

WARBIRD NOTES # 6 30 Dec 94 (15)
GAUGE INDICATIONS ON A FAILED ENGINE

In many years of instructing in various piston engined airplanes I've found a misconception that, when described, will leave most

of you saying "I knew that", others may have to stop and think about it a little bit - and then - the few individuals one really wishes would stop and analyze this situation. Whether it's the pure turbine background or what, I don't know, but they somehow subscribe to a dangerous fallacy, albeit a widespread one. This concerns a discussion of what happens to the indications on a piston engine's gauges when the mixture is moved to IDLE CUT OFF or the fuel supply shut off for training. And, obviously, this also applies to the indications on an engine that has actually failed. Carried to the extreme, this has resulted in feathering the wrong engine and other equally bad scenarios.

Back in the mid-fifties was the first time I remember hearing this question asked during a check ride periodically given to all of us USAF B-25 instructors. I wasn't the recipient of the question but sitting on the jump seat I did hear it, along with the wrong answer. I remember picturing in my mind the fuel pressure gauge dropping and, in all honesty, I know I would have also given the wrong answer if I'd been the one asked. After thinking about the system for a few minutes, I realized that the check pilot was right but it really taught me a lesson larger than this small bit of aeronautica. At the time we probably had less than a thousand total flying hours, most of it in B-25s and could probably fly that aircraft better than nearly anyone with far more experience. But, we had very little practical experience with really knowing the systems and the basic knowledge one gets while acquiring "some salt" in USN parlance. In addition, once we've adopted a preconceived idea, it's sometimes very hard to let go of that idea if we think we'll lose face. I don't know anyone of us in this business who was born "knowing it all". Most of this stuff is acquired over the years the hard way, listening and observing, with varying degrees of pain and sometimes with damage to the equipment. The preceding sentence is the reason for writing these bulletins, if something is passed on here it sure beats trashing some very expensive machinery!

Let's analyze the engine panel instruments one by one and look at just what they indicate and tell us. For all of this, we'll assume we are in cruise flight at cruise power at cruise speed.

Since the fuel pressure was mentioned above, let's look at it first. Think about the system for a minute and you'll remember that the gauge receives its pressure from a location in the fuel line after the boost and engine pumps but before it enters the carburetor. So, if you turned off the fuel tank selector the flow would be cut off and pressure would drop to zero on the gauge. Some instructors have been in the habit of giving "engine failures" to a student by doing this. I've done it sometimes (at altitude) when trying to make a point about the subject we're discussing in this bulletin or so that the student couldn't look at the mixture to determine which engine failed. It does demonstrate, obviously and without question, that fuel pressure falls when supply is lost. However, a couple of problems are lurking here. First of all, if you're close to the ground when you do this you'll need a fair amount of time to regain pressure if you need to abort the training process, in other words, this is not a simulated failure, it's real. Secondly, you need to know your aircraft, not just a generic aircraft, but the one you are instructing in. For example, on some B-25's the firewall shut-offs are fuel shut-offs only. On others they are fuel, oil and hydraulic shut-offs, the fuel is mechanical and the others are electrical. (Interesting how many pilots don't know the answer to this question on the B-25 they're flying.) You can tear up some pretty high buck equipment if you try the wrong thing on

one of these. There is one other thing you can teach here, if all fuel pressure is lost for real always try the boost pump during the trouble shooting process prior to feathering an engine.

Now, let's say you pulled the mixture to IDLE CUT OFF to initiate this practice engine shutdown. In this case the fuel pressure would not go to zero since it is all accomplished within the carb. Again, this is a common misconception when the question is presented "out of the blue" and almost forty years ago I sure bit on it.

Well, we started this with the easy one, the fuel pressure. Now let's go on to something a little more controversial like manifold pressure (MP). What's going to happen here when you cut either the mixture or the fuel supply? Cut a mixture and just leave the throttle alone where it was set at cruise, let's say, for example in this case, 27". If you can visualize a big air pump, that is exactly what the engine is, with the throttle located at the intake. After seeing for yourself that the MP stays unmoving at 27" move the throttle forward some. MP gauge goes right up normally, doesn't it? O.K., now pull it back some. Gauge also follows this reduction normally. Now, equalize the two throttles side by side, then move them together forward and back. They act the same, don't they? Only when you move the throttle to a setting asking for more than ambient pressure will the indication act differently. Still believe you can just look at the MP gauge and tell your instructor which engine failed?

How about oil pressure and temperature? Cut the mixture, then take a look. The engine keeps turning and as long as it does the oil pump keeps pumping, right? So the oil pressure stays up and doesn't give you a clue about which one failed. Over the short period we're discussing here the temperature stays up too. However, if the engine actually failed because of an oil pressure or temperature problem, that's a different story and outside the area of this discussion about training.

Now we'll have to get to the real bone of contention. I've listened to people describe some weird indications they experienced when they tried this. I'm reminded of one of the first things Andy Anderson, our instructor in test pilot school, tried to get across to us about filling out a flight test evaluation report. "Write down the test results you see, not the ones you expected or hoped to see!"

If we cut the mixture what's going to happen to the RPM? I listened to someone describing a sustained decrease in a B-25 of several hundred RPM after the mixture was cut. I was most anxious to see this for myself so arranged to fly that particular B-25, as well as one of our local ones. When we cut the mixture at cruise the RPM sagged about a hundred and then went right back to where it had been. Let's analyze that for a minute. The engine is still turning so the oil pump is still putting out normal pressure. Where does the prop governor get its supply? That's right, from engine oil pressure. So it keeps doing its thing according to your request through the prop control. You had the control set to cruise RPM so (after a second or two of decrease followed by an immediate increase as the blades assume a new angle) that's what it delivers. It will as long as it has oil pressure and, with this proviso, that the cruise speed stays high enough so that the blades don't reach the pitch stops while trying to maintain the requested RPM. On the PBY, if you're cruising above 105 KTS, the prop acts like we described above. Slower than that the RPM will fall somewhat while the MP stays constant. Think of it this way - the oil pressure stays up because the engine's still turning at cruise RPM and the RPM stays at cruise because the oil pressure's still being furnished to the governor. Quid pro quo, right? Oh, and just for the record, I recently tried this while flying B-17's and A-26's, same result.

After all of the above, can you look at the instrument panel and guarantee you can know which engine failed? W - e - I - I, yes. That is, if you're willing to wait – and wait – and wait – and wait, you'd finally see the cylinder head temp slowly decrease. Other than that, pretty much nothing! Looks to me like the old standby we taught forever, "dead foot – dead engine" is still the best game in town.

Another thing just for the record. No, I don't cut the mixture willy-nilly as the paragraphs above would seem to indicate, that was just for illustration. Any good student should be able to see what we're talking about after one or two actual shutdowns so we don't have to abuse some very expensive machinery. Usually retarding the throttle and prop works just fine, whatever we can do to minimize the reciprocating load.

You know, I keep thinking before concluding I should mention something else the aforementioned Andy Anderson taught us. Something else that isn't at all germane to this subject but probably saved my rear end more times than I'll ever know and just seems worth passing on for those of you who didn't know him. "Don't ever let an airplane take you someplace where your brain hasn't arrived at least a couple of minutes earlier!" I guess it could be paraphrased as "Give it a lot of thought before you try and expand the envelope!"

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