THE SPORT FLYER

NEWSLETTER OF THE SHELBYVILLE EAA CHAPTER 1326

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Chapter 1326 meets monthly on the Fourth Thursday of the month in the Shelbyville airport at 1800 (or 6:00 PM, whichever you prefer.) Any changes of meeting date and venue will be announced in the newsletter or by text message.

Kommandant's Korner

EAA Chapter-1326 members and friends,

Wow, that was a quick month. Actually, the year seems to be flying by (no pun intended).

Like many organizations, the "life" of EAA chapters depend upon members who wish to share their passion for some common interest. My spouse Leigh and I have LONG been passionate about aviation, and EAA was a local organization where we could share that passion with friends. In these days of expensive fuel, members scattered over a large area, and limited discretionary time, our last two EAA chapters had trouble finding new members with similar passions to keep their organizations active. To our delight, two months ago, a member of Middle Tennessee State University (MTSU) who works at the Shelbyville airport asked to address our EAA board about the possibility of MTSU students helping provide manpower and teaming up with Ch-1326 to help meet our common aviation interest and community goals. At that meeting, we were also surprised to discover this group of MTSU students were members of the professional aviation fraternity, Alpha Eta Rho (AHP), an organization that Leigh and I had belonged to while working on our Bachelor's degrees at Auburn University. Surely this seemed like an excellent match as the members of our AHP Chapter (Gamma Chapter) were active in any event supporting the local aviation community. So…we told our "brothers" from MTSU we'd be delighted to accept their help, and we would love to have them participate in any of our events and/or field trips, starting with the June Fly-In breakfast. They will also be helping at our July 22nd Fly-In breakfast when they will ALSO host a "plane wash".

Finally, it would almost be considered "negligent" of an EAA President to NOT note that EAA's highlight event, the Oshkosh Air Venture would be occurring the 24th through the 30th of July. Alas, my schedule won't allow me to get away this year, so I guess I'll be watching videos AGAIN. I'm not sure who from our Chapter is going that we can "tap" for a report, so maybe I'll have to reach out to our previous Kommandant, Mark Stauffer, who only recently took a new job up near Oshkosh for a report. Hello Mark! Are you still out there with us?

Hope to see y'all at the field!

Randy Kelly
EAA Ch-1326 President

Last Month's Meeting

The June 2023 meeting was scheduled for the normal "fourth Thursday", but one of Evil Editor Zurg's spies had heard that Ch-1326 member Tim (don't call me Doctor) Rosser had recently received some important parts for his RV-8 build and was hot in the middle of installation – sooooo – a Project Police raid was scheduled in lieu of a business meeting:

2023 June 22 Project Police Raid on Tim Rosser's house

After a wet and stormy Winter, the Project Police were itching to check on the status of some actual projects. During a secret meeting with other PP members, I as new Kommandant made a kommand decision to inspect Tim Rosser's RV-8, Thursday June 22nd. In an unusual, but hopefully soon to be repeated event, the raid information was strategically leaked to members of the Alpha Eta Rho (AHP) professional aviation fraternity from the Middle Tennessee State University (MTSU).

When Ch-1326 Project Police members Leigh and I (Randy Kelly) arrived at Tim's house, we discovered an RV-8 fuselage already in the driveway.

Leigh Kelly points out the primary target for the Project Police inspectors.

Tim walked out to meet us as we walked up the driveway and spotted the target and Tim's shop. Tim promptly offered us a bribe – uh – I mean, some tasty refreshments to make our visit in the Middle Tennessee humidity more pleasant.

Project Police bribery done the right way. (No, the panel and 406MHz beacon were NOT up for grabs.🤣)

Being the Project Police advance team tasked with locating the objective so we could talk any stragglers onto the target, Leigh and I were a few minutes early. While awaiting the rest of the team, Tim gave us a short tour of his garden in the back yard, complete with a fresh tomato growing experiment and a bluebird house that was visited by a bluebird possibly interested in taking up residence.

An "experimental" garden to keep the builder fed and healthy.

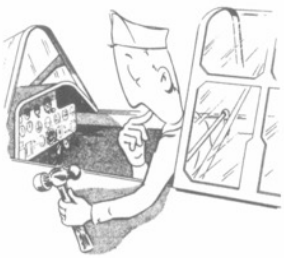
EAA experimental tomato item and control sample.

A few minutes later, the other Ch-1326 Project Police member as well as a bunch of Middle Tennessee State University (MTSU) Alpha Eta Rho (AHP) aviation fraternity members showed up. The total raid contingent consisted of Ch-1326 Project Police members Randy and Leigh Kelly, Tommy Lynch, and Mark Cannon. The MTSU AHP, Mu Tau Chapter was also well represented by Jon Fernandez (one of our KSYI linepersons), Esther McClendon, Anika Mite, Landry Dupree, and Garrett Bunch. Last but certainly not least, was our host, Dr Tim ("don't call me doctor") Rosser, a Ch-1326 member and MTSU professor.

A whole "flight" of Alpha Eta Rho members showed up for the "raid".

Once the crowd had assembled, it was time to start looking at Tim's handiwork.

Tim explains, "yes this is all built by hand by me".



Mark Cannon and Tommy Lynch inspecting the canopy fit and cockpit detail.

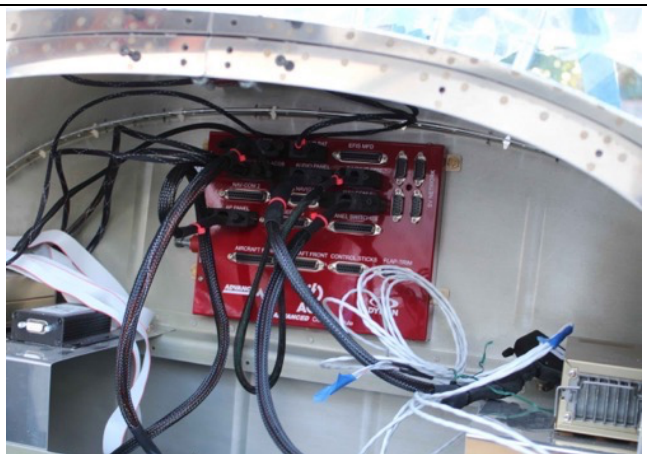
The most obvious thing noticeable about Tim's RV-8 was the new bubble canopy sitting on, but not yet attached to the sliding frame. Tim told us the canopy came in one piece as an $800 plastic bubble, and getting it to fit the frame and attaching to the frame was the big challenge.

Tim said the canopy needs to be carefully cut to avoid cracking and he had just finished cutting out the front and aft sections of the bubble canopy and had rough sanded the edges using 180grit sandpaper. He said he intended the follow-up the smoothing task with 400grit sandpaper. It must then be carefully drilled and riveted to fit the fixed front frame and sliding frame for the overhead and aft portions of the canopy. Tim also noted that the Van's "RV community" has apparently had some problems with stress cracking around the drilled holes, and some folks developed an alternative method of attaching the canopy using Sikaflex adhesive instead of rivets. Sikaflex is apparently commonly used on marine craft and windshields. (I do not recall specifically what method Tim said he was intending to use to attach "his" canopy.)

RV-8 front windscreen. Some "assembly" required yet.

Rear canopy is cut out. Smoothing, fitting and attaching are next. (Notice the high tech aviation rated clamps.🤓)

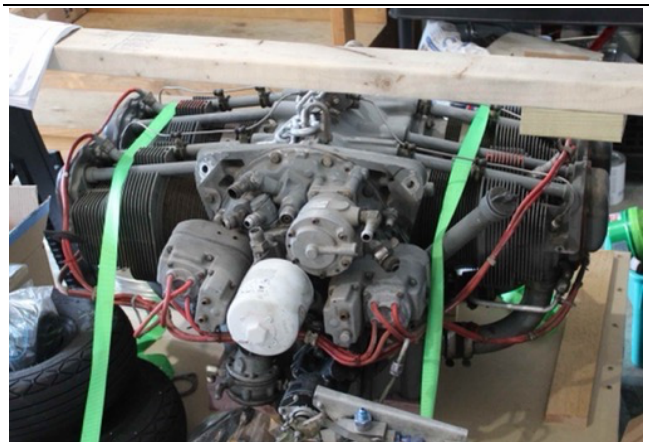
We then turned our attention to the rest of the fuselage details. Tim is using the Dynon Advanced Control Module avionics hub system as the primary core of his avionics wiring. The "hub" was spotted nested up against the pilot's side of the firewall. Tim's careful handiwork was also evident in his tail mount for the 406MHz emergency locator beacon antenna, and he said there was a combination air data computer and attitude reference package located in the aft fuselage so it would stay level. (Editor's note. We did NOT have a chance to talk to Tim about whether any moment arm corrections would be needed for the attitude system like inertial measurement platforms need to have.)



Dynon advanced avionics control module/hub.

406MHz beacon antenna (which will be hidden behind a fiberglass tail fairing.)

There was a used IO-360 sitting in a frame on the floor. As Tim explained, "It is a 1965 IO-360 B1B off a Beech Travelaire. The aircraft had a gear up landing, so it's (had a) prop strike. All the inspections show it's fine; flange dials out at zero, borescope inspection looks fine. There still could be a surprise lurking in there, but all indications are looking good. The engine has just a little over 1700 hours on it." Tim noted that new IO-360s were about $47K new, and that a rebuild was planned despite the 2000 hour TBO on the engine. (Editors note: Lycoming recommended TBO for an IO-360 is 2000 hours or 12 calendar years, but given this engine's history of a prop strike, we think a rebuild is a wise safety decision.)



Soon to be repurposed Lycoming IO-360 engine.

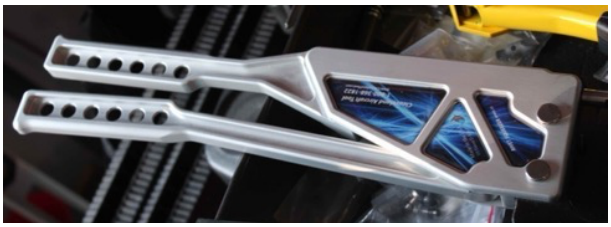
Given the fact most (if not all) of our invited MTSU students had no real background in homebuilt aircraft, Tim answered some additional questions about how homebuilts are built. Like a true EAA builder and mentor, he was especially forthcoming about what tools are required, how plans are used, aircraft fastening techniques, scratch building of sub-assembly stands, etc.

A collection of EAA approved aircraft builder training devices sitting in a corner of the garage🤣.

Tim explaining how the plans are used with instructions to build your own airplane.

Typical tools of the EAA building trade.

Small pop rivets? I guess Stanley helps you do things right.



Ratcheting rivet squeezer for those "normal" jobs along edges you can get to.

Now THAT'S a rivet SQUEEZER!!🧐

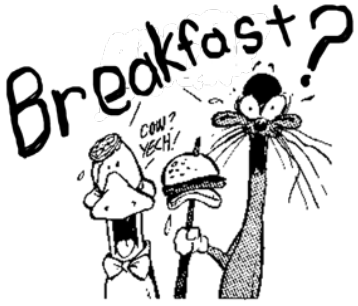
Nice view of typical "jig/stand" built by EAA members to hold major sub-assemblies like fuselages and wings.

With all the attention on the fuselage, somebody noticed there were no wings present and asked, "when are you going to build the wings"? According to Tim, apparently, the wings are already 90+% complete and have already been moved to the final assembly hangar.

After a 90+ minutes of examination, cross-examination, picture-taking, and camaraderie, the Ch-1326 team and their new AHP friends declared "Victory!" and headed home.

Randy Kelly
Staff Writer

June 24th 2023 EAA Ch-1326 Fly In Breakfast



The June 24th breakfast promised to have some interesting changes. As I noted in the May meeting minutes and Kommandant's Komments, students from Middle Tennessee State University (MTSU) had approached Ch-1326 about the possibility of helping out and co-hosting events. At our invitation, MTSU students showed up at the Project Police raid on Tim Rosser's house the evening of Thursday June 22nd, and at least two members of the Alpha Eta Rho (AHP) Professional Aviation Fraternity (Mu Tau Chapter) promised to show up for the setup on Friday morning June 23rd.

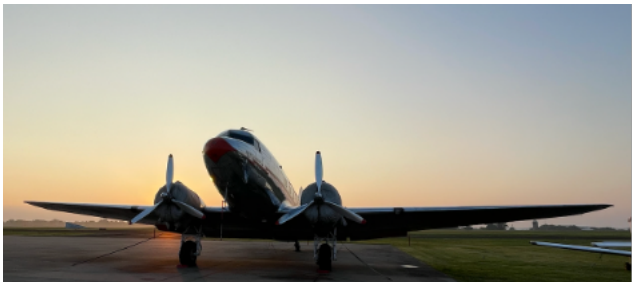
The first surprise that Friday morning was how many aircraft were scattered all over the KSYI ramp, and were even parked in the grass South of the EAA hangar. This was the result of closure of the Murfreesboro airport runway for repair and resurfacing the week earlier. Anybody at Murfreesboro who wanted to fly the next month needed to find alternate hangar or tiedown space, and the word was that Murfreesboro aircraft had disbursed all through middle Tennessee. We heard that MTSU had deployed their training fleet to at least four airports.

Ch-1326 members Randy and Leigh Kelly, Mark Cannon, Helene Wharton, Tim Rosser, and MTSU students Ridley Berry, Jon Fernandez, and Esther McClendon showed up to help setup tables, chairs, and the cooking stations. The extra help was DEFINITELY appreciated, and with eight sets of hands, we made short work of the setup.

Tim Rosser practicing his team management skills.

Many minions make short work of setup.

It was a beautiful Saturday morning when Randy arrived a little before 0600 to fill the coffee urns with water and pre-heat the ovens. Leigh showed up a few minutes later to add the ground coffee so we were "perkin" a few minutes after 6AM and into the ovens went the biscuits. About the same time, the "advance crew" for "Flagship Detroit", the DC-3 currently parked at KSYI, started showing up to start prepping the girl to go to an airshow for the weekend.



"Good morning Flagship Detroit".

While the "Flagship" folks sat around waiting for more of their volunteer force to show up, the other members of the main cooking crew for Ch-1326 (Randy Kelly, Mark Cannon, Helene Wharton, and Tommy Lynch) showed up and started getting the meats, potatoes, gravy, eggs, and pancakes prepped to start cooking. About this time, our MTSU volunteers, Pressley Kennemore, and Garrett Bunch showed up. I typically head up to the KSYI airport office a few minutes before 0700 for a "precautionary potty stop" before the cooking starts, and when I came back a few minutes later, the first airplane had arrived and parked next to the EAA hangar.

0700. Our first airplane arrival.

A little after 0700, all the grills had been fired up, and the Flagship Detroit team had finished their preflight, preliminary engine rotations and cranked up so they could head out to their scheduled airshow appearance.

Grills are going…so is Flagship. (Our grills don't smoke as much on startup though.)

The Ch-1326 cooks were "in the groove" by about 0715, and food was going into the steam table pans. It wasn't even 0730 yet, and already we had 3 planes on our ramp and more taxing in. It was beginning to look like it was going to be a busy morning.

More arrivals a few minutes before 0730.

Somebody's trusty Skylane arrives.

Ch-1326 member Sharon Tinkler and AHP member Pressley Kennemore were manning the

check-in station and I checked out AHP member Garrett Bunch on the pancake grill so I could go take pictures as ordered by Evil Editor Zurg. As I went out to take a few shots I passed a number of folks headed INTO the hangar. I took some quick photos and came back to discover the normal 0800 rush was a little early this day.

0800 rush hits with a vengeance, and Garrett makes good use of his checkout on the pancake grill.

Breakfast participants were lined up out the door!

Even motorcyclists showed up. (This is one of Zurg's "in cognito" aircraft identification specialists.

It WAS a busy morning. The cooks were keeping up with the surge, so I headed out for a few more pictures. People were still walking from planes to the hangar, planes kept taxiing in from the runway, and I even had to temporarily play marshaller to marshal aircraft that had hit the ramp but couldn't see the marshallers hidden by the aircraft already parked on the ramp.

Hidden marshaller – we had to use marshallers to direct folks to the marshallers!

As was normal we had the usual mixture of Vans RVs, Pipers, Cessnas, Aeroncas, and even an AA-1 Yankee, the first one I'd seen in several years. We even had a floatplane and a warbird show up.

Piper, Cessna(?), and Bearhawk. (The Citation was a non-breakfast transient.)

Van's RV-10

Grumman AA-1 Yankee.

Bearhawk, Bonanza, and Cozy.

A visiting Velocity.

A Super Cub (nice having a starter isn't it?)

Cessna 180 on amphibious floats.

An O-1 Bird Dog makes an appearance, complete with 2.75" Folding Fin Aerial Rockets (FFAR). (Gonna stay out of his way.)

The ramp was pretty full, and the marshallers and refuelers (including AHP member and KSYI lineperson Jon Fernandez) were staying busy. Inside the hangar, we pretty much had a full house on our hands and darn near every seat was occupied.

Busy refuelers, keeping the airport manager happy. ☺

Full house!

AHP members Garrett and Pressley take over the check-in table.

Things started slowing down about 0900 even though we did have a party roll in a few minutes after the official closing time of 0930. We had enough food to feed the late-comers, and as they chowed down, the Ch-1326 and MTSU volunteers started cleaning up, putting away chairs, tables, and washing dishes. Again, many hands turn big jobs into smaller ones, and we had the hangar transformed back from a breakfast venue into a hangar by 1100. Hum, EAA and AHP teaming together to support aviation….

"Louis, this could be the beginning of a beautiful friendship."

Randy Kelly
Staff Editor

Technicians Korner: Supplemental Oxygen, OR, "To breathe, or not to breathe, is NOT the question."

Evil Editor Zurg: I received several notes of appreciation about last months article about a flying club's close encounter with "The Fracture Mechanic" who committed "bad ju-ju" on a club aircraft's propeller bolts. Most of you who DON'T do your own maintenance will probably never run into such a problem. This month however, we're going to talk about an issue that is applicable to all of us, namely, the use of supplemental oxygen while flying. This article was written by a good friend and fellow aviator, Russ Erb. Russ was the editor of the award winning newsletter "The Leading Edge" for EAA Chapter 1000 at Edwards AFB for 25 years, and he still publishes occasionally with his newsletter "The Trailing Edge" (http://erbman.org/trailingedge). Russ was a U.S. Air Force Academy graduate, served for 20 years as an Air Force Officer, and is now a civilian employee on the faculty of the U.S. Air Force Test Pilot school at Edwards Air Force Base. This is the first installment of a three-part article on the use of supplemental oxygen, and Russ will make the case that it's actually a good idea to use supplemental oxygen at lower altitudes than mandated by the FAA regulations. This article is reprinted with his permission:

Why You May Want to Use Supplemental Oxygen at Lower Altitudes Than Required

Hypoxia Onset Altitudes

This article is not about hypoxia, its symptoms, or how to treat it. There are plenty of resources available on those subjects. However, we will briefly discuss hypoxia as it provides background for the topic at hand.

As a pilot, you are probably familiar with the FAA rules on supplemental oxygen use, straight out of 14 CFR 91.211:

Altitude	Requirement
Below 12,500 ft	No supplemental oxygen required
Above 12,500 ft	Supplemental oxygen use required for durations greater than 30 minutes
Above 14,000 ft	Supplemental oxygen use required for crew members
Above 15,000 ft	Supplemental oxygen must be available for all passengers

You may (also) be familiar with the US Air Force rules on supplemental oxygen use:

Altitude	Requirement
Below 10,000 feet	No supplemental oxygen required
Above 10,000 feet	Supplemental oxygen use required
25,000 feet	Maximum cabin altitude with supplemental oxygen
Above 50,000 feet	Full pressure suit required in pressurized aircraft
60,000 feet	Maximum altitude in F-22 with a partial pressure suit
Above 5,000 feet	Supplemental oxygen use recommended at night

If you go to altitude chamber training (highly recommended if you can get it), the emphasis of the training relative to the altitudes listed above is on Time of Useful Consciousness (TUC), or how long you can function in a high-altitude environment without supplemental oxygen before you go stupid or pass out. Because the TUC can get very short, the emphasis is on recognizing your hypoxia symptoms and getting on supplemental oxygen before your TUC runs out. Here is an FAA table of typical TUC, lifted directly from Wikipedia (Ref 1). Your mileage may vary.

Pressure Altitude	TUC (normal ascent)	TUC (rapid decompression)
FL180 (18,000 ft; 5,500 m)	20 to 30 minutes	10 to 15 minutes
FL220 (22,000 ft; 6,700 m)	10 minutes	5 minutes
FL250 (25,000 ft; 7,600 m)	3 to 5 minutes	1.5 to 3.5 minutes
FL280 (28,000 ft; 8,550 m)	2.5 to 3 minutes	1.25 to 1.5 minutes
FL300 (30,000 ft; 9,150 m)	1 to 2 minutes	30 to 60 seconds
FL350 (35,000 ft; 10,650 m)	30 secs to 1 minute	15 to 30 seconds
FL400 (40,000 ft; 12,200 m)	15 to 20 seconds	7 to 10 seconds
FL430 (43,000 ft; 13,100 m)	9 to 12 seconds	5 to 6 seconds
FL500 (50,000 ft; 15,250 m)	8 to 10 seconds	5 seconds

At 10,000 feet a reduced ability to learn new tasks can be measured (Ref 2). Additionally, a person who normally lives at sea level who finds themselves at 10,000 feet pressure altitude for an extended period of time (such as 12 hours or more) will eventually reach a blood oxygen saturation of around 84%, which is generally accepted as qualifying as "clinical hypoxia". Long exposures at higher pressure altitudes rapidly get worse (Ref 3).

Thus, the Air Force set the requirement for supplemental oxygen use at a cabin altitude above 10,000 feet. The Air Force has one advantage while mandating supplemental oxygen use. All of its aircraft intended to operate above 10,000 feet either have pressurized cabins (such that the cabin altitude never exceeds 10,000 feet) or the aircraft are equipped with supplemental oxygen systems. The last Air Force aircraft I know of that did not have a pressurized cockpit but was expected to operate above 10,000 feet was the Cessna T-37. In the T-37 the aircrew wore helmets with oxygen masks, and supplemental oxygen was supplied through a regulator.

However, many general aviation aircraft are not pressurized, do not have supplemental oxygen systems, and yet operate at altitudes just above 10,000 feet. The body has some spare capacity to operate at an acceptably degraded state slightly above 10,000 feet (Ref 3). Thus, the FAA allows for operations up to 12,500 feet without supplemental oxygen, and over 12,500 feet (but below 14,000 feet) for no more than 30 minutes. One possibly apocryphal tale states that these limits were set because it was possible for unpressurized commercial airliners, such as the DC-3, to cross the Rocky Mountains through certain passes without violating these rules, thus allowing the airlines to avoid the cost of installing oxygen systems in non-pressurized aircraft. Whether this story is true or not, it is possible to cross the Rocky Mountains without supplemental oxygen without violating the FAA regulations.

The altitudes for supplemental oxygen use are set assuming an individual with a healthy respiratory system. Those with asthma or other respiratory issues may notice hypoxia symptoms at lower altitudes. One person I know with asthma starts to feel the effects above 5,000 feet.

So, while very important, your altitude chamber training would lead you to believe that the sole purpose of supplementary oxygen use is to extend your Time of Useful Consciousness to longer than necessary to complete your flight. That is certainly one reason, but just like Yoda said, "there is another".

The Experiment That Started All This

Back in 2002, Gary Aldrich and I were flying in the Fightin' Skywagon to Oshkosh for AirVenture. On our first day we flew from Fox Field (KWJF) to Hays Kansas (KHYS). To get there, we had to fly over Colorado through the Cumbres Pass (V368) and La Veta Pass (V83-210). Both of these passes can be flown VFR without exceeding 12,500 feet, but not much lower. After flying all day without supplemental oxygen with one leg at 11,500 feet, at dinner that night we realized that we were both very fatigued, like we had been mountain climbing all day, even though it seemed to us that all we did all day was to sit. We did that at the office all day and still felt good enough to have a full evening of activities. How could sitting all day be so fatiguing?

For the next Oshkosh trip (2004), we flew from Fox Field (KWJF) to Casper Wyoming (KCPR). This route would require similar high altitude legs around 11,500 feet, mainly over the Provo River from Provo to Heber City Utah. This time Gary directed me to buy my own cannula so we could try using his oxygen system. This time we used the oxygen at altitudes below the required 12,500 feet, and when we arrived at Casper, we felt no more fatigued than after a day at the office. This was sufficient anecdotal evidence that supplemental oxygen could be useful at altitudes below where it is required.

Altitude Induced Fatigue is a Thing

So now we had reason to believe it was useful to use supplemental oxygen at altitudes below where it is required to ensure "useful Consciousness", but for years I have been trying to understand why. After all, sitting in my desk chair at a pressure altitude of 2300 feet doesn't *feel* any different than sitting in an airplane seat at 9500 feet, but clearly something is going on.

We are about to start talking about human physiology, and I will admit that I am not an Aerospace Physiologist, nor do I play one on TV. I did do well in my biology classes, but to make sure I had the details correct I consulted with the USAF TPS Staff Aerospace Physiologist (Ref 3).

At any given moment, the cells in your body have a certain demand for oxygen for metabolism. This demand depends on what you are doing. If you are sitting watching the pregame festivities for the Super Bowl and eating Tuki's yummy food, you don't need very much oxygen. However, if you are at Mountain Valley airport pushing a glider out to the runway or running inside to get a replacement yaw string, your demand for oxygen will be higher.

We all know how we get more oxygen to our cells when exercising. Exercise increases the metabolic demand of the cells. The blood needs to flow faster while (ideally) maintaining the same blood oxygen saturation (percentage of arterial red blood cells carrying oxygen) to supply the increased demand. Our heart rate gets faster (increase in rate) and the stroke volume increases (increase in volume) which pushes the oxygenated blood to the cells faster to keep up with the increased demand. Now that the blood flow has increased, the flow of oxygen in the lungs into the blood must increase to keep the blood oxygen saturation the same. To accomplish an increased flow of oxygen, our breathing gets deeper (increase in volume) and more rapid (increase in rate).

Our bodies (when functioning properly) have an absolutely wonderful control system to manage the blood pumping and breathing right to the minimum level required to meet the oxygen demand. If you exercise hard enough to overwhelm the ability of the heart and lungs to supply the required amount of oxygen, then you go into oxygen debt. However, if your oxygen demand remains within the capability of the heart and lungs, the body's control system will ensure that the effort required for blood pumping and breathing stays at the minimum required. This is because blood pumping and breathing both require muscular work, and this work consumes your energy supplies and contributes to overall

fatigue, just like that muscular work you used to walk that 10K.

So, we understand that if we exert ourselves, that will cause increased effort to deliver more oxygen to the cells. "But I thought we were going to talk about why I get tired just sitting in the airplane, not from walking that 10K with Stormy and Mary." That's right, we are. The difference is that your body's demand for oxygen isn't that much different between sitting in your office chair and sitting in your airplane, but your body's ability to deliver that oxygen is different.

For oxygen to be absorbed into the bloodstream in the lung's alveoli, the pressure of the oxygen in the lungs must be higher than the pressure of the oxygen in the bloodstream. More specifically, the partial pressure of oxygen in the lungs must be greater than the partial pressure of oxygen in the bloodstream. Partial pressure is the pressure of a gas in a mixture as if it alone occupied the entire volume of the mixture at the same temperature (Ref 4). In the case of oxygen, the partial pressure is about 20% that of atmospheric pressure, because air is 20% oxygen by volume. Because the partial pressure of oxygen in the lungs is greater than that in the bloodstream, the oxygen is "pushed" into the blood and latches on to some waiting hemoglobin. (Likewise, the partial pressure of carbon dioxide in the bloodstream is higher than the partial pressure of carbon dioxide in the lungs, so the carbon dioxide is pushed out of the bloodstream.)

When we go up in altitude, the atmospheric pressure decreases and thus the partial pressure of oxygen decreases. Because the partial pressure of atmospheric oxygen is less, but the partial pressure of bloodstream oxygen is the same, the difference (or gradient) between them is reduced. When the gradient is reduced, the amount of force "pushing" the oxygen into the bloodstream is reduced, **so less oxygen gets into the bloodstream**, reducing the blood oxygen saturation. Herein lies the big problem.

The demand of the body cells for oxygen has not changed, so the required mass flow of oxygen needs to remain the same. Mass flow is given by the continuity equation

$$\dot{m} = \rho A V$$

which says that the mass flow can be calculated as the product of density, cross sectional area, and velocity. In our example, we will assume the cross-sectional area of the arteries stays the same. Because less oxygen was absorbed into the bloodstream (because of the lowered partial pressure of oxygen in the atmosphere), the blood oxygen saturation (represented by density (ρ)) is reduced. If the density of oxygen is reduced, then the only way to maintain the required mass flow is to increase the velocity. That is, if fewer red blood cells are carrying oxygen molecules, then they need to be pumped faster such that the same number of oxygen molecules are pumped by the cell as at lower altitudes. This increase in blood flow comes from a faster heart beat (higher frequency) and an increase in heart stroke volume (higher volume).

Once again, because the blood flow rate has increased, the rate of oxygen absorption in the lungs must increase to maintain whatever blood oxygen saturation is possible. This is accomplished by breathing deeper (more oxygen available in the lungs) and by breathing faster (bringing in more oxygen per minute).

So, when less partial pressure of oxygen is available to the body, the body responds by pumping what it has faster so that the cells still see the same amount of oxygen, and by breathing deeper to capture more oxygen to maintain the blood oxygen saturation. All of this extra breathing and blood pumping takes energy, and **this leads to the additional fatigue caused by flying at high altitude**.

The real kicker to this problem is that this additional workload goes mostly unnoticed by the conscious brain, so you don't realize you are working harder. Generally, you won't notice a difference unless you are at least at 10,000 feet, and then only if you are doing mild exertion, such as walking up a hill. However, your body actually starts trying to compensate for the reduction in available oxygen at altitudes as low as 4500 feet. Remember the recommendation to use supplemental oxygen above 5000 feet at night for better vision? The eyes are perhaps the most

sensitive organs in your body to a reduction in available oxygen, and the reduction of oxygen even at this low altitude reduces the cones' ability to detect colors.

Thus, avoiding Altitude Induced Fatigue is the best reason for using oxygen at lower altitudes than required by the FAA, especially if you don't like feeling tired. I generally use oxygen starting at around 9500 feet, and sometimes even lower.

Increasing the Partial Pressure of Oxygen Available in the Lungs

So how do we increase the partial pressure of oxygen available in the lungs? No, it doesn't require attaching a hose to your face and inflating you like a party balloon. The key is that we need to increase the partial pressure of oxygen, not the overall pressure of gases in the lungs. To increase the partial pressure of oxygen in the inspired gases we must increase the percentage of oxygen in the mixture of gases. This can be done as simply as just adding pure oxygen to air, which will increase the percentage of oxygen in the mixture above 20 per cent.

However, just adding oxygen only works up to a certain altitude. At 35,000 feet pressure altitude, the ambient pressure is roughly equal to the partial pressure of oxygen at about 8,000 feet pressure altitude. Thus, at 35,000 feet pressure altitude, the mixture of breathing gases must be 100 per cent oxygen just to get the required partial pressure of oxygen for proper respiration. I have heard less informed sources state that the pressure inside an astronaut's space suit while on a spacewalk is equivalent to being at 35,000 feet. While strictly true, they leave out that the gas mixture inside the space suit is 100 per cent oxygen, so it is nothing like standing on top of Mount Everest, where the oxygen is only 20 per cent.

Flying above a cabin altitude of 40,000 feet does actually require inflating you like a balloon with 100 per cent oxygen at a pressure higher than the air pressure surrounding you. This is called "pressure breathing" and it is extremely exhausting and dangerous. The danger comes about because your breathing process is reversed. In normal breathing, you use muscular exertion to draw air into the lungs. Relaxing the chest pushes the air out of the lungs. Under pressure breathing, relaxing causes the lungs to fill with air. To exhale, muscular exertion (like blowing hard to inflate a balloon or pool toy) is required. The body's control system does not understand this, and it requires conscious effort just to breath. Relaxation will cause you to suffocate with inflated lungs.

The other option to increase the partial pressure of oxygen available is to inflate the airplane with air, which is usually referred to as pressurization. Most pressurized aircraft can only pressurize to a particular difference above the outside air pressure because of leaks or structural strength. Thus, above some critical altitude, the cabin pressure of a pressurized airplane will start to reduce as altitude is increased. Most airliners only pressurize the cabin to about 8,000 feet pressure altitude. This is sufficiently low that most people will not significantly notice the effects. Pressurizing to a lower altitude requires more bleed air from the engines, which reduces the thrust, which requires an increase in fuel flow to compensate. Additionally, higher pressure will put more stress on the structure of the fuselage, causing it to fatigue and crack quicker. If you've ever felt fatigued after a long flight in an airliner, even though you were just sitting there, refer to the discussion above. An altitude of 8,000 feet is sufficient for you to start feeling Altitude Induced Fatigue, especially after six or more hours.

Military fighters and bombers don't overpressurize for another reason besides structural airframe weight. An ejection at high altitude would clearly fit the definition of a rapid decompression. The likelihood of suffering decompression sickness (DCS, also known as "The Bends") is increased as the amount of pressure change is increased. It is quite possible that an aircraft at 50,000 feet pressure altitude might have a cabin pressure altitude as high as 25,000 feet, the maximum allowed without pressurization. The aircrew remain fully oxygenated because they are breathing from a demand regulator with a sealed mask. A rapid decompression from 25,000 feet pressure altitude to 50,000 feet pressure altitude is much less jarring to the physiological system than going from 8,000 feet to 50,000 feet. This is not as big of a problem

for airliners, as a small hole won't depressurize that fast. A hole big enough to cause a rapid decompression in an airliner is going to be big enough to cause even bigger problems. Aloha Airlines Flight 243 comes to mind.

Acclimatization to Lower Atmospheric Pressure

Yes, there are people living in La Paz Bolivia (elevation 11,942 feet) who don't seem to be passing out on a regular basis. When you moved from Texas to Colorado, you felt kind of krappy for a while but eventually felt better. Another compensation available to the body when exposed to a lower partial pressure of oxygen for an extended period of time is to increase the number of red blood cells in the bloodstream. This doesn't happen overnight, though. It actually takes about six months. More blood cells to carry oxygen helps with increasing the amount of oxygen in the blood at the same blood oxygen saturation. Of course, when you then move back to Texas, over the next six months your body slowly reduces the number of red blood cells by not replacing them as fast as they are removed because it has no need to maintain that many red blood cells.

A popular thing with athletes is to spend a few weeks at high altitude, thinking it will improve their endurance. The Arizona Cardinals will go to Spring Training for about three weeks in Flagstaff AZ (elevation 6,910 feet), then return to Phoenix. This brief time does not really increase the oxygen capacity (VO_2) of the players. At most, it teaches them to push through the discomfort and pain of oxygen debt to allow temporary bursts of increased output.

How Can I Detect Early Onset Hypoxia?

One way you can detect hypoxia is by going to the altitude chamber and learning what your hypoxia symptoms are. Of course, that's not available to everyone, and by the time you feel your symptoms it's really later than you had wished it would be.

Fortunately, there is instrumentation available! Remember the last time you went to the doctor and somebody clipped a thing over one of your fingertips and then wrote down some cryptic numbers? Well, the little electronic marvel that revolutionized medical care has applications in the cockpit too. Best of all, they're dirt cheap! Do a search for "pulse oximeter" and you will be presented with hundreds of choices. At the time of this writing, I saw one on Amazon for as little as $16.

Pulse Oximeter

This magic little battery powered device will tell you your current pulse rate (PR_{bpm}) and your blood oxygen saturation (SpO_2%).

How does this non-invasive magic happen? Inside the device on one side are two LEDs. One is colored red and the other is colored infrared. On the other side of the device is a photocell which can detect red light and infrared light. If you put your finger over a flashlight, you know that some light will pass through your finger. When the light comes out of your finger, it tends to look red, because all of the other color wavelengths were absorbed based on the colors of your tissues. Using this idea to advantage, the key principle at play is that red blood cells with oxygen (oxygenated) and red blood cells without oxygen (deoxygenated) are different colors, both in the visible spectrum and the infrared spectrum. As such, oxygenated cells absorb different amounts of red and infrared light when compared to deoxygenated cells. Deoxygenated blood (venous) is not colored "blue" like all of those diagrams in your biology book imply, but it is a different color than oxygenated blood.

"Okay, Spectrum Absorption Boy," you're probably thinking, "how do you separate that out from the absorption by bones, skin, fat, and the little guys who open and close the capillaries (Ref 5)?" The red and infrared absorption caused by those things remains constant, but the absorption caused by the blood cells pulses, because of, well, your pulse. The microprocessor in the oximeter ignores the constant part of the signal and focuses on the pulsing part. By counting the pulses, it can

tell you your pulse rate (frequency). By looking at the intensity of the colors of light received and comparing it with the known intensity without a finger, the microprocessor can do some maths and figure out what percentage of the red blood cells are carrying oxygen.

For a more complete explanation of how a pulse oximeter works, watch the Technology Connections video at https://youtu.be/4pZZ5AEEmekhttps://youtu.be/4pZZ5AEEmek (Ref 6).

While no one will publish what blood oxygen saturation values "should" be (because it varies person to person), it seems generally accepted that while sitting at rest, values from 100% down to about 95% are generally okay. Another generally accepted value is if you see 90% or less in flight you really need to take action—either get on supplemental oxygen or descend.

For those of you competitive types out there (you know who you are), you'll just have to be satisfied with 99% SpO_2%, because most pulse oximeters only have two characters on the display and thus can't display "100%".

One last faulty indication to be aware of—red blood cells bonded to carbon monoxide (CO) are the exact same color as they are when bonded to oxygen molecules. As such, the pulse oximeter can't tell the difference between carbon monoxide and oxygen, so it won't work as a carbon monoxide detector. You'll need a separate device for that.

Join us next month for part 2.

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Project Police Aircraft Spotters Quiz

Evil Editor Zurg

The last two month's spotters "classic movie aircraft" challenges were a result of a special request from one of our faithful readers, who is an avid aviation film aficionado. Several of our astute readers quickly identified the "stunt double" for "The Phoenix", so I thought I'd try a little more subtle challenge with this beauty.

Again, shortly after the issued challenge, local Project Police aircraft spotter Michael Knight correctly identified the subject as a Bristol Boxkite from "Those Magnificent Men in Their Flying Machines". One of my "covert operators" operators in another chapter not only correctly identified the aircraft, but also added the additional information that this was "…Bristol Boxkite replica, referred to as a Curtiss with an Anzani engine. Flown by Orvil Newton in (the movie)…" (Note: Orvil Newton was the character played by Stuart Whitman.)

The Boxkite pusher biplane was one of the first aircraft produced in any significant quantity. It was produced by the Bristol Aeroplane Company (actually known as the British and Colonial Aeroplane Company at the time) and

used as a trainer in several of Bristol's flying schools. Boxkites were purchased by the British War Office plus some were even sold to Russia and Australia as trainers up to the beginning of the First World War. Nearly half the British pilots trained before WW-1 learned to fly in Bristol Boxkites.

Although Boxkites were produced using several different type engines of that era, most of them were flown with 50Hp Gnome rotary (NOT radial) engines. The Boxkite replica built for the movie originally used a 65Hp Continental A-65 engine, which proved insufficient to push the Boxkite. (But how could 65Hp be insufficient to replace a 50Hp engine you might ask? Excellent question grasshopper. Power and thrust are NOT the same thing. Apparently the smaller prop configuration and higher RPM of the A-65 did not operate as efficiently in the slow speed range regime of the Boxkite.) So, the replica builders replaced the A-65 with a 90Hp Continental O-200-B, which proved sufficient to push the Boxkite into the air and between the various filming locations. Another interesting factoid is that when they were certifying the airworthiness of replica, their calculations showed the structure was designed to stress levels consistent with modern aircraft.

Well Project Police, that was fun. Just for grins, I've decided on a "triple header" for this category of aircraft. Here's this month's challenge. This should be an easy one, but like the previous two members of this "triple header", there's something unusual about this particular specimen.

As usual, send your answer or best "edumacated guess" to Staff Editor Randy Kelly, at electricrow@pobox.com. Oh, and Staff Editor Randy recently conveyed to me two other interesting facts. First, that several MTSU Alpha Eta Rho (AHP) members by request have been added to the Sport Flyer Newsletter distribution, and second, that aircraft recognition is a formal competition area of the National Intercollegiate Flying Association (NIFA) in which the AHP flying teams compete. I am therefore expecting some AHP "guesses" to roll in this month too ha, ha, ha (evil chuckle).

Project Police Tales Wanted

EAA members OR aviation enthusiasts. Do you have an interesting project you'd like to talk about or show us? Have you seen an interesting or unusual aircraft? Do you have an interesting maintenance or build story? Snap some pics and write up a short report or make some notes to give to our staff writer Randy Kelly for inclusion into ***The Sport Flyer.*** We're not picky. ***We don't care if you're from OUR EAA Chapter, some other EAA Chapter, or just an aviation aficionado*** – we'll publish your story anyway. ALSO, later in this issue you'll notice an *EAA Chapter 1326 Technical Assistants.* These are EAA and/or other aviation technology enthusiasts who may or may NOT be a real expert in that area, but are willing to share their knowledge and building expertise with other members who need some help (or just a sympathetic ear) while accomplishing their build. If you are able/willing to serve/help in this capacity, please contact Randy Kelly at electricrow@pobox.com.

Chapter 1326 Mission Statement

The Mission of the Shelbyville Sport Flyers Club, EAA Chapter 1326 is to enhance the quality of aviation life for its members by providing information about aviation, flying, and mechanical/maintenance knowledge shared by fellow members, guest speakers and special events which respond to the expressed needs and desires of all members.

Chapter 1326 Calendar

July 22nd, 2023; EAA Ch-1326 Fly-In Breakfast, 0730-0930, Sport Flyer Hangar, KSYI airport.
July 22nd, 2023; MTSU AHP Airplane Wash, 0730-TBD, KSYI airport.

July 27th, 2023; Regular 4th Thursday meeting. Program and location is TBD.

August 24th, 2023; Regular 4th Thursday meeting. Project Police Raid. Location will be sent to Project Police by secure means.
August 26th, 2023; EAA Ch-1326 Fly-In Breakfast, 0730-0930, Sport Flyer Hangar, KSYI airport.

Special EAA Chapter 1326 Board of Directors Meetings are sometimes held on an unscheduled, as needed basis. If you need to be at one of those, you'll be notified by email or text.

For a good summary of aviation related social and training events in Middle Tennessee, check out the website https://www.socialflight.com/

CHAPTER 1326 ADMINISTRIVIA

To join Chapter 1326, send your name, address, EAA number, and $20/year club dues to: EAA Chapter 1326, 2828 Hwy 231 N. Shelbyville, TN 37160-7326, attn Leigh Kelly. NOTE: You must also be a member of EAA National (https://www.eaa.org, or call 1-800-843-3612, $40/year National dues).

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Inputs for the newsletter or any comments can be e-mailed to Randy Kelly at electricrow@pobox.com

*From the **Project Police** legal section: As you probably suspected, contents of The Sport Flyer are the viewpoints of the authors. No claim is made and no liability is assumed, expressed or implied as to the technical accuracy or safety of the material presented. The viewpoints expressed are not necessarily those of Chapter 1326 or the Experimental Aircraft Association. **Project Police** reports are generally printed as they are received in the next "convenient" issue, with no attempt made to determine if they contain the standard aviator caveat of at least 10% truth. So there!*

THE SPORT FLYER

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ADDRESS SERVICE REQUESTED

THIS MONTH'S HIGHLIGHTS:

- Kommandant's Komments
- June Project Police raid
- June Fly-in Breakfast
- Technican's Korner:
- Evil Editor Zurg's Aircraft Spotters Quiz
- Monthly plea for "Project Police" participation for new stories