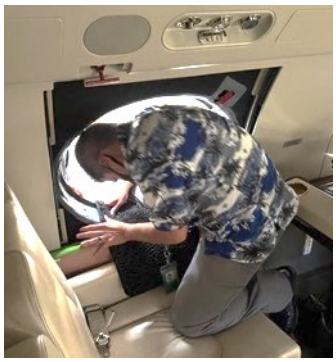
Introduction

As a reminder, FAR 135.331 is an FAA annual requirement for 135 aircrews. Initially, and then every two years, hands-on training needs to be included (using fire extinguishers, life preservers and rafts, pulling emergency exit, emergency evacuation, etc.).

Emergency Drill Training (Hands-On Labs)

If you need the labs to complete your biannually required Initial training, you can add them after completing our online course. CAPS Emergency Drill Training is offered during the final three hours of our in-person classes in Van Nuys, CA (Los Angeles) and Buda, TX (Austin). You can find CAPS course schedule here.






Final Congratulations from CAPS Aviation

CAPS Aviation has been in business since 1983 and is committed to impeccable quality, performance, and customer service in everything we do. This handout has been designed to supplement both our in-person and online courses. We hope you found it helpful.

Any comments are welcome and should be sent to cabinsafetyteam@capsaviation.com.