The infamous Dragon 800 lean surge, lean stumble, midrange seizures, midrange detonation—one plausible cause. I have an idea that may be at least a partial cure that could be EPA friendly. More surmising by DynoTech Jim Czekala

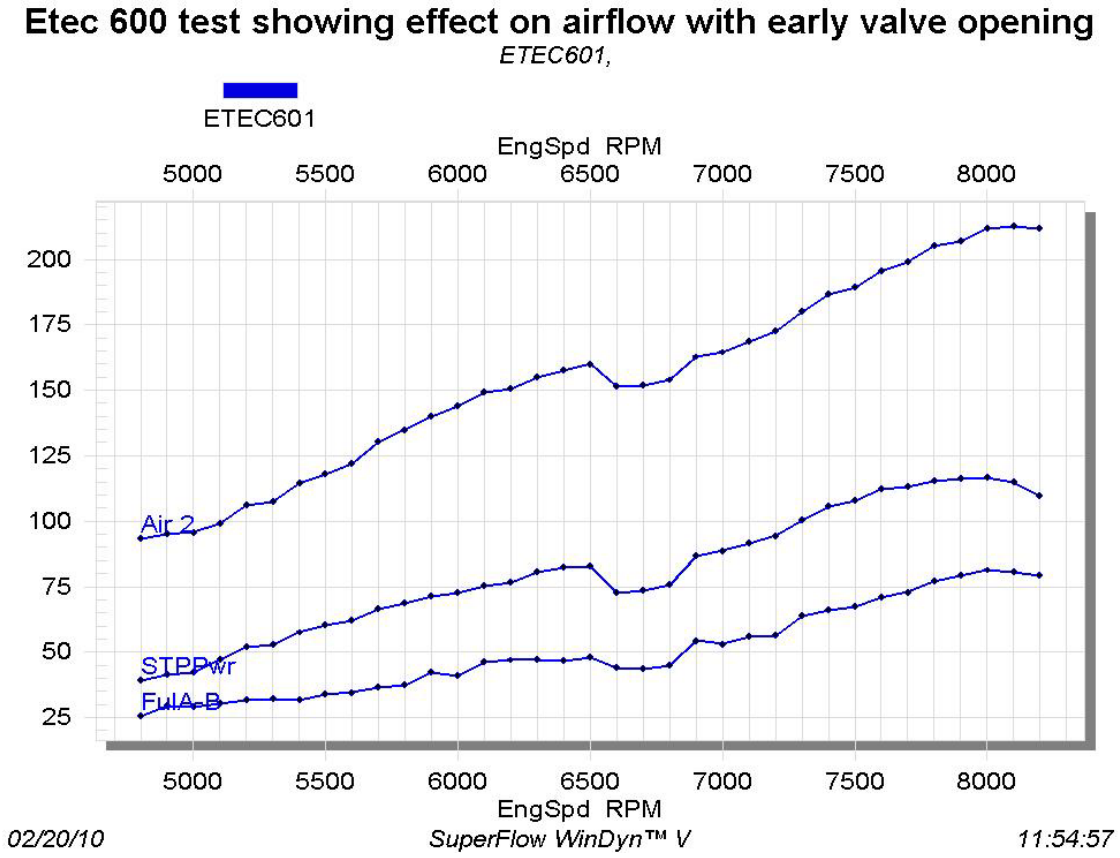
Warning! This may be completely wrong, but I doubt that it is…

Rich misfire usually occurs at 10/1 A/F mixture or richer.
Lean misfire usually occurs at 17/1 A/F ratio mixture or leaner.

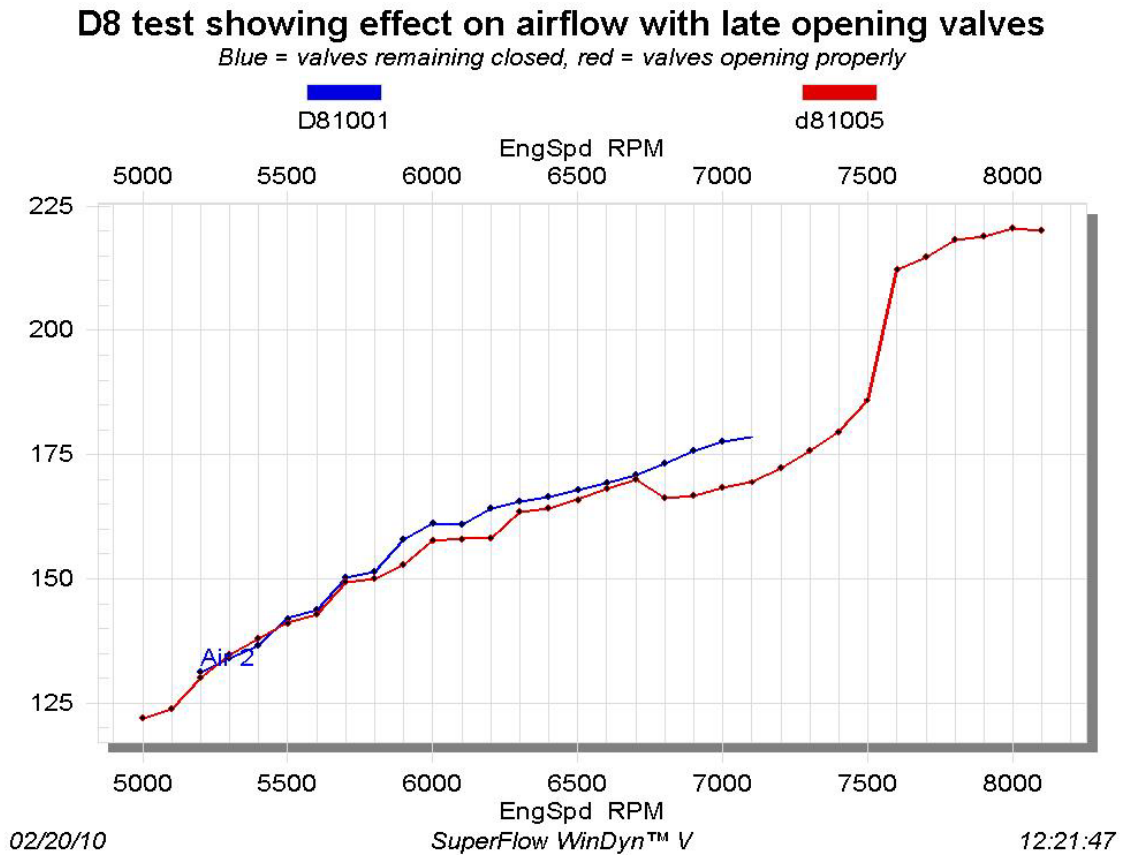
Why are the Polaris 800 Dragon twins with factory EFI so "finicky" in the midrange? Why do some Dragon 800's, with the 1/14 reflash run dandily at part throttle while others with identical ECU programming stumble, detonate and seize? Why do I need to have FIVE different Power Commander V midrange maps for the infamous 1/14 reflash to make these sleds run cleanly at all RPM, all throttle positions?

I've studied lots of dyno test results on Dragon 800's and other engines with exhaust valves. My opinion now is that imprecise control of the D8 exhaust valves is the most likely culprit causing lean midrange. During light throttle condition some exhaust valves may be lazy, late opening, creating an instantly lean condition that causes a "flat" spot or stumble, creating knock that puts the engine into "protect-me" mode. In the worst case scenario the engine may be so lean it won't knock and protect itself—it will just overheat the pistons until they grow to a diameter just larger than the bore size.

But if exhaust valves are late or lazy opening as revs increase, wouldn't that *choke* airflow causing rich misfire? Usually not! It is just the opposite with valves that are timed to open at too low RPM. Here is a graph showing what happens to airflow through engines when valves open early. As you can see when the valves snap open on the dyno, airflow *drops significantly* along with horsepower. Properly mapped EFI causes the fuel flow to drop in synch with the drop in airflow after valve opening. Note how this Etec 600 drops fuel flow as valves open.



Most of us know that the D8's exhaust valves are forced open by combustion pressure fed through an orifice in each cylinder wall just above the exhaust port. Pressure from combustion is routed to below the diaphragms, and just a few psi of pressure will open the valves. Since it is imperative that the time that valves open be precise, so that the poor devil who is tasked with creating the perfect EPA compliant and driver pleasing EFI fuel map will know exactly when the fuel map must be shifted to accommodate the instantly changing airflow. Polaris' method of control is to bleed off the combustion pressure beneath the diaphragms until it is time to open them. Then, a normally open gas control solenoid snaps shut, and traps the combustion gases beneath the diaphragms and up go the valves. Or at least they are supposed to. But sometimes they may be lazy, late, or won't lift at all, perhaps due to fouled valves, springs too stiff, or just low combustion chamber pressure. Here is a graphic example of valves remaining closed on a Dragon 800 that Boyesen Joe brought here to test reed cages. I began a dyno test with too low a coolant temp, and the ECU refused to allow the valves to open. See what the airflow CFM does compared to the second test with warmer coolant and cooperating ECU. The valves remain closed, and airflow increases as revs climb! Of course, if valves stay closed too long, eventually airflow will drop along with power.



.

But this is all happening on my graphs at WOT full load, and it is extreme. But it shows what may be happening at light load, part throttle if one or both valves are late opening when the D8 ECU closes the solenoid.

If the engine is EPA compliant it is probably tuned at part throttle to 15/1 or leaner, maybe 16/1 to keep both CO and NOx at an acceptable level.

When you are accelerating with light throttle opening, as the engine passes some RPM where the ECU expects the exhaust valves to open and airflow and programmed fuel flow both to drop maintaining that ideal 15.5/1 or whatever A/F ratio necessary to be legal. But if at that point one or both valves hang low, it only takes the slightest increase in airflow as the programmed fuel delivery is reduced to cause the offending cylinder(s) to lean out to 17/1 on the edge of misfire, get hot and detonate there or even misfire at 18/1. That lean condition not only makes riding miserable, it can further reduce combustion pressure, keeping the valves closed even longer! So all you can do is squeeze the throttle open more and more and then the valve(s) finally slams open and the engine runs fine. Grrrr.

To correct this annoying and potentially damaging situation, I have been premapping Power Commander V fuel controllers with various amounts of added midrange fuel

(depending upon the owner's description of RPM/ TP where stumble occurs) and greatly leaned out top end fuel to "fix" the issues plaguing the Dragon 800. What we (me and many independent sledders fine tuning PCVs in the field) have been doing is adding up to 25% more fuel in the part throttle area with the Power Commander fuel controllers, sort of a general "blanket" of added fuel so anywhere the valves are lazy, there is enough fuel to stay away from the dreaded 17/1 or leaner surginess or misfire. This surely would prevent the sled from being EPA compliant, but I would submit that neither is a stumbling, misfiring untuned D8 engine EPA compliant. But what that blanket of added fuel does is make the sled run on two cylinders all the time. Maybe in the transition area where valves are supposed to open we may have it running 13/1 instead of 15.5/1 but we just have to cover that awful 18/1 area that will drop a cylinder. As long as it runs without misfire all are happy.

Adding to the evidence to support my surmisation is the fact that Arctic Cat, with its' precise mechanical control of the valves has no such issues. SkiDoo had similar electric stepper motors operating the Mach Z exhaust valves, and also was precise in valve control. The new Etecs have pressure operated valves, but seem to be precise enough to drive cleanly.

Also note last year's final 2009 D8 PCIII map that Wayne Stoutner, Casey Mulkins, Chad Okeson and I created. In that case, many people complained that backing off the throttle from WOT gradually created a rich misfire at about 7500. We found that on the dyno—backing off the throttle from WOT 8000 I think the valves dropped early due to lack of combustion pressure. So that required a large block of –25% fuel reduction in that RPM/ TP range to cure, and it was dandy! Yes, the valves were dropping before the solenoids opened probably due to drop in combustion pressure, and at those high revs the early closing valves were causing airflow to *drop*! Once again, the lack of mechanical control of the valves was responsible for that particular malady. I think this year, they are commanding the valves to close early when backing off the throttle and tuning the ECU for the expected drop in airflow there. This year, happily, there is no off-throttle misfire to contend with. But that midrange is driving many D8 owners crazy.

What could fix this? 12vdc stepper motors precisely controlling the valves would surely work, but doesn't seem like an easy retrofit. How about enlarging the orifice in each cylinder wall, and the passages to the valves? Could this fill the area beneath the diaphragms more quickly? Shorter, smaller diameter hoses from diaphragm to solenoid might help. ***Perhaps just allowing the valves to remain closed until higher RPM, and/ or require greater throttle opening before commanding the valves to open would allow combustion pressure reaching the diaphragms to be greater, and force the valves to open quickly and positively***. If SkiDoo can operate their exhaust valves with adequate precision, then so can Polaris.

I think that if, indeed, it is the lazy valve opening causing the part throttle lean condition, then a mechanical fix can surely create happiness among the D8 owners who refuse to purchase fuel tuning devices and are currently discouraged, angered and perhaps planning to revolt en masse.

How about the fat top end fuel flow? With such excellent detonation protection, it's difficult to understand why the D8 needs 110 lb/hr fuel flow at torque peak! The PCIII and PCV program that many hundreds of D8 bone stockers are using to make their sleds run clean in the midrange also are operating with 10% less top end fuel flow (and 10 more HP) with no problem. A few have called me to say their deto light is coming on after long WOT runs, and just adding about 3% more fuel right there at 100% throttle solves the issue. No piston, no foul.

I hope that Polaris figures out how to correct this, because in January I had an $800 cel phone bill because I went 2000 minutes over my 2000 minute plan! That was 66 hours on the phone, mostly talking to D8 owners who wanted to cure their stumble and really needed to purchase a PCV from me, and talking to many of those who had already invested in PCVs and were delighted that adding the midrange fuel actually works, and also talking to those who still needed minor tweaking to get the PCV tuned correctly for their situation. The extra 10 HP on top end with stock exhaust is just a bonus. Add clutch weight, go faster. Happiness is a good thing. Damn the EPA—let's make those Dragon 800's run!