PHILIP GREENSPUN: All right, folks. Welcome back. So now we'll learn about the process of learning to fly and some of the regulations around it that will be on the test. All right, so when you learn to fly, you'll pre-flight the aircraft with the instructor. Learn about that-- how to inspect everything. The first few lessons are really about learning to see the aircraft attitude, seeing whether you're pitched up, pitched down, banked left or right. Most people have a fairly easy time with.

Then you learn to take off and land. As I said earlier, that takes about five or 10 hours. And in fact, people used to solo after four hours of flight training, especially young people. Now it takes a little longer, because they want you to know about more bureaucracy and how to talk to the control tower and so forth.

A good trainer airplane-- why not start with the best and just learn how to fly your personal Gulfstream or whatever. If it's a very heavy airplane like a Gulfstream, which can weigh 100,000 pounds, then you have to think ahead because of inertia. The airplane tends to keep doing whatever it was doing five or 10 seconds earlier.

At the same time, though, a really tiny airplane like some of the little two-seaters, they are unstable. And they just get kicked around by the wind so much that you're not sure if it's something you did or something that the environment did to you. Also people have gotten heavier. The owner of East Coast Aero Club says that when he started in the '80s 85% of the customers and instructors could train in the two-seat Piper Tomahawk. Now 85% require training in the four-seat Piper Warrior.

You don't want it to be too powerful, actually. And that's because when you go from-- on a go around, for example, and you go from near idle power to full power, that's a huge transition. And those left turning tendencies that Tina mentioned mean that you need immediate and significant rudder input and so forth. So an airplane that has a narrower band of possible powers is easier to learn on.

You want something that won't spin if it's abused. And also ideally an airplane that if you just let go-- the Cessnas tend to have this characteristic. They'll come out of most bad situations if you just let go of the yoke. So the best trainers-- my personal favorite is the Diamond DA-40. It's kind of physically uncomfortable, which is why I don't use it as a family airplane anymore.

The Cessna 172 and Piper Warrior are the most popular. You can check these out. The Cirrus

SR20 is the most popular personal-- or the 20 and the 22 together-- the most popular family and personal airplane these days. They're OK trainers. And some airline training programs and college training programs use them. But they're a little bit more challenging to handle than the Cessnas, Diamonds, and Pipers.

The marginal operating cost of all of these is about $100 to $150 an hour. So flight schools usually have to mark that up a bit in order to stay in business, because they have to cover the fixed costs, as well, of owning the aircraft, hangering, and paying insurance. But that cost includes the fuel and the engine overhaul and the prop overhaul.

What about doing gliders? So we don't want to sell you too hard on the idea of just starting in a single engine land airplane. You can go out to Sterling, Massachusetts, get towed up to 3,000 feet, and then on a handful of good summer days stay up by soaring in the thermals. Ridge lifts-- people have soared all the way down for, I think, about 1,000 miles-- tend to be the record for soaring. That's usually on following the edge of a mountain range where the wind blowing, let's say, from the west generates a lift right on the Western edge of the mountain range, right in the center.

You can be a Captain Sully-style hero on every landing, actually. Raise your hand if you think that there was another pilot in the aircraft with Captain Sully or if he was by himself. Who thinks that there was a second pilot in there? OK, who knows the name of the second pilot? Without going to your phone, does anybody in this room know the name of that second pilot? All right.

AUDIENCE: Jeffrey Skiles.

PHILIP GREENSPUN: Jeff Skiles, all right. Hold on a sec. We've got to give this guy his reward.

[LAUGHTER]

I'll pay out $20 to this student for that answer.

[APPLAUSE]

I only brought a handful of cash, because I knew I wouldn't need most of it.

[LAUGHTER]

OK, a good trainer helicopter-- same issues. The really light helicopters-- the Robinson R-22 is very popular for training, because it's inexpensive to operate. But it's so light that it's unstable and gives people the impression that heroic skills are required. Also you want reasonable amount of rotor inertia for autorotations. And helicopters, a lot of the training after those 10 hours-- after you've learned to fly, you also need to learn to fly a helicopter with no engine. And that requires making some adjustments in the pitch of the rotating blades or spinning wings. So if there is no inertia in those blades, then it becomes a little bit harder to control during the autorotation.

If you're a student, you may not make the best landings-- so rugged skids. This ends up all pointing towards the Robinson R-44. It's a four seat helicopter. And those extra two empty seats in the back give you a lot of performance margin.

That's more expensive to operate. And therefore, the prices that flight schools have to charge are higher. Because all the rotating components get thrown out every 2,200 hours. The blades, the transmissions-- there's more that gets overhauled.

OK, you can get a pilot's certificate from FAA by doing your pre-solo written exam with an instructor on the characteristics of the aircraft and anything that's important locally. Then you do some solo flight after your training. You'll do some flights by yourself. You will do cross-country trips. So you will go with an instructor on some trips that are at least 50 nautical miles if you're in an airplane-- 25 in a helicopter. That's called cross-country. You don't have to go all the way to California or Alaska. And then you'll do a bit of solo cross-country flying.

You will do a checkride preparation. That has to be, I believe, at least three hours in prep with an instructor for your checkride. And once you take your checkride with an FAA employee or a designated pilot examiner, you get issued the pilot certificate.

It takes you about 40 hours of flight time. And I believe only 10 of that has to be solo. The other 30 is typically with an instructor. 55 hours is probably more typical, but young people like yourselves who do it intensively can come and finish pretty close to the 40 hours.

There's my certificate. Notice it says airline transport pilot there. Oh, let's use the fancier feature. Airline transport pilot. So that's a different level of certificate. There's private, commercial, and ATP-- again, beyond the scope. Notice also there's a hole punched in it. Because when you get an additional rating, they issue a new certificate and destroy the old

one.

OK. What can you do once you have your private? You can go anywhere in the world in a US registered airplane and carry friends and family as long as you're not charging the money. You can fly at night. That's not true in some other countries, but it is true in the US. You don't need any additional rating to fly at night. You will have had three hours of training in night flying with an instructor.

And you will fly what you learned in. So if your mom has a hot air balloon and that was your first aircraft, you will have a rating for flying that hot air balloon. You don't have to start with a Cessna or similar.

So Congress passes kind of loose laws about aviation. But really most of the things that you might think of as laws governing flying are actually regulations that are drafted by the bureaucrats in the FAA and the agency. A lot of the stuff is public. You can look up anybody who claims to be a pilot in the airman registry.

One reason it's not called a pilot registry is that there are actually other functions for which certificates are issued-- for example, flight engineer. Maybe in the old days, there was navigator. Similarly, airplanes. If you see an interesting airplane, you can look up the tail number and see to whom it's registered. Sometimes it's obscured with a shell LLC somewhere. But it can be interesting.

This is one of the worst parts of the FAA and the exam. They use the words category and classes in two different ways. One is for getting your pilot's certificate, in which case a category is something like airplane or rotorcraft. And then you have this class, which could be multi engine C in the case of this Grumman. I think it might be a mallard there on the right-- 1940s Grumman seaplane. So that's a multi engine C rating that you would have in the airplane category.

Here's your little matrix. You can study this from the books. But you see these are the different categories of aircraft here on the left. Some of the fun ones like powered parachute, weight shift control. Fortunately, there are no flight schools for those kind of aircraft that I know of in the area. Wouldn't be much fun in a New England February. Category, class. Very exciting.

So just to give you an overview of the pilot and instructor certification. On the left here, you have your levels of pilot. We're concentrating on private pilot. Recreational pilot is extremely

unpopular. Sport pilot-- it's just a handful of schools for that as well. So really, it's private, commercial, ATP are the three core levels of a pilot certificate.

To those, you add ratings. So airplane single engine land-- that lets you fly the Icon A5 seaplane that you might have seen. And you also need type ratings for heavier or turbo jet powered aircraft. That means you've had special training for your DC 3, which is heavy, or for your Boeing 737, which has turbo jets.

The flight instructor has a separate certificate. And that has its own set of ratings which are simpler. So single engine airplane-- notice it doesn't say land or sea. So I have a commercial seaplane rating. And I have an instructor certificate for single engine airplane. So for anybody who wants to die by drowning, I can offer you instruction in a single engine seaplane or a multi engine seaplane, for that matter. Although there aren't too many of those.

There is a totally separate certificate. If you are also passionate about drones, you'll end up with three pieces of plastic-- one for the pilot certification, one for the instructor, and one for being a remote pilot. So aircraft, they use the same words but to mean different things. We will have a normal or utility category of aircraft or acrobatic. Those are the three that you're going to see at your typical flight school.

On the right there is the GameBird, a very interesting plane that I just flew in Bentonville, Arkansas. I would encourage you guys to look that up. And then you have class. If you have a really big helicopter, it's a transport category and rotorcraft class. All right, there on the right is-- I think that's a Pitcairn autogyro. So that's a rotorcraft autogyro from the 1930s. That's a replica from Oshkosh, which we'll hear about at lunchtime.

The bureaucracies. You have the NTSB, the National Transportation Safety Board-- a little bit separate from the FAA, which is part of the Department of Transportation. The structure of regulations-- the Code of Federal Regulations is huge. I think it's doubled in size in the last 20 years or so. The FAA is part of that in title 14. If you look up the FARs, the Federal Aviation Regulations, oftentimes you'll be directed to a site that has the entire electronic code of federal regulations.

The most relevant parts for this class are 61-- what does it mean to become a pilot? And part 91-- what can you do if you're flying privately? If you want to have fun extra knowledge, these are some of the other FARs that are occasionally worth looking at. You can look at doing charter and airline operations. Those have air carrier certificates. And then you add something

for scheduled big airplanes, like FAR 121, or smaller charter airplanes, 135.

If you want to see what kind of engineering you have to demonstrate to the FAA to get your product certified, you can look into, for example, FAR 27 to see what Robinson had to do for the R-44 to show that it was safe.

FAR 61 is about pilots, flight instructors, and ground instructors. The standards are actually reasonable. You have to do a flight review with an instructor every two years in order to continue to exercise the privileges of your certificate. If you want to add, for example, the capability to fly in the clouds, that's the instrument rating that Tina was talking about. And that's in FAR 61.65.

Some of these are just sign-offs. For high performance or complex you just need an endorsement from an instructor that you did it. For the type ratings, you'll actually get a new pilot certificate after usually simulator training at a simulator center.

All right, so these are some of the things that you need to know for the test. Until 9/11, the pilot certificate was a piece of paper, I think. And the photo ID was not required. So you could just go out and fly with your piece of paper and your medical certificate. Now you don't need that, actually, because of this thing called BasicMed.

You know, I guess, that-- you have to know, I think, for some test question that they can be inspected by these various agencies. All right, drugs and alcohol. This is actually one of the worst parts of the FAA certification projects for young people. People my age, we don't get invited to parties.

[LAUGHTER]

So getting arrested for DUI is not really an issue. But I know this guy, really wonderful young guy, about 20-- very enthusiastic, very smart. He was in college. He was drinking. And he got arrested for DUI. And the FAA treated him like they would-- if I were arrested for DUI, it would mean that I was an alcoholic. But he was not an alcoholic. But they don't have different standards.

So they can't just say, well, he's in college. So of course, he's drinking. They said, well, he's an alcoholic. So they wanted him to do years of proving that he went to alcohol treatment programs and all this other stuff. So really, you have to report any time that you have an

alcohol related infraction with a motor vehicle. And that's how I would say this is probably the number one reason that pilots lose their certificates.

Marijuana. I was just in Haiti actually. And the shaman was showing-- not the tourist part of Haiti, of course, but the authentic Haiti. So the shaman was showing us the 50 different medicinal plants that they used to treat various ailments. And I said, you guys are so primitive. In Massachusetts, we have one plant that people say will cure almost any kind of problem. And that's medical marijuana.

[LAUGHTER]

So you can't really be a stoner and honestly answer the questions on the-- despite the legality in Massachusetts, you can't be a stoner and hold your pilot certificate. Because you're supposed to tell the FAA about your glaucoma and how you're treating it with medical marijuana.

So the certificate duration is two years for flight instructors. They want us to do recurrent training or sign off so many students that we don't need it. For remote pilot, they want you to pass a test every two years.

The pilot certificate never expires. Here's a couple pictures from last week. I was out in Sonoma, California. And I stumbled on this airport where one pilot was flying this 1940s Howard airplane that you see on the left. And another pilot was flying this P-51 Mustang-- which on a 2,500 foot runway, that's a pretty short runway. And it's very windy, nasty wind patterns off the bay. So that's kind of a short runway for a $3 million airplane. Those were $1,500, by the way, when the government sold them as surplus at the end of World War II.

But anyway, those pilot certificates never expire. Somebody could not fly for 30 years, go out and do a little bit of recurrent training, and get signed off by an instructor for a flight review, and fly again, assuming-- I guess he or she would need to get a renewed medical certificate. For you all, you're going to have a third class medical that'll be valid for five years. Everything's based on calendar month. So if you get it on the 1st of June, it will expire at the end of June five years later.

Airline pilots need first class medicals. The captain needs a first class medical by regulation. Might be true of the first officer too. Just ordinary charter use or doing helicopter sightseeing or whatever, that's a second class medical operation.

One reason that people like sport pilot and glider flying is that these medicals are not required. So if they think that they might not pass a medical, then they'll transition to one of those. I think they say that you have to have a current driver's license. And it's a little bit of self reporting. You have to basically consider yourself to be healthy.

BasicMed, you start with the third class during your training. And then you'll go every four years to a regular doctor. You can see in FAR 61.113 that there's a limit to what you can do under BasicMed. You can't fly a heavy fast airplane with a lot of people in it.

OK, for most tests you need an endorsement from an instructor. For the checkride you can pass it. It can be discontinued-- maybe the weather turned bad. You can fail, usually on one or two maneuvers. You can retake the failed test, which might only be on those one or two maneuvers at the examiner's discretion. You have to log sufficient to prove to the FAA that you meet currency requirements-- like you've done three takeoffs and landings within the last 90 days if you're carrying passengers, or that you had a flight review within two years.

That's from a-- I have a nephew in medical school. So you're supposed to ground yourself if you get sick. So you've got a medical certificate five years ago. But if you're not fit to fly, then you ground yourself. There's a regulation about that.

The flight review requires an hour of ground and an hour of flight at a minimum-- whatever the instructor thinks that you need to be safe. Or if you get a new pilot's certificate, for example, because you got an instrument rating, then the flight review is not required. So oftentimes, people are enthusiastic about it. They won't have a flight review for the first five or 10 years of their aviation journey, because they keep getting new certificates for this or that. The insurance requirements for more complex aircraft usually require training every 12 months. So they essentially are more stringent than the FAA requirements.

So as I mentioned, you need to have done some recent flying by yourself or with passengers before you can take additional passengers. And if you're going to carry passengers at night, which is defined for this currency as one hour after sunset to one hour before sunrise, you have to have done three takeoffs and landings to a full stop before you can carry passengers at night. This is the one where people often have trouble maintaining their currency and have to make a special trip to the airport to build currency.

This has to be in category, class, and type, if applicable. So if it's a jet, you have to-- if you're

typed in a Boeing 737, you have to have done the three takeoffs and landings at night in your Boeing 737 to be current to take more passengers at night. It's not enough to do it just in a Cessna 172.

The flight review, oddly enough, doesn't work that way. You can do it in any of the aircraft for which you're rated. Again, the insurance company might be stricter about that.

Tell the FAA if you move. This is packing up for a recent trip to Florida. So it sure looked like we were moving. Let me tell you, once you have a light aircraft and a family, every trip becomes just like that movie *Sophie's Choice.* You have to decide who or what is going to be left behind. It's pretty painful.

OK, student pilot. Before you can solo, you pass a little written test that's kind of chosen and given by the CFI. You have to receive training on specific listed maneuvers that are in this FAR 61.87. You get signed off for solo flight. And that has to be renewed every 90 days.

You can't take passengers or go above a broken or overcast layer. So as unwise as it may sound, if you're only visually rated you can take off, fly over clouds with the expectation that when you get to your airport, the weather is forecast to be clear, or at least you're hoping it will be clear. They won't let you do that if you're a student pilot. The CFI may also add other limitations like a maximum wind, for example.

Each cross-country flight-- so if you're going from, for example, Hanscom Field up to Portland, Maine as a solo cross-country or to Keene, New Hampshire, that requires that you do the flight plan and review it with the CFI-- doesn't have to be a regular CFI. And have the CFI sign off that your planning is adequate. You can, actually, fly in Bravo airspace. We'll get into that a little bit later. The most controlled airspace in the US, basically-- right around the biggest airports. However, you have to have a sign-off from the flight instructor.

You can actually land at a class Brave airport. Salt Lake City has a flight school. So they obviously have people who are soloing at a huge commercial airport. However, in the FARs, appendix D, some airports are excluded from student use of the actual runways as opposed to the airspace. Logan happens to be one of them.

So once you get your private pilot certificate, what can you do? This is what I like to do. Fly over Boston. I've got the family in the back. We start in the Cirrus. We end up at Provincetown. We find the whales by-- after careful study of marine biology, I've learned that the best way to

find whales is to look for a whale watching boat.

[LAUGHTER]

They're just off shore. It saves, actually, a lot of time. It's about 20 minutes to P-town. And the whale watch cruises that leave from P-town, those are three or four hours. So this is a very efficient way to see the whales.

Who is eligible? A lot of people solo on their 16th birthday. And they get a pilot certificate on their 17th birthday. You can do it even a little bit younger, a year younger, in gliders and balloons. You must have that CFI sign-off to take the practical test, pass the knowledge test that's kind of the end of this course, and meet the experience requirements. That means at least 40 hours of total time, three hours of night, and so forth-- 10 hours of solo.

Flight proficiency. So this is the stuff that's in the airman certification standards that we talked about. So it says you've got to be able to fly, power off landing. You've got to be able to demonstrate a soft field take-off, like how you would take off if you were on grass and so forth. Everything's in there, including some basic instrument training, actually. The FAA has three hours of training. And they want you to demonstrate that you can fly by reference to instruments, at least well enough to get back out of the cloud that you inadvertently flew into.

So as I noted, you need 20 hours of training from a CFI minimum, 10 hours solo minimum. The other 10 hours is at your discretion. Almost all people would choose to do that with an instructor, because it's not a big added cost compared to the airplane rental. The training from the CFI will include one long cross-country. That's kind of the interesting part. 100 nautical mile cross-country. I think it has to stop at three different airports. So the one you took off from and two more, like a triangle flight. And those three hours of instrument training I told you about and the three hours of test prep within two calendar months.

Oh, yeah. So actually-- sorry, I was mistaken about this one. 100 nautical mile cross-country flight at night does not require three legs. But your solo-- you have to do one solo 150 nautical mile trip, three legs of about 50 nautical miles each-- one at least 50 nautical. So that's the one where the FAA thinks, OK, this person is really good to go and start taking his or her friends. Which, as I said earlier, you might think that that might not be what the friends want. You might say, no, I'd rather be in a five-seat Cirrus with you and the more experienced pilot in the front. And we'll sit in the back and party.

All right, so this is a little bit tricky. But basically, you can fly if it's part of your business. So if your company requires you to get to a meeting, you can do that with a private pilot certificate. Generally, though, you have to be paying for most of the stuff that you do. You can't let your friends pay the full cost of renting the airplane, for example.

You can tow a glider. There's kind of elaborate rules that have gotten more complex every year about how to do charity flights. But it can be done. Regulation versus insurance. So here's a question for you. What if, hypothetically speaking, somebody shut down the government and there was no FAA?

[LAUGHTER]

Could this work? And I think actually it could. You would just say, it's illegal to fly without insurance. Because let's think about it. The FAA says that you can go to East Coast Aero Club, fly around in a Piper Warrior, get your certificate, and then just get a couple of sign-offs from an instructor for complex, high performance-- actually, I guess it's three-- high altitude.

And then at 43 hours of flight time, you get yourself into this $5 million Pilatus PC-12. You've got the entire family. You pitch your tent at Oshkosh. Everybody's happy.

Well, that's legal from the FAA's point of view. But the insurance company says, you know, we don't really want to buy you a new Pilatus after you go sideways off the runway at Oshkosh. So we're not going to let you do that. You don't have enough experience. You're going to need specific training for the airplane.

Again, this is the single engine land airplane. It's not over 12,500 pounds, so you don't need a type rating. And therefore, you could just get in there. And most people don't lock the doors. So just jump in, push the start button, and go. FAA is happy.

Well, again, the insurance company wouldn't have let you do that to begin with. So if this complex regulatory environment didn't exist but insurance were required, I think you'd end up with something that was substantially similar and basically the same.

The FAA system, I will say in favor of it, it's kind of motivational. It's sort of like the bad system that the Boy Scouts-- I guess they're not Boy Scouts anymore. The Scouts and the Girl Scouts-- they're still the Girl Scouts-- that the Scouts run. And it motivates people to get the next one.

Everything except the drones is hanging off either the pilot or the CFI certificate. And just remember that you're going to stay FAA current by flying every quarter and with an instructor every two years. A lot of people in New England, though, they don't fly much during the winter. So they go up and do a currency flight in the springtime before the flying season starts.

So while you're thinking about your questions, about the regulatory framework or learning to fly, I'll just show you a flight that you could do with just a private. There is an entangled whale in New York Harbor with fishing gear all over him. And the people that could untangle him were in Provincetown. So Noah asked me to volunteer, because they had my email from the sea turtle flights.

They said, hey, would you mind flying over Boston, picking these guys up in Provincetown, going over New York Harbor in the area just outside of it to look for the whale, land them on the New Jersey Shore, so they can get into a zodiac boat and chase after the whales? They didn't tell me to go visit my parents in D.C. but I did while they were out chasing the whale.

[LAUGHTER]

And then come back. And I dropped them off, I think, right-- just after sunset I landed at Provincetown after sunset. And then I did a night flight over water in a single engine plane that's about to-- it's just reached its 2,000 hour overhaul for the engine. So maybe that wasn't the wisest thing to do. But I do have a life jacket and a raft.

So that was an entire day of flying from about 7:00 AM to about-- I don't know-- 9:00 PM when I landed back in Hanscom. And I think that didn't require more than a private certificate, because it's all volunteer. People say, have you ever been scared? Philip, you've flown 4,000 hours. What's the scariest thing that's ever happened to you?

And I think actually it was on this flight. Because if you see, there's that IFR. That's an IFR intersection that the FAA came up with. So for those of you who are familiar with Judaism, you will know that is not something you ever want to see.

[LAUGHTER]

All right, so who has a question about that material? Or should we zip into systems?

AUDIENCE: Are there any medical conditions that would prohibit you from flying altogether?

PHILIP GREENSPUN: The question is, are there any medical conditions that really preclude a person from getting a pilot's certificate or getting the medical to go with a pilot certificate? I guess you need the medical to get it, because you need to solo. The FAA-- they have an exemption process. And they have their own physicians in Oklahoma City that review. So usually you can work with an aviation medical examiner and get some kind of exception.

Diabetics, they're kind of concerned about. But if the person has a long history of controlling it well, they'll usually give an exemption. People have heart bypasses. And then they have to go through some rehabilitation process that makes the FAA happy.

So it's all laid out. There's a lot of stuff online about the standards that they use. And it's complicated. But the doctors-- there's a lot of good local aviation examiners. One of them works right at Cambridge hospital. So that's a fairly easy question to get answered.