Gold Seal

Oral Exam Summary

A Concise Guide to the FAA Practical Test Oral Exam

The Gold Seal Online Ground School

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Private Pilot

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A Study Guide for the Private Pilot Practical Test

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Introduction

It's been a long road, but you're finally getting ready for your checkride. You've worked very hard to get to this point. Congratulations are already in order and you are to be commended for the time and effort you've invested in your new skills and knowledge.

The hardest parts are honestly behind you. Now it's just a matter of polishing up and preparing to give your examiner a good performance.

If you're like a lot of pilots, as the day of your checkride approaches, you may start to get nervous. I know I've missed more than one night of sleep in anticipation of a practical test. The best way to minimize your stress is to over-prepare yourself and develop confidence in your ability. There shouldn't be any surprises during your practical test – it's all material that you've already learned.

Your practical test will be broken into two parts – the oral exam and the flight test. Depending on the examiner, the oral test will probably last between one and two hours. The examiner is not going to come prepared to trick you or fail you. He wants you to pass. But he also wants to ensure that you are a safe and proficient pilot.

There is a wide variety of material that your examiner can discuss with you. And that's probably the first thing to remember. Although he will expect you to come up with the answers, your oral exam is a dialog, not a monologue. The two of you will discuss flying issues and the questions will naturally appear as part of the conversation. He will probably even give you a little prompting here and there if he senses that you know the material but can't quite get it out in the verbiage he's looking for. In some cases, he may even let you look up the answer – if you indicate to him that you know where to look.

Your examiner will be looking at the big picture. He's not going to fail you just because you didn't know one or two answers. His job is to ascertain that you have a good enough grasp of the required aeronautical knowledge to leave him as a safe, conscientious, and adequately skilled pilot. He understands that your pilot certificate is truly a "license to learn." He needs to know that you have a knowledge base sufficient to fly and learn on.

Go into your oral exam with a friendly smile. Not only does that mark you as a confident pilot, but it will also help you to manage your own stress level. Look clean and sharp just like you would for a job interview. Have all your materials and documents separated out in a file folder so you don't have to dig for them. Use the Practical Test Checklist at the end of this book to confirm that you have everything. Try to wear a shirt with a pocket to store a pencil, ballpoint pen, and a folded sheet of fresh paper. Maybe even a small electronic calculator. Bring your FAR/AIM with tabs in it pointing to key sections of Parts 61 and 91. And absolutely make sure that all of your publications and charts are current. Many examiners will fail a candidate on the spot for appearing with expired charts.

Everything that may be covered in your oral exam is important. None of it is just something to regurgitate for the test. As a licensed pilot, it will remain knowledge that is important to you for as long as you fly.

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VFR Requirements

Required Documents

Your oral exam will most likely start with a review of the paperwork that you need to fly. Hopefully, your instructor has drilled AROW into you from day one. I'm sure you remember what it stands for: A-R-O-W

(A) Airworthiness certificate,
(R) the registration,
(O) operating handbook, and
(W) weight and balance data.

These are the documents that must be in an airplane before you may fly it. Airworthiness, registration, operating handbook, weight and balance

What documents are you, as a pilot, required to have with you? A logbook was required when you were a student pilot, but it is not required to be in the airplane with you once you become a private pilot. You do need to keep one to show currency, but are not required to carry it with you.

You must have either on your person or available in the airplane:

(1) your valid pilot certificate,
(2) your valid medical certificate, and
(3) a picture ID.

That's three things. A pilot certificate is essentially valid forever, but your medical certificate must be renewed periodically, based on your age. A Class 3 medical certificate is good for five years if you are under the age of 40, and good for two years if you are 40 or over. It expires at midnight on the last day of the month two or five years from the date it was issued.

In case the examiner asks, be ready to tell him that *the airplane's airworthiness certificate remains valid for as long as the airplane remains in airworthy condition* as defined in the Federal Aviation Regulations – the FARs.

When you leave your checkride, smiling because you passed with ease, you will have a temporary paper license in your hand. This will authorize you to act as pilot in command of a single engine land airplane. But be aware that there are a few other restrictions.

Special Endorsements

You may not fly an airplane having an engine greater than 200 horsepower, retractable landing gear, or a tailwheel without additional training and logbook endorsements attesting to your satisfactory completion of that training.

So that kind of brings us back to the logbook again. You don't have to have it on board the airplane, but you must possess one with the necessary requirements and endorsements for the type of flying you will be doing.

Remember:

You may not act as PIC in a high performance airplane, that is, one powered by more than 200 horsepower without an endorsement.

You may not act as PIC in a complex airplane, that is, one with retractable landing gear and a constant speed prop without an endorsement.

And you may not act as PIC in a tailwheel airplane without a separate endorsement.

Change of Address

Here's a favorite question of many examiners: If you move, how does that affect your pilot-in-command privileges? The answer is easy. If you move, you have 30 days to notify the FAA that you have a new address. If you don't provide them with the new address, you can legally fly for only thirty days after your move.

Currency

That takes care of most of the paperwork involved in being a legal pilot. But as you remember from your written test, there are other requirements necessary for you to remain current. There are three main ones – day VFR landings, night VFR landings, and a biennial flight review.

To carry passengers during daylight hours, you must have made at least three takeoffs and landings within the preceding 90 days. They don't have to be fullstop landings – touch and goes are fine. If your 90-day period has lapsed, you must either make these takeoffs and landing solo or with a certificated instructor on board.

To carry passengers during nighttime hours, you must also have made at least three takeoffs and landings within the preceding 90 days. These night landings, however, must be to a *full stop*. No touch and goes for nighttime currency requirements.

If you get a tailwheel endorsement at some point, you will have a similar requirement for takeoffs and landings within 90 days. In this case, regardless of whether it is day or night, landings in a tailwheel airplane must be to a full stop to qualify for currency.

And while we're on the subject, what constitutes nighttime? For the sake of nighttime currency, night is defined as the period that begins one hour after sunset and ends one hour before sunrise. Night is one hour after sunset until one hour before sunrise.

Category and Class

All of these landing requirements for currency refer to the aircraft's category and class. *Category* is the broad group of flying machines. It contains airplane, glider, rotorcraft, and lighter-than-air aircraft. It's easy to remember if you note that the word *category* has the letters A, G, and R in it. A-G-R. Category breaks aircraft into airplanes, gliders, and rotorcraft.

For you, the airplane *class* will be single engine land. Look at the letters in the word *class*. L-A-S. Land and sea. Class breaks airplanes into land and seaplanes.

Fuel Requirements

Fuel management is obviously a very big issue to pilots. A surprisingly large number of off-airport landings are the result of fuel starvation. If you run an airplane out of gas, but set it down without a scratch in a beautiful forced landing, your pilot buddies will *not* admire you. In fact, some insurance policies will not pay a claim that results from a crash landing when the pilot simply ran the airplane out of gas. Civil Air Patrol pilots have it really tough – if they run an airplane dry, they are grounded as CAP pilots permanently.

I can pretty much guarantee that your examiner will ask you about fuel requirements for day and night VFR flight. I'm sure you know those, but just to be complete, I'll point out that day VFR flight requires enough fuel to reach the first airport of intended landing with enough remaining fuel to fly an additional 30 minutes. At night, it's enough fuel to fly to the airport and remain flying an additional 45 minutes. Personally, I'm not flying anywhere without at least one hour of reserve fuel.

Be aware that in order to know how much fuel is burned in 30 or 45 minutes, you must know how much fuel your airplane is burning per hour. Your fuel burn requirements should be an important part of every flight plan you put together.

Inspections

We said that an airplane must have the AROW documents on board before it can be legally flown. There are some other regulatory requirements, too.

Rental airplanes must undergo a 100-hour inspection every hundred hours. The inspection must be logged in the airplane logbooks, endorsed by a licensed A&P mechanic. A&P, by the way, stands for "airframe and powerplant." If you rent an airplane that has not had a hundred hour in the last hundred hours, you are the one who can will get nailed if the FAA does a surprise ramp check and discovers it.

Virtually every airplane, rental or pilot-owned, must undergo an annual inspection each year. This is essentially the same as the 100-hour inspection, but must be signed off by an A&P with an IA certification. IA stands for "inspection authorization."

The ELT, or emergency locator transmitter, must be inspected each year. Most A&Ps do this as part of the annual inspection. ELT batteries must be replaced after one hour of cumulative use, or when half of their useful life has expired.

If your airplane contains a transponder, it must be inspected every two years. This is not normally included in an annual inspection.

If you are the pilot of an airplane flown outside of annual, it doesn't matter who owns the airplane. You'll be the one in trouble. Be prepared to show your examiner the endorsements in the aircraft logbooks proving that it is current in terms of 100-hour and annual inspections. Not knowing where to find these endorsements would be an inauspicious start to your oral exam.

VFR Equipment Requirements

Finally, there are some equipment requirements for day VFR flight. I've seen all sorts of elaborate acronyms to help students remember them. Honestly, I think it's easier to simply memorize them. *Seat belts are required in all aircraft. Newer aircraft must also have shoulder harnesses. And with a few exceptions, an ELT is required equipment.*

For VFR flight, an aircraft must have three navigation instruments: an airspeed indicator, an altimeter, and a compass. Think about it - you have to be able to tell how fast, how high, and in what direction you're going. *Airspeed indicator*, *altimeter*, and *compass*.

The airplane must also have an oil pressure gage, a temperature gage, and a fuel gage. These are the instruments that let us monitor the engine's likelihood to remain running. *Oil pressure gage*, *temperature gage*, and *fuel gage*.

And so that the pilot can control the airplane, a *tachometer*, a *manifold pressure gage* if the airplane has a constant-speed prop, and a *landing gear position indicator* if the airplane has retractable landing gear are required. Think of what you need to control the engine's power and the airplane's landing gear. Since it is unlikely that you'll be doing your checkride in a high performance, complex airplane, the only gage you'll need from this final group is the tachometer.

Instruments required for day VFR flight include:
(1) Airspeed indicator, altimeter, compass
(2) Oil pressure gage, temperature gage, fuel gage
(4) Tachometer, and maybe a manifold pressure gage and maybe a landing gear indicator

Night VFR Flight Equipment

For night flight, the aircraft must also have:
Approved position lights, approved anticollision lights, a landing light (if the aircraft is used for hire), *and a spare set of fuses* (obviously, not needed if the aircraft is equipped with circuit breakers). You'll thrill your examiner if you include a pair of flashlights.

Preventative Maintenance

Although most of the work on an airplane must be performed by a licensed A&P mechanic, Part 43 of the FARs does allow an owner to do some minor preventative maintenance on his or her airplane. Examples include changing the oil, lubricating the wheel bearings, and refilling hydraulic fluids.

Minimum Altitudes

At this point, I'm sure you will have impressed your examiner completely with your grasp of regulatory knowledge. He's happy and ready to talk about flying. Be prepared to talk about minimum safe altitudes.

Over a heavily populated area, it is 1000 feet above the highest obstacle within a 2000-foot radius.

Over open water or sparsely populated areas, there is no minimum altitude, although a pilot must remain at least 500 feet from any person, vehicle, or structure.

Separation from Clouds

For VFR flight, we also must remain specific distances from clouds. There's nothing inherently *wrong* with being close to a cloud. The issue is IFR traffic that might suddenly emerge. You need to remain far enough away so that you and the IFR pilot have enough time to see and avoid each other.

Surely you know these, but let's review. Generally speaking, in most airspaces, a VFR pilot should remain at least 500 feet below a cloud, 1000 feet above a cloud, and at least 2000 feet away horizontally.

So, let's say there is an overcast at 1400 feet AGL. Can you fly VFR? Well, if you subtract 500 for your cloud clearance, that puts your altitude at 900 feet AGL. Not particularly wise, but it is legal as long as you stay away from heavily populated areas.

Over them, the overcast would have to be at least 1500 feet AGL for you to squeeze through, 500 feet below the clouds and 1000 feet above the ground.

Course and Altitude – The Hemispherical Rule

All right, assume that the clouds aren't an issue. Conditions are solid VFR. We're on a trip from Tyler, Texas to Houston. True course is 177 degrees, but with the magnetic variation thrown in, our magnetic course will be 171. What altitudes may we choose from?

Well, of course it has to be some number of thousands plus five hundred feet. We're going in an easterly direction so we use odd thousands plus five hundred feet. 5,500 feet, 7,500 feet. Something like that.

Now, consider that we have a stiff crosswind from the west and we need to put in about 10 degrees of crab angle. We add our 10-degree crosswind correction to our 171 degree magnetic course yielding a new magnetic heading of 181 degrees. What happens to our altitude now? Nothing. That's right, absolutely nothing. No one cares what our magnetic heading is. All that matters is the *course* that we track over the ground and that's still 171 degrees.

So, the rule that says we use odd thousands plus 500 for *easterly* courses, and even thousands plus 500 for *westerly* courses means exactly what it says. Use your magnetic course, *not* your magnetic heading.

When you go out for the actual flight portion of your practical, the examiner might have you flying at an altitude that is 1800 feet above the ground. Regardless of the direction of flight, why is this a legal altitude? It is legal because the east-west rule (known as the hemispherical rule) does not apply when flying below 3,000 feet AGL.

Visibility Requirements

In addition to cloud separation and altitude requirements, there are also visibility requirements for VFR flight. Generally speaking, anything less than three statute miles is considered IFR, but that does vary with airspace. In class G, for example, you can legally fly VFR with a one-mile visibility during the day. Smart? No. But legal? Yes, it is. If you'll abide by a three-mile minimum, you'll be VFR legal in just about every case.

Another note about visibilities. *Visibility is always defined in terms of statute miles*. Virtually everything else we do as pilots are in nautical miles, but just remember that visibility is measured in statute miles.

Oxygen Requirements

I would guess that most VFR flights are conducted below 10,000 feet. Above 12,500, however, there are some requirements for oxygen use that you must be aware of.

From 12,500 to 14,000 feet, the *crew* of an aircraft, and that is usually just the pilot for small piston-driven airplanes, is required to be on supplemental oxygen for any period of time longer than 30 minutes. The crew is required to use supplemental oxygen during periods longer than 30 minutes at altitudes from 12,500 to 14,000 feet.

At altitudes above 14,000 feet, the crew is required to be on supplemental oxygen continuously.

At altitudes above 15,000 feet, supplemental oxygen must be *available* for everyone on board.

So, from 12,500 to 14,000 feet, the pilot and crew have a grace period of thirty minutes. After that, they must be on oxygen. Above 14,000 feet, there is no grace period. They must be on oxygen continuously. At altitudes in excess of 15,000 feet, oxygen must be provided for the passengers although there is no requirement for anyone but the crew to actually use it.

Flight Planning Requirements

There is one, final requirement for VFR flight. It applies to IFR as well. The FARs demand that a pilot familiarizes himself with *all available information concerning the flight*. That is pretty much a catch all, but the FAA in its wisdom chose to go one further. Specifically, we are admonished to determine the runway lengths at our destination airport and to be aware of our airplane’s takeoff and landing capabilities.

Section Summary

The AROW documents are required to be on board a flying aircraft.
They are the airworthiness certificate, the registration, the operating handbook, and the weight and balance data.

A pilot must have a valid pilot certificate, a valid medical certificate, and a picture ID in his possession. Although it is required that a pilot keep a logbook to show compliance with currency requirements, it is not necessary to have it on board the airplane.

A pilot certificate does not expire.

A third class medical certificate is valid for five years for pilots younger than 40, and is valid for two years for pilots 40 and older.

A pilot must undergo a biennial flight review every two years. If he is issued a new rating, the next BFR will not be due for two years after that.

The airplane's airworthiness certificate remains valid as long as the airplane remains airworthy as determined by the FARs.

A separate endorsement is needed to fly airplanes with high performance engines, that is, those with greater than 200 horsepower.

A separate endorsement is needed to fly a complex airplane, that is, one with constant speed propeller, flaps, and retractable landing gear.

A separate endorsement is needed to fly a tailwheel airplane.

If you change your mailing address, you must notify the FAA within 30 days.

In order to carry passengers during daylight hours, you must have made at least three takeoffs and landings within the preceding 90 days.

In order to carry passengers at night, you must have made at least three night takeoffs and landings to a full stop within the preceding 90 days.

Nighttime is considered to be the period starting one hour after sunset and ending one hour before sunrise.

You must have a minimum of 30 minutes reserve fuel for day VFR flight.

You must have a minimum of 45 minutes reserve fuel for night VFR flight.

Rental airplanes must undergo a 100-hour inspection every one hundred hours.

All airplanes must undergo an annual inspection.

Equipment required for VFR flight includes:

Seatbelts, probably shoulder harnesses, and probably an ELT
An altimeter, an airspeed indicator, and a compass
An oil pressure gauge, a temperature gauge, and a fuel gauge
A tachometer, and possibly a manifold pressure gauge, and possibly a landing gear indicator

Additional equipment required for night VFR flight includes

Approved position lights
Approved anticollision lights
A landing light (if the aircraft is used for hire)
A spare set of fuses (unless the aircraft is equipped with circuit breakers)

Over heavily populated areas, the minimum altitude is 1000 feet above the highest obstacle within a 2000 foot radius.
Over lightly populated areas, the minimum altitude is 500 feet AGL.
Over unpopulated areas and open water, there is no minimum altitude.

For magnetic courses between 0 and 179 degrees, legal VFR altitudes are *odd* thousands plus 500 feet.

For magnetic courses between 180 and 359 degrees, legal VFR altitudes are *even* thousands plus 500 feet.

The hemispherical rule does not apply below 3000 feet AGL.

VFR aircraft should remain 500 feet below clouds, 1000 feet above clouds, and at least 2000 feet horizontal to clouds. This is a generalization but applies in most airspaces.

Three statute mile visibility is the general minimum for VFR flight below 10,000 feet.

A pilot is required to familiarize himself with all information regarding a flight including the runway lengths at his destination airport, and the takeoff and landing requirements of his aircraft.

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Airplane Systems

Hopefully, the airplane in which you will take your checkride is one that you've been practicing in regularly. The examiner is going to expect that you have a lot of knowledge about this particular bird. Make sure that you have your own personal copy of the Pilot Operating Handbook – the POH - to study from. It is very important that you know your airplane well.

First of all, the obvious. What kind of airplane is it? A Cessna 172 or a Piper Warrior? I don't think you'll miss this one. Fill in this chart for your airplane. Memorize it!

Empty weight:	
Maximum takeoff weight:	
Best glide speed:	
Vso – stalling speed in landing configuration:	
Va – maneuvering speed:	
Vx – best angle of climb speed:	
Vy – best rate of climb speed:	
Vno – maximum structural cruising speed:	
Vne – never exceed speed:	
Range in hours considering full tanks:	

What kind of engine does it have? Maybe a Lycoming O-320? Maybe something smaller like an O-235. The examiner will want to know the manufacturer and designation for your engine. And he's very likely to ask you what the designation means. In these two examples, an O-320 and an O-235, the letter "O" stands for *opposed*. The cylinders in the engine are opposed – they are laid out horizontally, half pointing one way and half pointing the other.

In cars, cylinders are usually V or inline. In airplanes, opposed is the norm. The term opposed means that they pull on the crankshaft in exactly opposite directions.

Next, that number. O-320. The 320 means that the cylinder displacement of the engine is 320 cubic inches. If you had an O-235, the displacement would be 235 cubic inches.

How many cylinders are there? Most light piston airplane engines below 200 horsepower have 4 cylinders. You will need to confirm that for you airplane. The engine will be described in detail in your pilot operating handbook.

How much horsepower does the engine produce? Again, you'll find it in the pilot operating handbook, or POH. It's probably somewhere between 110 and 180 horsepower.

Is your airplane fuel injected? What does that mean, anyway? In carbureted or normally aspirated engines, fuel and air is mixed in the carburetor. This vaporized mix is sucked into the cylinders to be burned.

Fuel injected engines, however, have no carburetor. In them, the fuel is injected directly into the cylinder. A performance increase is the result. Plus, the lack of a carburetor means no chance of carburetor icing.

Your engine manufacturer and designation:	
How many cylinders?	
How much horsepower?	
Is it fuel injected or carbureted?	
How many quarts of oil?	

The electrical system in your airplane is not involved in the firing of the spark plugs. That's what magnetos are for. Think of them as little engine-driven generators that send high voltage pulses to the spark plugs. The electrical system could go completely dead and the spark plugs would continue firing normally.

The electrical system *is* used to power the airplane's lights and avionics and to charge the battery. The battery exists only to drive the starter. Once the engine is running, the alternator, or generator in some older airplanes, creates the electricity needed. After starting your engine, flip the alternator switch. You should see a slight discharge on the ammeter. This indicates that your alternator is doing its job. If the needle doesn't move, your alternator may have failed and you'll be running on battery power alone.

Airplanes typically have either 12 or 24-volt electrical systems. You'll find which yours has in the POH. Does your airplane have a ground plug? If so, it is probably for starting the engine after your onboard battery has given up. Ground plugs generally *cannot* be used for recharging the battery.

Your fuel system consists of the fuel tanks, vents, caps, drains, a selector valve, fuel pumps, and the fuel lines. Most light piston singles have two tanks, one in each wing. The fuel caps generally have a vent allowing air to enter the tanks to replace the volume evacuated as the fuel is burned. There is probably a separate vent tube that also serves the same function. Without the venting, a negative air pressure would develop as the fuel was used.

High wing airplanes normally are gravity fed with an engine driven fuel pump. Low wing airplanes are more likely to have an additional backup fuel pump, driven by the electrical system.

Each tank will hold a specific number of gallons. Make sure that you know what that is. Of this quantity, a small portion will be unusable. Imagine that you drained all the fuel from the tanks. Even though the gas was essentially gone, a few gallons would remain in the low points of the system and in the fuel lines. This is the unusable fuel. It's there and contributes to the gross weight of the airplane, but is unavailable for burning. Thus, when you calculate your fuel burns for a trip, remember that only useable fuel should be considered. Be prepared to tell your examiner the total number of gallons your airplane holds and how much of that is useable.

Fuel burns vary by altitude and power setting. There is some average number of gallons that you should simply memorize for your airplane. For a Cessna 152, that might be around 6 gallons per hour. A Cessna 172 might average about 9 gallons per hour. Find out what it is for *your* airplane.

Total fuel in gallons:	
Useable fuel in gallons:	
Average gallons/hour burned:	

The vacuum system drives the attitude indicator and the heading indicator. You may have also heard these instruments referred to as the artificial horizon and the directional gyro. Here's how the system works.

A vacuum pump, driven by the engine, pulls air from the cabin, through the instruments, and expels it into the engine compartment. As the air moves through the instruments, it spins the gyroscopes which, in turn, drive the instruments. *If the vacuum pump fails, the attitude indicator and the heading indicator will also fail.*

The loss of a vacuum pump in VFR conditions is not that critical. But a vacuum failure while flying IFR in the clouds could be disastrous. That's why the turn coordinator, another gyroscopic instrument is electrically powered. It's there as a backup in case the vacuum system fails. Remember that: *the turn coordinator is electrically driven as a backup to the vacuum system instruments*.

The pitot-static system is the air pressure system that drives the airspeed indicator, the altimeter, and the vertical speed indicator.

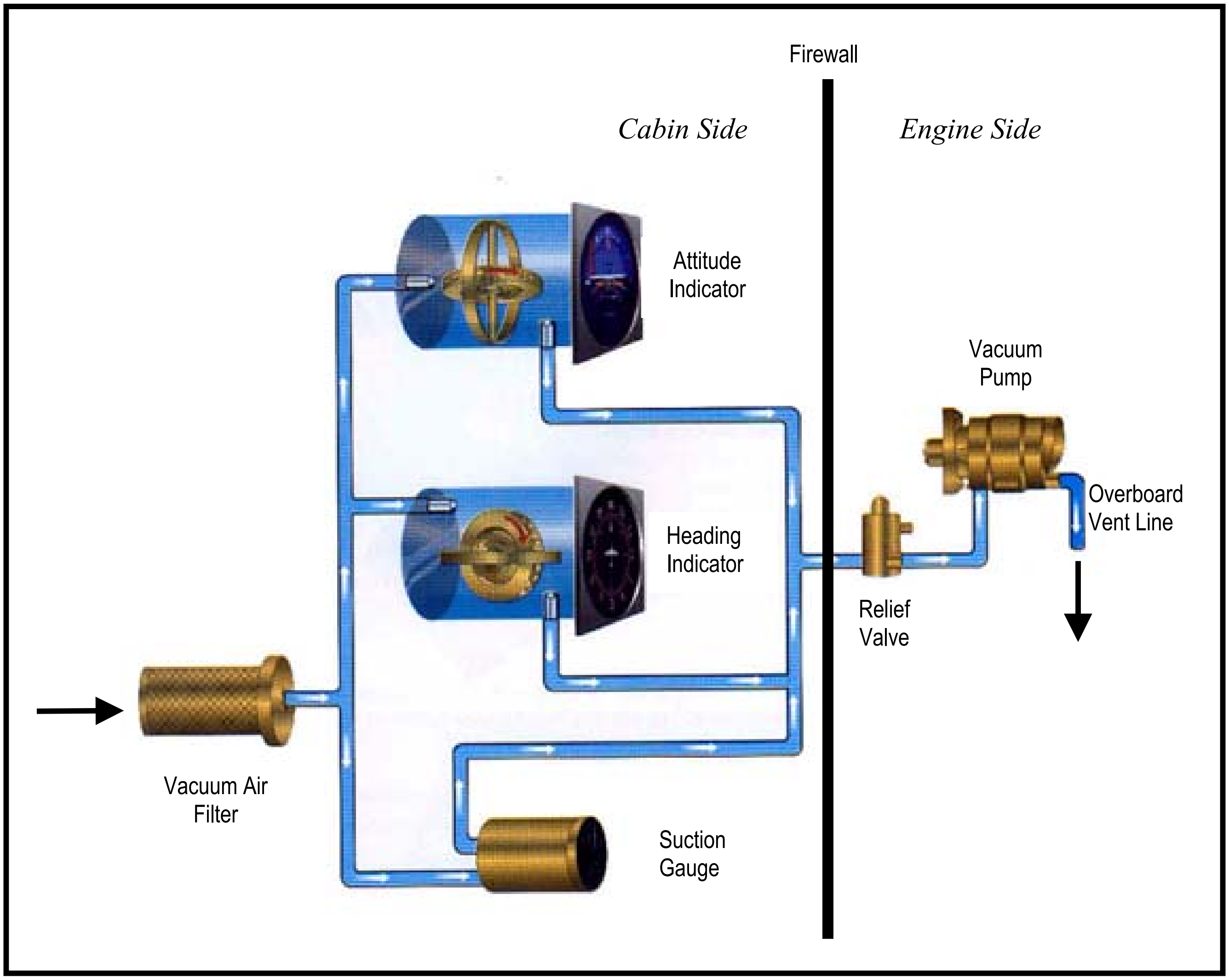
The pitot tube provides ram air for the airspeed indicator. *If the tube becomes blocked, the airspeed indicator will malfunction*. It will work like an altimeter. That is, it won't register any changes in airspeed, but *will* show an increase when the airplane climbs and a decrease when the airplane descends.

If the static port becomes blocked all three instruments will be affected. The remedy for a blocked static port is to use an alternate air source. There should be a switch for that in the cockpit. It won't do you any good if you don't know where it is.

A blocked pitot-tube will only affect the airspeed indicator. A blocked static port will affect the airspeed indicator, altimeter, *and* the vertical speed indicator.

Our airplane systems include engine, electrical system, fuel system, vacuum system, and pitot-static system. Study the operation of these in your Pilot Operating Handbook.

The Vacuum System



The Vacuum System powers the Attitude Indicator (aka Artificial Horizon) and the Heading Indicator (aka Directional Gyro or DG). These two gyroscopic instruments are of particular significance during flight in conditions of restricted visibility. If the Vacuum System fails, usually due to a failed vacuum pump, these two instruments will gradually begin to fail as their gyroscopes slow to a stop.

The electrically-powered Turn Coordinator acts as a backup for the Vacuum System instruments.

The vacuum pump is driven by the engine. It pulls air from the cabin through the instruments. This air movement spins the gyroscopes. The air is ultimately dumped into the engine compartment.

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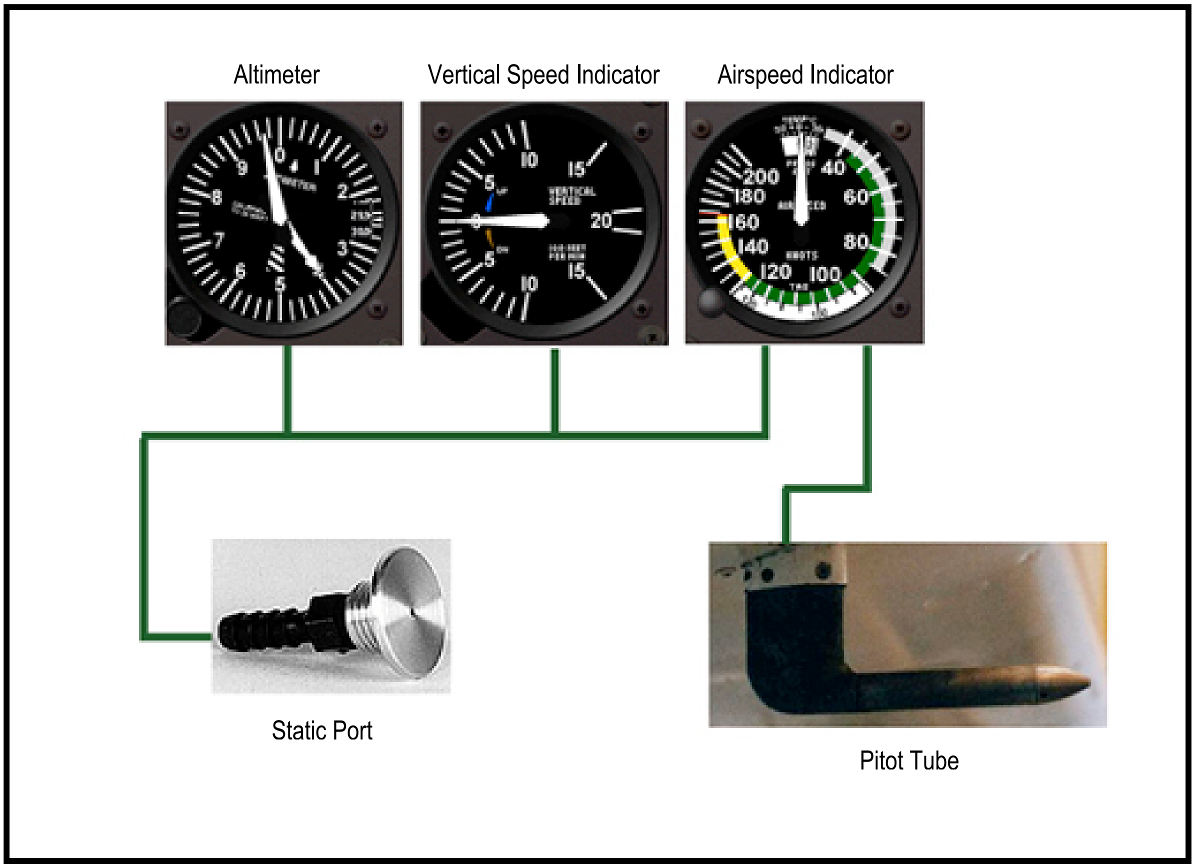
The Pitot-Static System



The Pitot-Static System drives the Altimeter, Vertical Speed Indicator (aka VSI), and the Airspeed Indicator. These instruments interpret air pressure.

The Pitot Tube supplies ram air for the Airspeed Indicator. If the Pitot Tube becomes blocked, only the Airspeed Indicator will be affected. It will malfunction and act like an Altimeter. That is, it will not show airspeed, but will show an increase when the aircraft climbs and a decrease when the aircraft descends. This incorrect indication of airspeed can be disastrous. If ice is the cause for the blockage, apply pitot heat.

The Static Port supplies ambient air for all three instruments. If it becomes blocked, all three instruments will malfunction. The corrective action is to use an alternate static source, usually controlled by a switch in the cockpit. Alternatively, the glass on the VSI can be broken to allow ambient cabin air into the system. When cabin air is used, expect the instruments to read slightly higher than normal.

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Aerodynamics

Lift

Lift is developed as the result of smooth airflow over an airfoil. If the airflow separates from the wing's surface, turbulence develops and lift is lost. This is what happens in a stall.

The FAA and NASA tend to have slightly differing explanations regarding the causes of lift. But since this is an FAA test, let's go with their somewhat dated explanation. It involves a law of physics known as Bernoulli's Principle.

Bernoulli's Principle states that as the speed of a fluid increases, its pressure decreases. Airflow is accelerated *over* the wing, thus causing a relative low-pressure area above it. Additionally, air is compressed *under* the wing causing a relative high-pressure area below. It's this pressure differential, so the FAA says, that causes lift.

Lift is the force that pulls upward on wing. It is opposed by the weight of the airplane that pulls downward. Thus, if lift exceeds weight, the airplane climbs. If weight exceeds lift, the airplane descends. *Lift and weight are equal in level flight.*

Stalls

Now, we already said that a stall is simply a loss of lift. To fully understand what a stall is, we need to understand two additional concepts – chord line and relative wind.

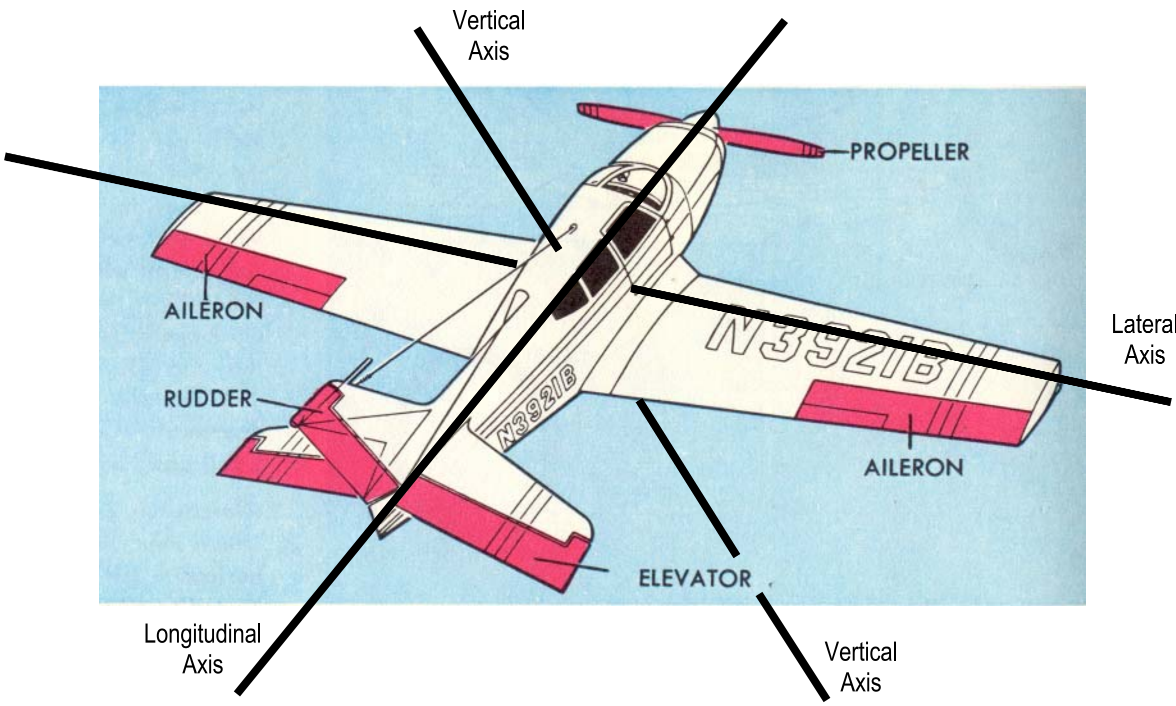
The chord line is an imaginary line that runs from a wing's leading edge to its trailing edge. The relative wind is the airflow that hits the wing. It strikes the wing at an angle exactly opposite to the airplane's line of flight.

The angle formed by the wing's chord line and the relative wind is defined as the angle of attack.

When a wing flies, there is always some positive angle of attack. At low angles, the airflow adheres to the wing's surface and lift is created normally. As angle of attack increases, at some point known as the *critical* angle of attack, the airflow can no longer follow the wing's upper surface. At this critical angle of attack, the airflow separates and turbulent eddies form. This results in the loss of lift that we call a stall.

A stall occurs when the critical angle of attack is exceeded. It is not a function of pitch or airspeed. It is only a function of angle of attack.

That's why we reduce the back pressure on the yoke to recover from a stall. We let off on the yoke, the nose drops, and the angle of attack is reduced below the critical angle. At that point, the airflow resumes its smooth flow over the wing and the airplane begins flying again.



Spins

Expect your examiner to ask about spins. First of all, you know what causes a spin. You learned it for your written test. *A spin results from a stall where one wing is stalled to a greater degree than the other.* Both wings are stalled, but one wing is stalled more than the other.

Remember that in any stall, there is a loss of lift, but not a *complete* loss of lift. When one wing is stalled more than the other one, it creates less lift than the other one. Thus, the less-stalled wing creates an off-balance lifting force, twisting the airplane around the longitudinal and vertical axes into a spin. A spin is a twisting, turning stall caused by an unequal *amount* of stall on the two wings.

What's the standard recovery for a spin? Kill the power, push forward on the yoke to reduce the angle of attack, and apply opposite rudder to stop the rotation. Reduce the power, apply opposite rudder, and push the yoke forward. *To recover from a spin, reduce the power, apply opposite rudder, and push forward on the yoke*.

Turns

When we were discussing lift, we noted that lift opposes gravity to keep the airplane flying straight, neither climbing nor descending. Lift points upward, gravity, or the weight of the airplane points downward toward the center of the earth.

Now, imagine what happens when we bank the airplane. Gravity still points downward, but the lift vector points off to the side at an angle. It is no longer straight up, opposing the gravity vector completely. This redirection of the lift vector pulls the airplane into the turn. The standard verbiage says, *a turn results from the horizontal component of lift*.

When the airplane banks, the lift vector is redirected into the horizontal. This horizontal component of lift is what causes the turn. This balance of lift and gravity is used to turn the airplane. A turn results from the horizontal component of lift.

Load Factor

Load factor describes the force of gravity as it affects an airplane in flight. In straight and level flight, the airplane and its occupants feel one G of force. We feel our normal weight as we sit in our seats. If the pilot pulls up suddenly, we feel our arms get heavy and our cheeks sag as the G forces or load factor temporarily exceed their normal levels. It's all involved with *inertia*.

Inertia is the force, described by Isaac Newton, that tends to keep us in our current state of motion or rest. The airplane accelerates upward, inertia tries to hold us back, and the result is an increase in our apparent weight.

In level banked turns, we also feel an increase in load factor. For your written test, you memorized that *load factor doubles in a 60-degree banked turn*. That means we feel twice our normal weight in a level, 60-degree bank. The airplane's wings must support twice the weight of itself and its occupants.

As load factor increases, so does the airplane's stalling speed. But wait a second! We just finished saying that an airplane stalls as a result of angle of attack, not airspeed. And that is absolutely correct. It *is* a function of angle of attack.

Since most airplanes lack any instrument that tells us the angle of attack, we let the airspeed indicator *imply* the angle of attack. In a certain configuration, say straight-and-level, the critical angle of attack will occur at Vs, the airplane's stalling speed as specified in the POH. In another configuration, a 60-degree banked turn for example, the critical angle of attack occurs at a higher airspeed. The increase in load factor caused by the bank causes the airplane to stall at a speed higher than Vs. The stall speed is higher, but the critical angle of attack remains the same.

So, we can say that stall speed increases as load factor increases even though its really the critical angle of attack that we're dealing with. Think about that: Stall speed increases as load factor increases. We are more likely to stall the airplane in a bank than in straight and level flight because the stall speed is higher.

Left Turning Tendency

Propeller driven airplanes have a built in tendency to turn to the left. That actually applies to most, but not all propeller driven planes. Those whose propellers turn to the right have this left-turning tendency. Airplanes whose propellers turn to the *left*, however, have a *right*-turning tendency.

Since most airplanes have props that turn to the right, we'll consider this left-turning tendency to be the norm.

The left-turning tendency is most apparent in conditions of high power, high angle of attack, and low airspeed. High power, high angle of attack, and low airspeed. Can you think of a couple of situations where those conditions exist? How about slow flight? That's definitely a situation where we have high power, high angle of attack, and low airspeed. Takeoff would be another one. In both cases, we counter this left-turning tendency with a little extra right rudder.

Left-turning tendency is caused mainly by three things:
(1) Torque,
(2) Spiraling slipstream, and
(3) P-factor

Left-turning tendency is caused by torque, spiraling slipstream, and P-factor. It is most noticeable in conditions of high power, high angle of attack, and low airspeed.

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Airspaces and Airports

Lettered Airspaces

The air that we fly through is divided into a variety of volumes, each with different names and different rules. We can first divide them into controlled and uncontrolled airspaces.

In controlled airspaces, some types of ATC services are available. ATC services included in controlled airspaces are Flight Following and IFR. These days, most of the controlled volumes of air are covered by radar. Thus, when we're flying around squawking 1200 on the transponder, we're probably showing up on someone's radar screen.

In uncontrolled airspaces, no ATC services are offered. There is only one type of uncontrolled airspace.

Airspace classes are identified by letter: A, B, C, D, E, and G.

A through E are *controlled*. Class G is the one *uncontrolled* airspace we noted.

Of the controlled airspaces, Class B, C, and D surround towered airports.

Class A airspace covers the entire continent, but never touches the ground. Class A begins at 18,000 feet MSL and continues upward. Think of "A" for "altitude." VFR flight is not allowed in Class A. You must have an IFR clearance any time you fly 18,000 feet or higher.

So, Class A is all airspace above 17,999 feet MSL.

Classes B, C, and D surround towered airports. We already said that. You need to know that there are approximately 30 Class B airports in the United States. You must have an explicit clearance to enter their airspaces. Examples include Atlanta, Los Angeles, New York, and Chicago. Small airplanes generally stay away from Class B airports.

That leaves us with Class E. What is it? It is every other cubic inch of controlled air. Think of "E" for "everything else." E is all controlled airspace that is not A, B, C, or D. It usually starts at 1,200 feet AGL.

Except when we're near an airport, most of our VFR flying is done in Class E. Remember, Class E represents the controlled airspace outside of the airport airspaces.

Class **A**	*controlled*	Altitude greater than 17,999 feet MSL; *IFR only*
Class **B**		Biggest airports; shaped like an inverted wedding cake
Class **C**		Congested airports, but less so than Class B
Class **D**		Down-home airports; shaped like a column or a drum
Class **E**		Everything else that is controlled; usually starts at 1,200 ft. AGL
Class **G**	*uncontrolled*	Ground upward; may contain untowered airports

Class E airspace usually begins where the Class G *below* it ends. Class G starts at the ground and generally extends upward 1,200 feet. Then Class E takes over and continues up to 17,999 feet. From there it's Class A all the way up to 60,000 feet. I suppose NASA takes charge from there.

Now that is a generalization of Classes G, E, and A. There is an exception. In a few cases, Class E extends all the way to the surface around some untowered airports. On a sectional, they are designated by a magenta segmented circle. That's FAA verbiage for "a purple dashed line." So, in *these* cases, Class E starts at the ground and goes up to the overlying Class A, starting at 18,000 feet.

Special Use Airspaces

In addition to the lettered airspaces, there are a variety of special use airspaces scattered around the country. Examples include:
MOA
TRSA
Restricted
Prohibited
and TFR.

A MOA is a Military Operations Area. On sectional charts, MOAs are surrounded by magenta hatched outlines. VFR flight is allowed inside of a MOA, but it is a good practice to avoid these areas when there is ongoing military activity.

A TRSA is a Terminal Radar Services Area. This is an area, generally surrounding a busy Class D airport that is under control of an approach controller. On sectional charts, TRSAs are surrounded by concentric dark gray circles. VFR flight is allowed inside of a TRSA, and communication with the controller is recommended, but not required. That is a favorite question of examiners – *participation in TRSA services by the pilot is voluntary.*

Restricted Areas are identified on sectional charts by a blue hatched outline, and labeled with a bold letter R followed by identifying numbers. You must have a permission from "the controlling agency" to enter a restricted area (if it is active or "hot").

Prohibited Areas are also identified on sectional charts by a blue hatched outline. Inside, however, is a bold letter P followed by identifying numbers. Flight inside of prohibited areas is, well, prohibited. Don’t go there. If you do, expect to have your license suspended afterwards.

TFR stands for Temporary Flight Restriction. These are locations where flight is either severely restricted or prohibited altogether. Because of their temporary nature, they do not appear on any charts. TFR areas have become much more common since 9/11. They might pop up while important politicians are visiting or a large gathering of people is ongoing. It is really important to find out if there are any TFRs in your path before embarking on a trip. Flight Service can give you this information when you get your briefing. If you fly with Flight Following, ATC will probably tell you if any TFRs are ahead, but ultimately, it is your responsibility to know where they are and avoid them.

Entry Into Airspaces

For Class A, you must have an IFR clearance to enter. No VFR flight at all in Class A.

For Class B, you must have an explicit clearance to enter. Just talking to ATC is not good enough. The controller must say “cleared into the Class Bravo” before you enter. A transponder is required for entry into Class B airspace.

For Class C, you must be in communication with the ATC controller who covers the area. As long as he has said your tail number, you can consider yourself to be in communication with him. A transponder is required for entry into Class C airspace.

For Class D, you must be in communication with the tower controller at the airport. As long as he has said your tail number, you can consider yourself to be in communication with him. A transponder is *not* required for entry into Class D airspace.

For Class E, there are no special requirements for entry. As we said, you will be in Class E during most of your VFR flight.

Class G is uncontrolled and there are no special requirements for entry. Class G normally starts at the ground and extends upward to either 700 feet or 1,200 feet AGL.

For a MOA, there is no special requirement for entry, but it is recommended that you talk to ATC to find out if the area is “hot.” That means that the military is using it. If so, it is best to avoid it altogether. If you do decide to enter a MOA, use extreme caution and keep your eyes outside the cockpit.

For a TRSA, there is no special requirement for entry. If you wish to participate in the services, contact the approach controller who covers the area and he will give you a transponder squawk code. Obviously, you must have a transponder to participate.

Airport/Facility Directory

Airport/Facility Directories, or A/FDs for short, are the ubiquitous green books that provide all the legal information for airports. Each AFD covers an area of several states. They are issued every 56 days. Make sure that the one you bring to your checkride is current.

When you look up an airport in an A/FD, be aware that they are in alphabetical order by city, not by airport name.

Underneath the city name, you will see the name of the airport followed by its identifier. Below that, the airport's elevation above sea level will be listed as a number.

The remainder of the listing will give you the runway numbers, lengths and widths, radio frequencies, and remarks about operations at the airport. If an explicit traffic pattern altitude is listed, make note of it. Else, round the field's elevation to the closest hundred feet and add 1,000 to it.

Unless otherwise specified, remember that standard traffic pattern turns are to the left.

Make sure that you spend time studying the legend in the front of the A/FD so that you are extremely comfortable interpreting it properly.

Note: *It has become commonplace to use smartphone or tablet apps such as ForeFlight to look up airport information. For your checkride it is strongly recommended that you bring the official hardcopy version of the A/FD and use that.*

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Emergencies

In any emergency, if possible, use the emergency checklist for your airplane. If you have a co-pilot aboard, ask him or her to find it and read it to you. Honestly, though, unless you're really high, you may not have the time or presence of mind to dig out a checklist and read it. Thus, develop general procedures for emergencies and memorize them.

Loss of Power in Flight

In general, upon losing your engine, the first thing you do is establish your airplane's best glide airspeed. In the case of a climbout immediately after takeoff, that would imply that you lower the nose. This is one that many examiners will ask you about.

By establishing best glide speed, you guarantee yourself the maximum distance in your glide. That makes sense because you are trying to reach the best landing area and it might not be immediately below you.

So, even immediately after takeoff, best glide speed is your first reaction. However, if the examiner asks what you do if your engine quits right after takeoff, he wants you to say, "Lower the nose!"

That's right. Lower the nose to reduce the angle of attack. This minimizes your chances of stalling your already crippled airplane. So yes, you are going for best glide speed, but think of this case as lowering the nose to reduce the angle of attack. THEN worry about establishing your best glide speed.

Here's a good memory checklist for loss of power in flight: A – B – C

A – Airspeed. Establish your airplane's best glide airspeed and trim it to stay there, hands off.

B – Best landing area. Maybe there aren't any great spots within gliding distance. Your job is to find the *best* of your options. Beware of power lines or other obstacles that you might not see until you are close to the ground. Ideally, fly a standard pattern and land into the wind. Keep the weight off the nose wheel even after touchdown.

C – Cockpit duties. You have things to do in the cockpit, most noticeably, to try to restart the engine. If the engine quits right after you did something, go back and reverse what you just did. Otherwise, carburetor heat goes on, mixture goes rich, and think about swapping tanks. If you simply ran a tank dry, usually just switching to a different tank will get the engine running. If you have a fuel pump, turn it on. Next, try different mag settings. Maybe the engine will run on one of the mags better than the other. If the prop has stopped turning, engage the starter.

After trying your restart unsuccessfully, get on the radio. Hopefully you're already on Flight Following. If so, all you have to do is say, "Mayday, mayday, mayday," followed by your callsign. They know where you are so you are relieved of having to figure out your location. Otherwise, if you're on someone's tower frequency, use it. As a last resort, try the guard channel: 121.5. If you have time, squawk 7700 on your transponder so that controllers can pick you out of the clutter on their screens.

One important thing to remember: do not go through your ABC checklist, one item at a time. Start each item in order, but you should be doing them all at once. For example, you've started slowing the airplane to best glide speed. While you're doing that, you should already be looking for your best landing spot. And while you're looking, be turning the carb heat and fuel pump on, pushing the mixture in, and switching fuel tanks. It will be a very busy time, but get those items going. Don't wait to complete A before moving on to B!

Finally, before touchdown, turn off the fuel valve and master switch and crack the door so that it does not get lodged shut.

Fire or Smoke in the Cabin

Cabin fires are usually electrical in origin. Frequently they are the result of chaffed wires or a shorted switch.

The first thing to do if you see smoke or suspect an electrical fire is to turn off the airplane's master switch. Hopefully, this will stop the smoldering. If so, you should land at the first available airport and diagnose the problem on the ground.

Another, more risky option after turning off the master and seeing that the smoke has stopped is to turn all your avionics and lights off, then turn the master switch back on. Carefully note whether the smoke returns. If you are positive it has not, one by one, turn the avionics back on. You may be able to detect which component is causing the smoke and simply keep that one turned off.

If there is flame associated with the smoke, I hope you have a fire extinguisher handy. Turn off the master switch and use the extinguisher to kill the flames. Most airplanes say to close all the vents in the airplane in the event of a cabin fire. The theory is that this will reduce the oxygen needed to sustain the fire. Personally, I'm not sure I buy that. Pilots also need oxygen. And I am not convinced that you could reduce the oxygen supply enough to hurt the fire anyway. But that's just me. I recommend that you study your POH and do whatever it says in the case of a fire.

Engine or Wing Fire

Again, your POH will be the oracle for this one. Study it and be prepared to do what it says. Generally speaking, turn the fuel selector valve to the off position and perform an emergency descent. If the flames are lapping toward the cockpit, slip the airplane in the descent to blow the flames to the side. Get on the ground!

Fire While Starting

As before, study your POH and be prepared to do what it says. Generally speaking*, if the fire starts while cranking, keep cranking.* With some luck, when your engine starts, it may suck the flames back into the cylinder.

Carburetor Ice

This one does not have to turn into an emergency if you recognize the symptoms early.

Because of the physics of refrigeration, air gets cooled as it rushes through the carburetor throat by as much as 40 degrees Fahrenheit. That's why you can get carburetor icing on a 70-degree day. It doesn't have to be freezing outside to suffer from carburetor icing.

The first signs of ice might be roughness in the engine sound. Fluctuations or a reduction in RPM (or manifold pressure if you have a constant-speed prop) might be noticed.

When carburetor heat is first applied, you may see a further reduction in power as the frost in the venturi melts and is ingested into the engine. Soon, however, the power (RPM or manifold pressure) should start to come back up again. If that happens, problem solved. Continue your flight with the carb heat on.

Remember that carburetor heat degrades the performance of the engine. You will not get your pre-icing power back fully. Oh, and don't forget – fuel injected engines don't have a carburetor. If you have fuel injection and notice engine roughness or loss of power, look elsewhere for the problem.

Structural Icing

This is one that most VFR pilots should *never* have to experience. *To get structural ice, you must be in visible moisture and the temperature must be at or below freezing.* Unless you are in the clouds or flying through freezing rain, you aren't going to collect any ice.

If you believe that you may encounter icing conditions, immediately turn the pitot heat and windscreen defroster on. These are considered anti-icing devices. De-icing devices are not commonly found on light single engine aircraft. They would include expandable leading edge boots or chemical drip systems on wings and propellers.

Sometime, a chance dash through a tenuous cloud may result in a layer of frost on the windscreen or leading edges of the wings. If that happens, turn on the defroster and ensure that you stay out of additional moisture. The frost should disappear naturally through sublimation. If it doesn't, try to stay VFR and land as soon as practical.

Buildups of ice are dangerous since they add considerable weight to the aircraft, while reducing lift and increasing drag. If you land at an airport carrying a load of ice, make sure that you approach at a faster-than-normal airspeed. With all that junk on your wings, your stall speed may be significantly higher.

If you find yourself stuck in the clouds, collecting ice, the rule of thumb says to climb. This may require a huge leap of faith, but give it a try. The theory is that colder air can hold less moisture. Thus, if you can get to a higher, colder level, you may find dryer air and the ice you carry can begin to sublimate away.

Icing can become a severe emergency condition very quickly. Even after you get your private pilot certificate, I strongly recommend that you study icing further. Read about it in textbooks, and consider attending some of the FAA and AOPA seminars that are frequently held. Knowledge is life.

High Density Altitude

While not an emergency, the existence of high density altitude is something that a pilot certainly wants to be aware of. By definition, *density altitude is pressure altitude corrected for non-standard temperature.*

Density altitude is pressure altitude corrected for non-standard temperature.

True altitude is the altitude above mean sea level.

Absolute altitude is the altitude above the surface.

Standard temperature is 15 degrees Celsius or 59 degrees Fahrenheit.

Standard pressure is 29.92 inches of mercury.

High density altitude can be confusing. It means that the air, in terms of density, has the quality of air at a higher true altitude. Thus, high density altitude identifies air which has a lower than expected density. *High density altitude describes low density air*.

On high density altitude days, air is less dense than normal and airplanes perform worse than normal. The engine breathes less dense air and produces less power. Fewer air molecules move through the prop reducing thrust. And fewer molecules dash over the wings creating less lift.

Plan on longer than normal takeoff runs on high density altitude days as well as more sluggish climb performance.

High temperature and high humidity produce high density altitudes. A solution to the problem is to plan your takeoffs early in the morning when the air is cooler and consider offloading some quantity of baggage or fuel to reduce the airplane's weight. Fuel weighs six pounds per gallon.

Wake Turbulence Avoidance

All aircraft trail swirling vortices of air while they are flying. These vortices spin off the wingtips of airplanes as a byproduct of lift. Wake turbulence is most severe when the producing aircraft is heavy, clean, and slow. Size and weight differential contribute greatly to the effect of wake turbulence on small aircraft.

The pair of vortices can trail for several miles behind an airplane. They have a tendency to sink below the producing aircraft's flight path and are blown by existing winds. Thus, *the simplest method of avoidance is to remain on a higher flight path, upwind of the producing aircraft*.

On landing, touch down further down the runway, past the landing point of the larger aircraft.

On takeoff, become airborne prior to the larger aircraft's point of rotation. Stay above and upwind to the larger aircraft's flight path.

Wake turbulence is most severe when the producing aircraft is heavy, clean, and slow.

Dryden Flight Research Center ECN 3831 Photographed 1974
B-727 vortex study NASA photo

Weather

This is a broad area and there is no guarantee what your examiner may have as favorite topic. Generally, an examiner will probably not grill you in the same detail that the written test did. But he can. Go back and review everything. I'll give you the most common topics that you can expect to discuss in your oral exam.

Temperature and Air Movement

Weather results from a heat exchange. You probably remember that from your written test preparation. Heated air expands. Thus, a given volume of warm air will contain fewer molecules than the same volume of cooler air. *Heated air rises, cooled air sinks*. That results in the vertical air movement we call *convection*.

Air Pressure and Air Movement

Cool air is more dense and weighs more than warm air for the reason sited above. It contains more molecules per given volume. Humidity also contributes to air density. *Dry air weighs more than humid air*.

Air masses separate themselves because of their differing amounts of pressure. A dense air mass will exhibit a relatively higher pressure than a less dense air mass. These fluid air masses tend to push each other around due to the differences in pressure. The lateral movement of air is called *advection*. More commonly, we refer to it as wind.

Some weather charts connect points of equal pressure by lines called *isobars*. When isobars are close, expect to see higher winds since the pressure differential will be more pronounced. Remember that - it's a common question asked in oral exams. *Isobars are lines that connect points of equal barometric pressure.*

Clouds, Fog, and Dewpoint

Fog, by definition, is a cloud that occurs within 50 feet of the ground. Otherwise, clouds and fog are the same thing. They are simply local masses of air that are saturated with water vapor.

Why are some clouds white while others are black? It has nothing to do with rain or water content. Clouds are 100% saturated, so one cannot hold any more water vapor than another one. All clouds are essentially white. When they appear black, it is only because less sunlight is being filtered through. A black cloud is simply a white cloud in a shadow.

Any volume of air is saturated when its temperature reaches the dew point. When we listen to the temperature and dew point on the ATIS, we are simply trying to determine how far apart these two numbers are. If temperature and dew point are close, the air will be close to the point of saturation. If temperature and dew point on the ground are equal, expect to see fog.

Air Stability

Air masses are divided into two categories: stable and unstable. This distinction is very significant to pilots since it tells us what type of weather to expect. In real life, we would normally see some combination of stable and unstable conditions. There is usually not a sharp line between the two.

Stable air will usually be smooth, but have poor visibility. Storms are not likely, but we might expect fog, clouds, and possible steady rain.

Unstable air will usually be choppy, but have good visibility. Thunderstorms are more likely to appear.

Stratiform clouds are associated with stable air.

Cumuliform clouds are associated with unstable air.

Stable air is characterized by stratiform clouds, poor visibilty, and smooth air.
Unstable air is characterized by cumuliform clouds, good visibility, and turbulent air.

Thunderstorms

Thunderstorms are violent, local phenomena that include rain, high winds, and lightning. That's right, thunderstorms always have lightning. Big surprise, huh? Without lightning, you have no thunder, and you have a storm, but not a thunderstorm.

Thunderstorms may sometimes appear in lines. These are called *squall lines*. Frequently, they appear at the leading edge of a moving front.

Three conditions are required for a thunderstorm to develop.
(1) High humidity,
(2) Unstable air, and
(3) A lifting force

Thunderstorms develop in three distinct stages.

Cumulous Stage – Unstable, humid air is lifted and cumulous clouds begin to tower. The cumulous stage of thunderstorm is characterized primarily by updrafts.

Mature Stage – The top of the cumulonimbus cloud starts to spread and rain begins to fall. Both updrafts and downdrafts are present. This is the most violent stage of a thunderstorm.

Dissipating Stage – The updrafts that feed the storm cease, and air movement becomes primarily downward as the storm collapses on itself.

In VFR flight, we can frequently see the towering cumulous clouds that identify a thunderstorm. In these cases, give them a wide birth and simply fly around them. Never attempt to fly underneath a thunderstorm. Severe turbulence, heavy rain, and possible hail are likely to greet you. Wind shear can appear at any altitude and in any direction.

If we are flying IFR in the clouds, we need to be especially cautious of embedded thunderstorms. Hidden in the surrounding clouds, we could stumble into one without ever seeing it. A forecast of embedded thunderstorms might be a good reason to stay on the ground.

Lines of thunderstorms are to be avoided altogether. Park the airplane and go catch a movie.

If you inadvertently find yourself in a thunderstorm, do not attempt to hold your altitude. Maintain a level *attitude* and try to fly your way out.

Cloud Coverage

A ceiling is defined as the lowest layer of broken or overcast clouds. There is an easy memory aid to remember the order of cloud coverages. In the real estate business there is a term called FSBO (pronounced FIZBO). It stands for "for sale by owner." The same acronym works for clouds.

FSBO – Few, Scattered, Broken, Overcast

Types of Fog

Here's a phrase that will help you remember the types of fog:
"Fog usually seems present after rain."

That gives you the letters U, S, P, A, R.

U – Upslope
S – Steam
P – Precipitation Induced
A – Advection
R - Radiation

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Weather Reports

Relating to weather reports:
Ceiling – Lowest layer of broken or overcast clouds
IFR – Ceilings less than 1,000 feet and visibilities less than three statute miles
MVFR – Ceilings between 1,000 and 3,000 feet AGL and visibilities from three to five statute miles

Weather Briefings

The primary means for obtaining a weather briefing is for the pilot to call Flight Service at 1-800-WX-BRIEF.

Three types of weather briefing are available.

Standard – This one gives you everything you need for your flight. Generally, prior to a flight you should request a standard briefing.

Abbreviated – This would be requested when you had previously received a standard briefing and simply wanted an update on some specific conditions.

Outlook – This type of briefing is requested six or more hours prior to your departure time.

The first thing given in a standard briefing is **adverse conditions**. If a line of thunderstorms, for example, existed across your flight path, you might choose to cancel the trip altogether and the remainder of the briefing would not be necessary.

Next you are given a **synopsis**. It is an overview of current conditions in the broad geographical area.

Following that, **current conditions** are given at your departure, enroute, and destination points.

Forecast conditions are provided next at your departure, enroute, and destination points.

Winds aloft are given at three thousand foot intervals as you request. You may need to interpolate to discern the forecast winds that will affect you.

Finally, the briefer will describe **NOTAMs** that may affect you and will indicate the presence of any TFRs along your route of flight.

Remember: the types of briefings available are standard, abbreviated, and outlook.

AIRMETs

An AIRMET is an advisory of significant weather conditions primarily of interest to smaller aircraft. Issued every six hours, AIRMETs report IFR conditions, moderate turbulence, moderate icing, and surface winds of 30 knots or greater.

SIGMETs

A SIGMET is an advisory of non-convective conditions hazardous to *all* aircraft. SIGMETs report severe turbulence, severe icing, and obscurations due to duststorms or volcanic ash. SIGMETs forecast conditions for a maximum of four hours.

Convective SIGMETs

A Convective SIGMET is basically a SIGMET associated with thunderstorms. The text of the bulletin contains either an observation and a forecast, or only a forecast. Forecasts are valid for a maximum of two hours.

METARs

A METAR is a routine weather report. It is an hourly observation at an airport. It is one of the more common types of textual weather reports that pilots and briefers consult.

TAFs

A TAF (Terminal Aerodrome Forecast) is a 24-hour forecast of conditions expected within five statute miles of an airport. It is also a commonly used textual weather report.

Aviation Area Forecasts

An Aviation Area Forecast (FA) is general weather forecast that covers several states and uses abbreviations similar to those used in TAFs. They are issued three times a day.

Internet Provided Weather Charts

Although pilots used to consult a wide variety of weather depiction and prognostic charts, today most people consult more modern representations of the weather on the Internet.

In general, radar charts show current conditions of precipitation. Radar shows rain, hail, and snow, but does not show clouds.

Satellite charts show clouds, but do not show precipitation. Visible satellite depictions only show clouds in daylight. Infrared charts show clouds in day or night, evaluating them based on their temperature.

Many online weather services show composite charts which overlay radar and satellite images for a more complete picture.

Surface Analysis Charts

Generated every three hours, a Surface Analysis Chart shows fronts, winds, and temperature/dewpoints across the contiguous United States. This is the type of overview chart that you usually see in newspapers and on television weather reports.

Significant Weather Prognostic Charts

Also called Low Level Prognostic Charts. The term "Prognostic Chart" is simply a Surface Analysis chart shown as a forecast in increments of 12 hours into the future. Nothing special except that the aviation version outlines areas of IFR, MVFR, and significant turbulence. The FAA written test, at the time of this writing, still assumes that the government meteorologists and Flight Service briefers are using the old style fax charts. They aren't. Thus, the old four-panel black and white Significant Weather Prognostic Chart that you will be tested on is virtually non-existent. There are Internet based four-panel charts, shown in color, but they tend to be used less frequently than other single panel charts.

Weather Depiction Charts

The Weather Depiction Chart shows fronts, cloud coverage at reporting stations across the country, and outlines current areas of IFR and MVFR. It is peppered with small circles that represent reporting stations. The circles are filled in to indicate cloud cover.

Radar Summary Charts

These charts are produced hourly and identify areas of precipitation and discrete cells. Honestly, I don't know why anyone would look at one of these when you can get realtime radar on the Internet. These charts do give maximum tops.

In-Flight Weather Information

While in flight, you can talk to a weather briefer on 122.0. This facility is called Flight Watch. Tell them your approximate location on your initial call. That will enable the briefer to talk to you via the closest ground transmitter.

HIWAS is a recorded broadcast of hazardous weather transmitted over the voice channel of some VOR stations. You can locate them on your sectional. The availability of HIWAS will be indicated by a small circle with the letter "H" in it within the VOR information box.

If you are being tracked by Flight Following, ATC controllers may be able to tell you about precipitation that is close to you. For weather further away, you'll have to check with Flight Watch.

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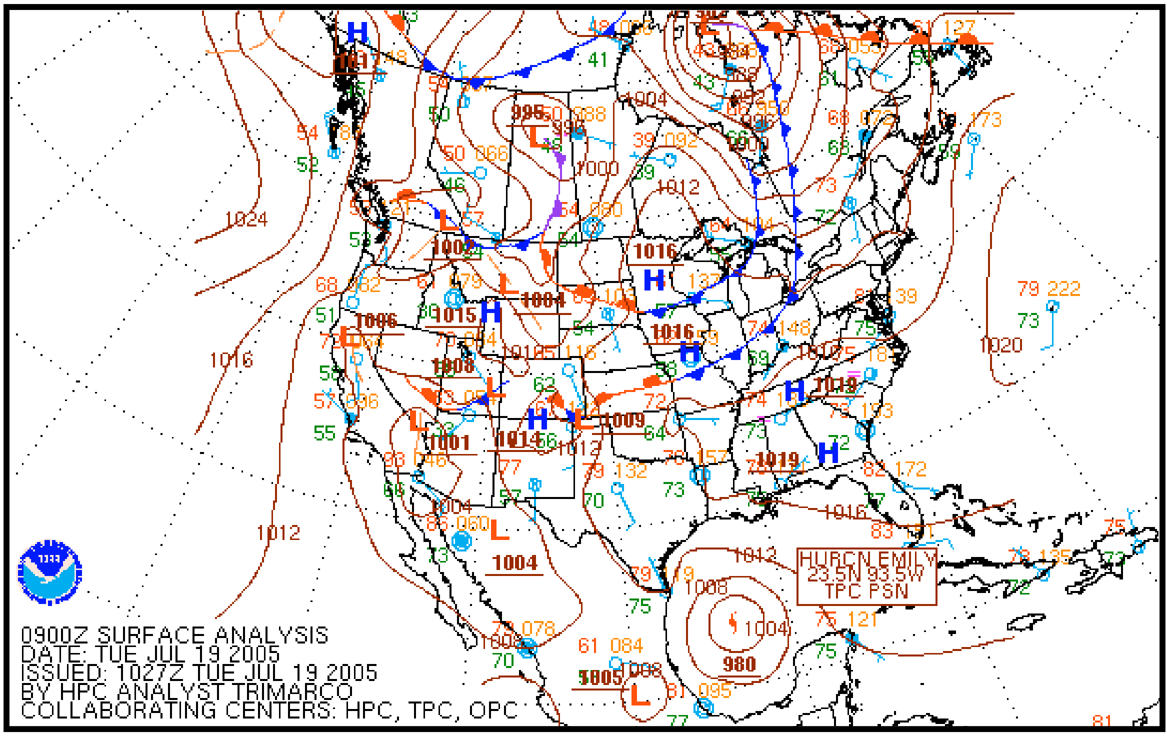
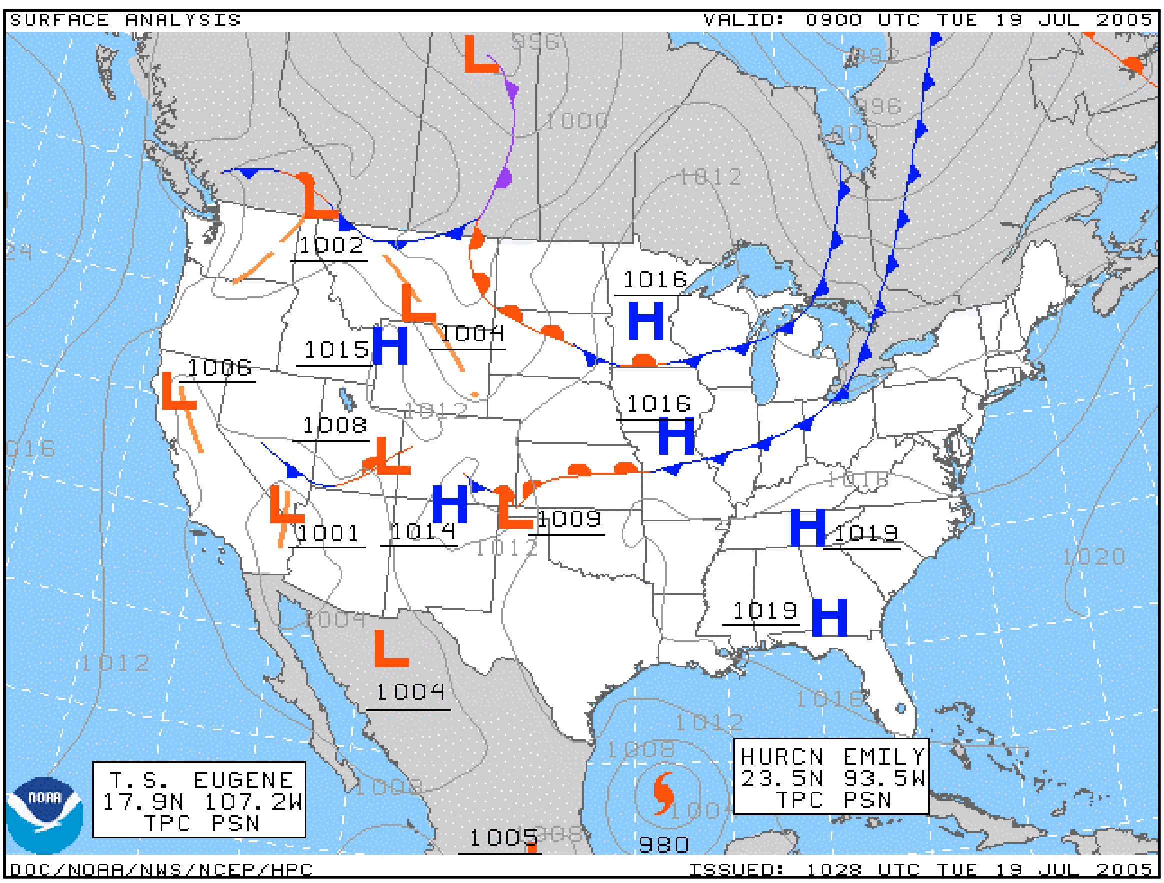
Surface Analysis Charts

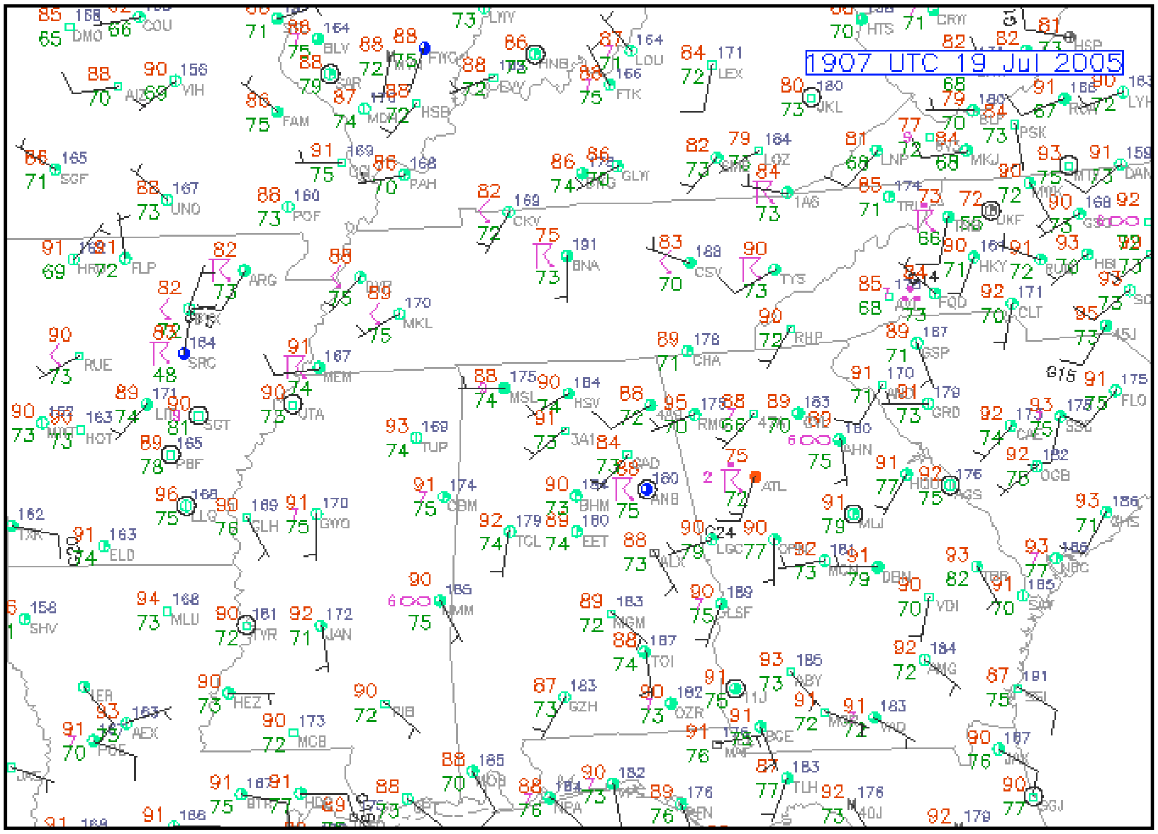
Both charts are different graphical representations of the same thing, although the top chart shows more detail from specific weather reporting stations (including temp/dewpoint and winds).

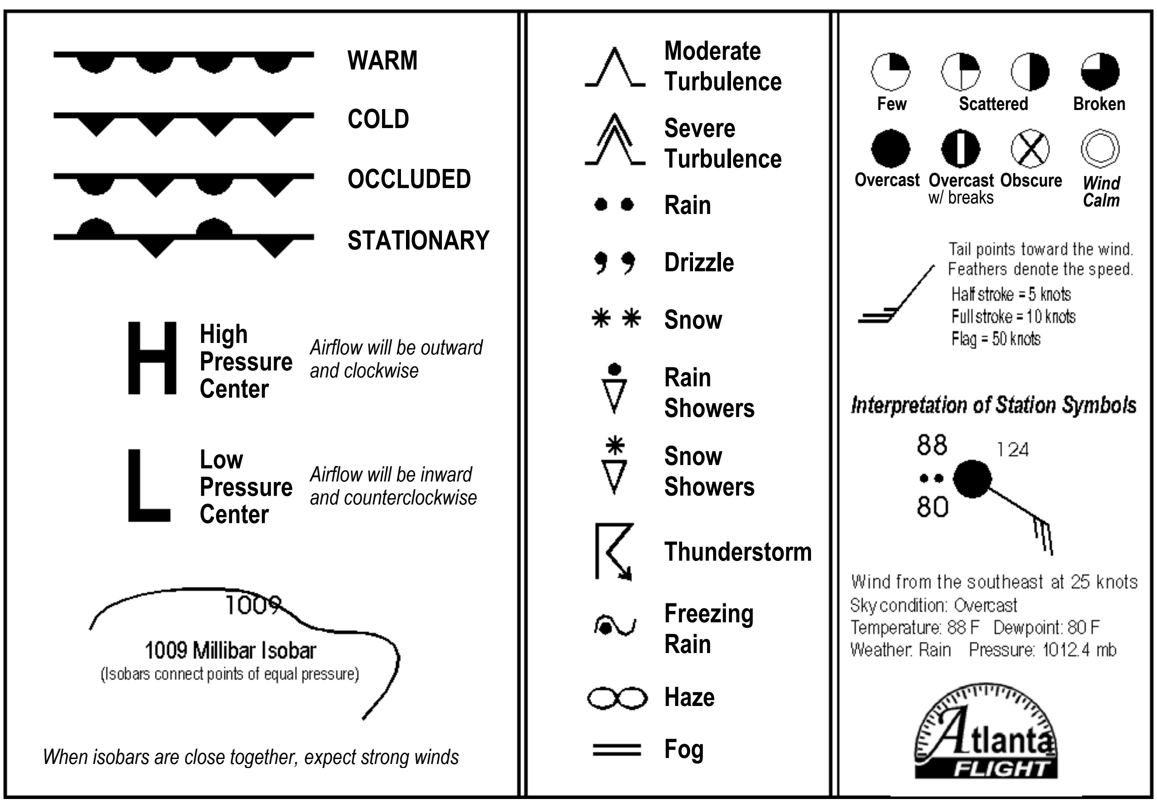




Another Surface Analysis Chart – Southeastern United States

This is one you probably won't see on an FAA test, but it is commonly used by meteorologists.





METAR - ***A METAR is an observation of current conditions.***

METAR KPDK 151645Z 12010G18KT 10SM SKC 24/15 A3001
METAR KLAX 101212Z 08004KT 6SM BR SCT008 BKN090 17/16 A2996

Interpretation:

(1) METAR: Reporting station is KPDK, observation on the 15th of the month at 1645 Zulu.
Winds – from 120 at 10 knots, gusting to 18 knots.
Visibility – ten statute miles.
Sky clear.
Temperature 24 degrees Celsius, dewpoint 15 degrees Celsius.
Altimeter – 30.01 Hg.

(2) METAR: Reporting station is KLAX, observation on the 10th day of the month at 1212 Zulu.
Winds – from 080 at 4 knots.
Visibility – six statute miles in mist. ("BR" = mist, "HZ" = haze, "SHRA" = showers, "TSRA" = thunderstorms)
Scattered clouds at 800 feet AGL, broken clouds at 9,000 feet AGL.
Temperature 17 degrees Celsius, dewpoint 16 degrees Celsius.
Altimeter - 29.96 Hg.

TAF - ***A TAF is a forecast.***

TAF KCLT 290530Z 290606 VRB06KT P6SM SCT060 OVC120 TEMPO 2124 SHRA FM0200 09010KT 3SM OVC015

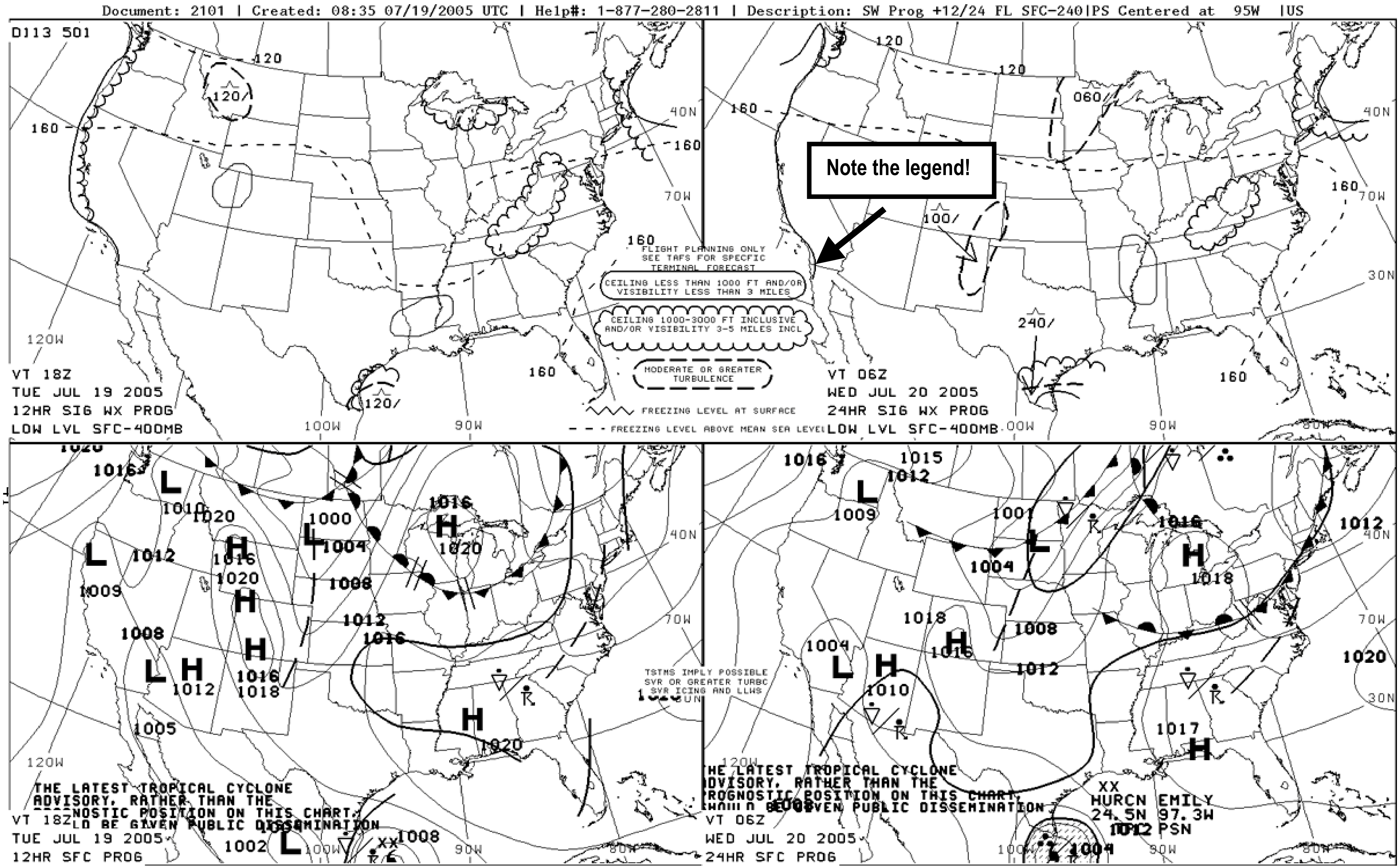
Interpretation:

TAF: Forecast within 5 statute miles of KCLT. Prepared on the 29th day of the month at 0530 Zulu. Valid from 0600 Zulu on the 29th until 0600 on the following day.

Winds variable at 6 knots. Visibility greater than 6 statute miles ("P" means plus or greater than). Scattered clouds at 6,000 feet AGL, overcast at 12,000 AGL.

Temporarily, between 2100Z and 2400Z, rain showers are expected.

Beginning at 0200 Zulu, winds from 090 at 10 knots. Visibility 3 statute miles. Overcast at 1,500 feet AGL.



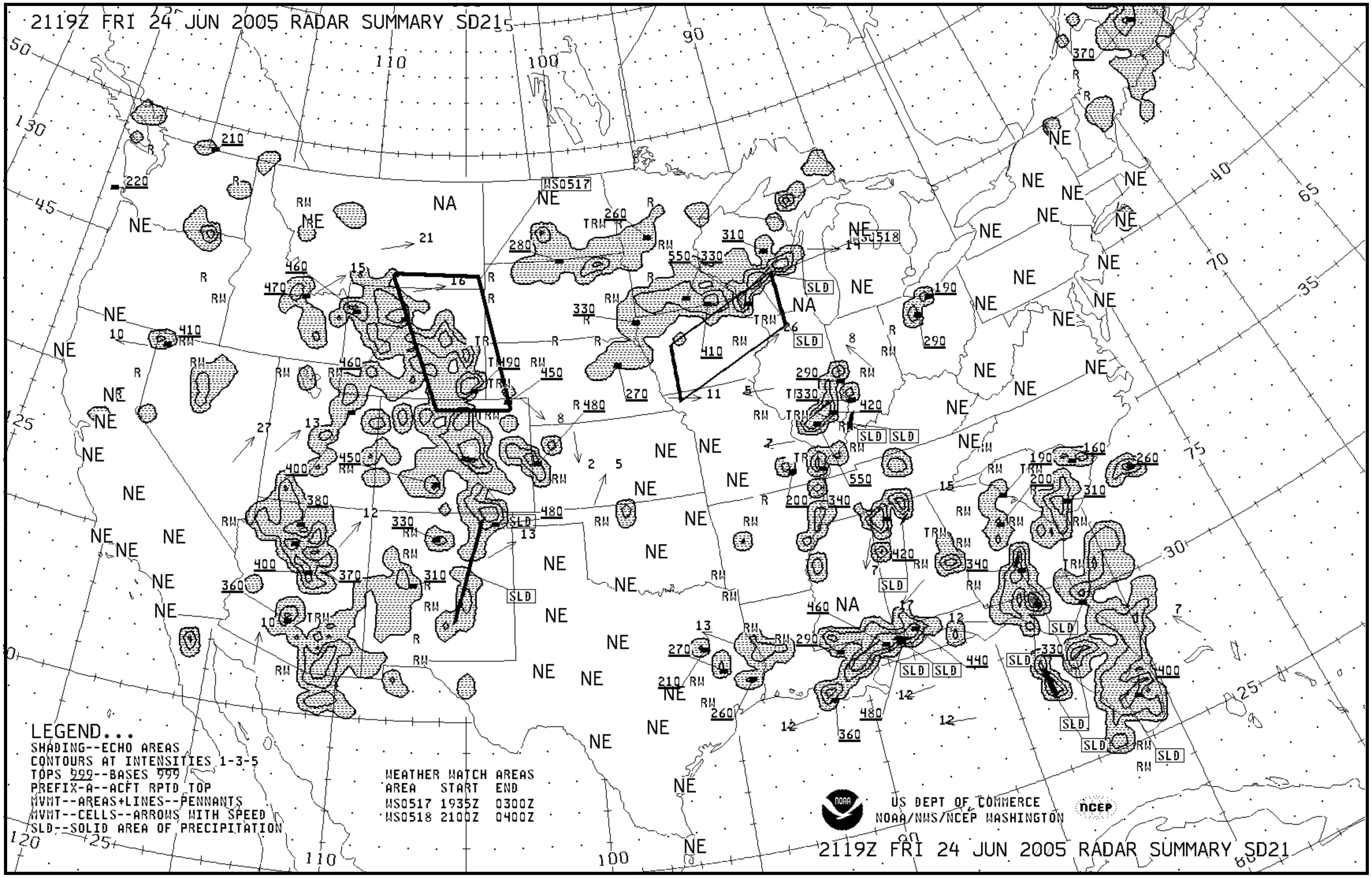
The Significant Weather Prognostic Chart is broken up into four panels. Modern Internet-distributed charts are in color, but the ones on the FAA test are black and white like this one.

The top two panels show forecasts from the surface to 24,000 feet. The bottom two panels show forecasts at the surface. The two left panels give a 12-hour forecast. The two right panels give a 24-hour forecast.

Areas surrounded by solid outlines indicate areas of IFR conditions. Scalloped outlines surround areas of MVFR conditions.

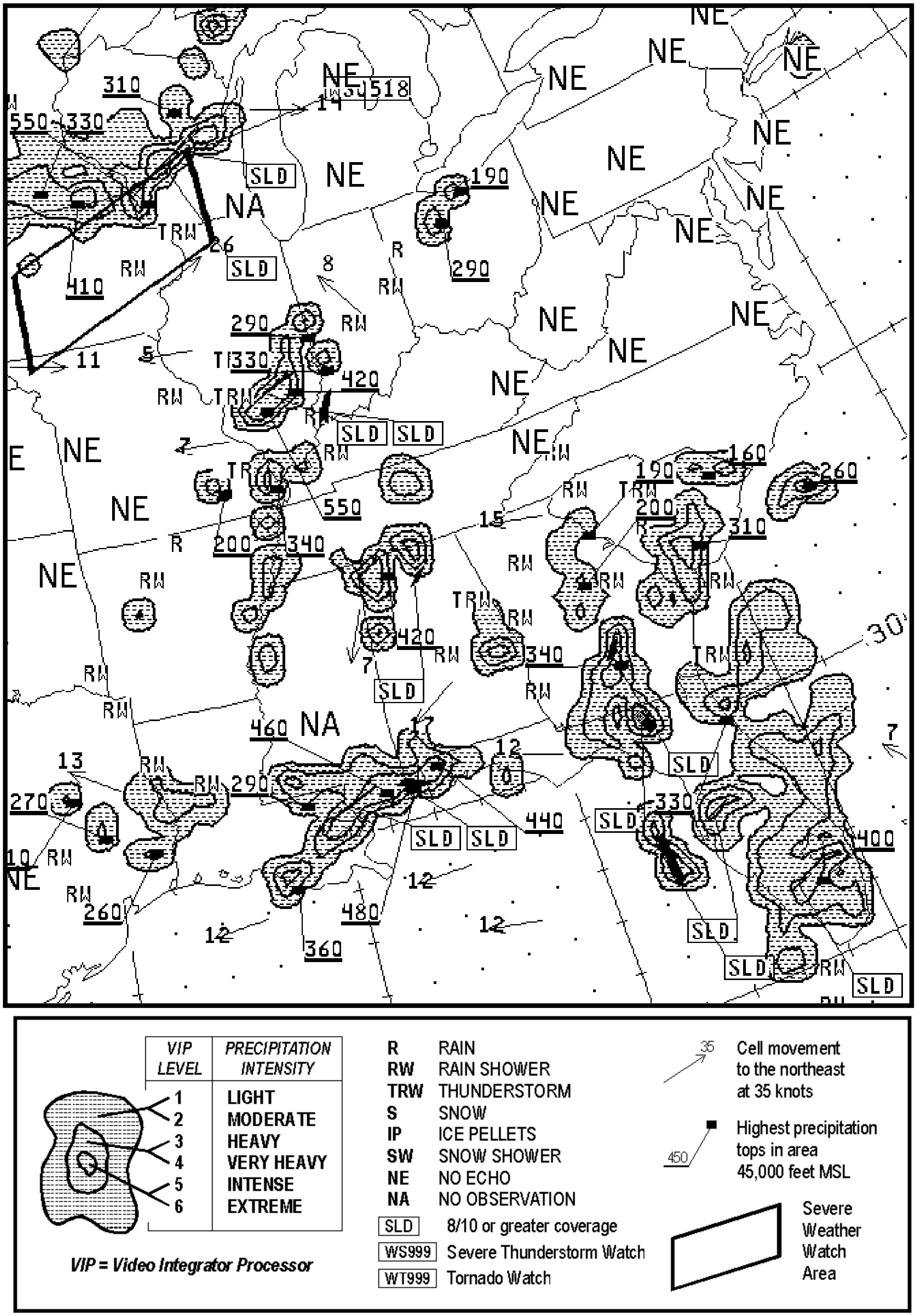
Light dashed lines indicate the freezing level above mean sea level. Heavy dashed lines surround areas of moderate or greater turbulence.

Shading indicates that precipitation covers at least half of the area.



Although FAA written exams may show dashed rectangles, in real life, Severe Weather Watch Areas are outlined with sold rectangles as shown here. Areas of precipitation are shown in concentric, irregular outlines in increasing levels of severity. “NE” means “no echo”.

Closeup of Radar Summary Chart – Eastern United States



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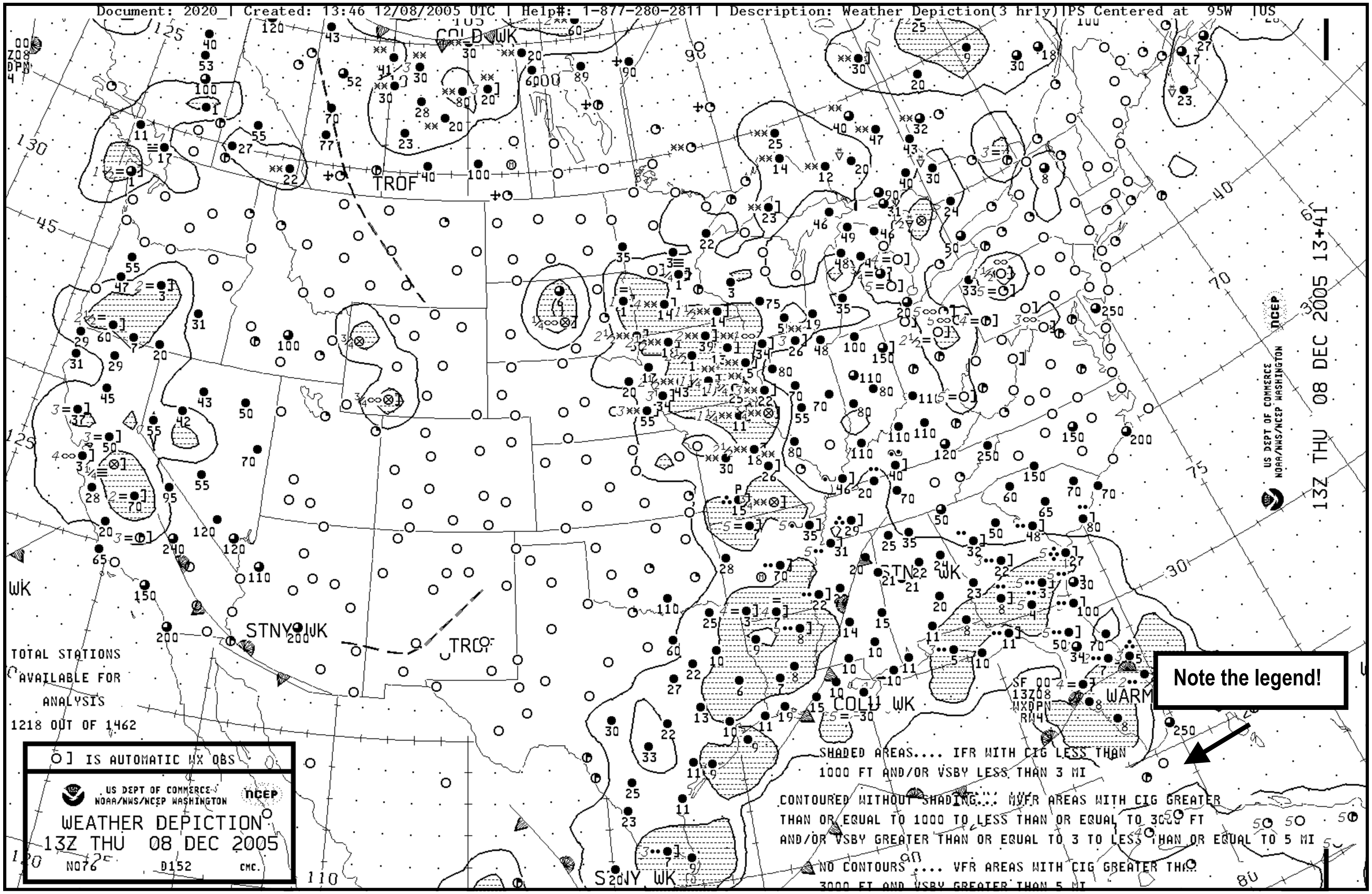
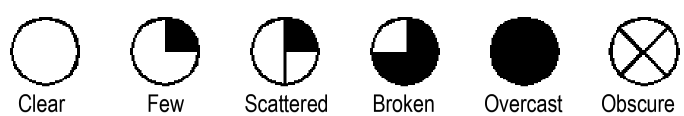


STNY Stationary
OCLD Occluded
TROF Low Pressure
WK Weak
CIG Ceiling



Each circle represents a reporting station. Bases of clouds are indicated in hundreds of feet AGL and appear below the circles.

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Aeromedical Factors

Hypoxia

You are already well aware that the higher you go, the less dense the air becomes. There are fewer molecules of air at higher altitudes. That means there is less oxygen available for breathing. Hypoxia is the condition that results. Hypoxia is caused by an oxygen deficiency in the body. Some people will start to feel the first signs of this at altitudes as low as 10,000 feet. Symptoms include headache, loss of alertness, dizziness, and inability to think clearly.

At night, vision may suffer from a lowered concentration of oxygen in the blood at altitudes as low as 5,000 feet.

Carbon Monoxide Poisoning

Carbon monoxide is a colorless, odorless gas that is produced as a byproduct of combustion. Ideally, all of the carbon monoxide and other exhaust gases are expelled from the engine through the exhaust manifold and harmlessly dissipate into the surrounding outside air. No system is perfect, though, and there may be some leaks. If carbon monoxide gets into the cockpit in sufficient concentration, disaster could be the result. This problem is particularly significant during winter when outside air vents are likely to be closed and the heater is turned on.

Carbon monoxide reduces the blood's ability to transport oxygen. As the concentration of carbon monoxide builds in the bloodstream, symptoms of hypoxia may appear. The ultimate result could be unconsciousness followed by death.

Opening outside air vents and using supplemental oxygen will reduce the likelihood of carbon monoxide poisoning.

Hyperventilation

Hyperventilation is a condition characterized by rapid, uncontrolled, shallow breathing. It is usually instigated by stress or anxiety. In this process, carbon dioxide is removed from the blood quicker than oxygen is added to it. Thus, the normal balance of carbon dioxide and oxygen is disturbed. Hyperventilation is frequently self-propagating.

Hyperventilation can be reversed by forcing a slower breathing rate. Breathing into a bag will cause the reabsorption of some of the expelled carbon dioxide. That's a very common trick. And talking out loud will help the sufferer to resume a more normal rate of respiration thereby reducing the effects of hyperventilation.

Motion Sickness

Motion sickness is caused by conflicting signals to the brain regarding movement and orientation. In a bank, for example, the eyes supply one message, the vestibular system provides another, and the body may feel unfamiliar G-forces. Taken together, these signals cause some amount of confusion in the brain. Stress and fear can be contributing factors. The result may be anxiety, weakness, sweating, dizziness, and ultimately, vomiting.

Most people have some initial tendency toward the symptoms of motion sickness. Generally, straight-and-level flight in calm air will not cause any of these symptoms to occur. But turbulence, abrupt changes in pitch, and steep banks can precipitate feelings of discomfort in many people until they develop a tolerance over the course of several flights.

When a pilot or passenger feels the onset of symptoms, straight-and-level flight should be assumed immediately. Direct cool air vents onto the person and suggest that they focus on objects outside of the airplane. Instruct them to avoid unnecessary head movements. If symptoms do not abate, a gentle descent to an airport landing is probably the best option.

Spatial Disorientation

Spatial disorientation specifically refers to the lack of orientation with regard to the position, attitude, or movement of the airplane in space. This type of confusion usually occurs when outside visual references are lost. The symptoms of motion sickness are not normally seen since the person experiencing it may not sense anything out of the ordinary.

The vestibular system frequently provides erroneous information to the brain during flight. In visual conditions, it isn't necessarily a problem since the pilot tends to believe his outside references. But place that pilot in the clouds or in dark nighttime conditions and he starts to react to his vestibular inputs.

Perhaps a turn is perceived when the airplane is in straight-and-level flight. Or maybe a descent is interpreted as a climb. A common example finds a pilot in IMC (instrument meteorological conditions) believing he is in a turn. He corrects to what he senses is straight-and-level. In reality, his correction may have placed the airplane in a turn in the opposite direction. As the lift vector is redirected into the horizontal, a turning descent or spiral develops. Airspeed increases as the spiral steepens. When the pilot realizes that something is amiss, he may not make the proper correction, or, worse yet, panic may set in.

Prevention is the obvious best solution to spatial disorientation. Without extensive instrument training, a pilot should avoid situations of limited outside visibility. If outside references are lost, the only course is to trust the instruments and ignore the sensations produced by the vestibular system.

Scuba Diving

Scuba diving subjects the body to increased pressure. This causes more nitrogen to dissolve in the body tissues and fluids than normal. When this occurs, a slow depressurization of the body is needed. Otherwise, nitrogen bubbles can form in the body. This painful and potentially incapacitating condition is called “the bends.”

Since we experience relatively rapid decreases in pressure when we climb in an airplane, flight should be avoided immediately after scuba diving. A minimum of twelve hours should be allowed between scuba dives and flight up to 8,000 feet MSL. For higher flights, wait at least twenty-four hours after the scuba dive is completed.

Night Flight

Most of the aeromedical issues relating to night flight result from diminshed vision. When flying at night, we may have more trouble seeing other aircraft. At altitudes above 5,000 feet, the reduced oxygen levels further limit our ability to see well. Additionally, depth perception may be impaired making it difficult to judge distances.

Before any night flight, ensure that you have adequate lighting on board the airplane. Your preflight inspection should include a thorough test of all the lights – cabin and external.

Take two flashlights with fresh batteries. Protect your night vision by avoiding looking into brightly-lit areas. While using a flashlight, place your fingers over the lens so that only a thin sliver of light is emitted. Red lights are good at preserving your night vision, but are difficult to use when reading sectional charts.

If you are subjected to bright light or flashes of lightning, cover one eye. This will help you to protect your night vision in that eye. Those black eye patches sold in drug stores work perfectly. Keep one in your flight bag.

Make your traffic scan slow and deliberate. Give your eyes time to focus on each section of sky. Look at dimly-lit objects slightly off center. If you find yourself in clouds or significant haze, turn off the strobe lights. Their reflection on the clouds could cause spatial disorientation.

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Airman's Practical Test Checklist

"Don't leave home without it."

Airplane

- AROW documents
- Aircraft Maintenance Records (i.e. the aircraft logbooks)
- Pilot Operating Handbook

Pilot Candidate

- Documentation
  - Photo identification
  - Medical/student pilot certificate
  - Logbook with necessary endorsements
  - FAA Form 8710-1 completed and endorsed
  - Computer test report from the FAA Knowledge Test
  - Examiner's fee

- Equipment
  - View-limiting device
  - Current sectional chart
  - Current Airport Facilities Directory
  - Current FAR/AIM
  - Computer and plotter
  - Pens and/or pencils with erasers
  - Flight plan forms
  - Electronic calculator

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