

California Off-Road Engines and Components Life Span Assessment

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June 23, 2023



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This report is part of CARB Project NO. 22MSC001 funded by the California Air Resources Board.

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Appendix 1 Additional Comments

This appendix contains the service managers' additional comments regarding each engine component that may provide further insight into useful life and repair issues for each part. The comments are listed by component in the order of the interview questions.

Selective Catalytic Reduction

- Rarely replaced, but frequently work on sensors.
- Usually a sensor fails, rare for entire system to fail, they'll go 10,000 hrs.
- Failure would mostly be due to operator error, running engine at wrong speed.
- Some sensors fail in the system. It depends on amount of use. In grapes they might go between 30-100 hrs.
- Never had to replace whole system catalyst itself, just sensors.
- Haven't had many fail - some of the tractors, if they don't use the HP, the whole system builds up with a crystal, have to change the whole piece. Usually last 10,000 - 12,000 hrs.
- Lot of things going on in SCR - manufacturers have a longer warranty on emissions components than on motor.
- Goes back to operator, sometimes 3,000 hrs., sometimes 10,000 hrs.
- Main thing is that if the tractor sits, the DEF crystallizes. Usually 3,000 – 4,000 hrs.
- Depends on how equipment is used and if routine maintenance is done. If regens aren't done, that causes derate & shut down.
- Unless you had a failure or contaminant, go up to 9,000 hrs. before needing to be cleaned or replaced.
- System that we have the most failures with - SCRs fail a lot more frequently than we would like. [REDACTED] is more common - a lot of failures at 250 hrs., then get to 2,500 – 3,000 (75 - 150 HP range).
- Operator is the biggest failure - clogs them up really fast - if they don't know how to run system and shut down in the middle of regen. Seen 100 hrs. to almost never had to have that part done. In theory, the SCR is supposed to never have to be replaced if used properly.
- Only replace when damaged, otherwise could be cleaned.
- Could be 50% of repairs that we see - vast majority of smaller engine failures but see similar failures across the board in system - one part causes other parts to fail.
- Don't see failure too often, sometimes see a code with another emissions problem. DPF is a problem, needs to be cleaned. Usually due to operator error.
- Only had to change when engine is totally failed - SCR is contaminated. Otherwise, not a problem for whole catalyst.
- More likely that smaller component fails.
- Rare, don't really see whole system fail, mostly sensors, mostly deals with idling of tractors.
- Anywhere from 100 hrs. all the way up – we file a ton of warranty claims with [REDACTED] on emission components.

Turbochargers

- Not very often, those rarely fail - from 2,000 - 10,000 hrs., we only have one or two per year, not that often.
- Rare for turbos to fail.
- Not typically a problem.
- At 3,000 - 4,000 hrs. they need changing - there's a valve on the turbo that blocks to heat up air more, it's built in, and those fail.
- Good conditions, probably the same as an SCR, take warranty and add 30%.
- Very few repairs on 100 HP equipment, only had 4-5 go bad.
- Operator error, oil/changes, makes a difference, varies by customer.
- We've replaced maybe 10 turbos, hrs. vary. In cold climates, if they start the engine and oil is thick, it doesn't get into turbo bushing quick enough, will cause a bushing to fail and will start eating oil and dump oil into turbo.
- Not a lot of failures, only when you haven't replaced crank case filters and oil gets into turbo.
- Some fail sooner, variable geometry, not as robust as they should be.
- 6,000 hrs. for standard turbos. Two types that we deal with - a variable geometry (VGT) - those are problematic, it's the actuator, because they're variable gate. They monitor & adjust turbo. Anything moving mechanically has problems. Other non-VGT turbos aren't a problem.
- Fail due to lack of maintenance, didn't do oil change or air filter isn't installed properly. Otherwise keep going.
- Not that often, dual thermal turbos have more pressure 2,000 – 3,000 hrs., single turbos last the life of the engine.
- Die within 1,000 hrs., get too hot with smog, most commonly around 2,500 hrs.
- At least on [REDACTED], we go through them on a certain model – 3,000 – 8,000 hrs.
- We go through turbos, they're running hard, 1,000 – 2,000 hrs.
- Turbos normally don't see problems under 5,000 hrs.
- Maintenance is the primary issue - [REDACTED] uses oil to control boost - if oil isn't changed regularly, then oil holds more carbon and causes a lot of issues.
- Type of turbo makes a difference - variable geometry only last around 4,000 hrs., waste gated go 8,000 - 10,000 hrs., also maintenance-related.
- Mostly operator error - tend to run too hot and tend to crack.
- Big determination is emission level. Variable geometry fails more frequently on Tier 4 engines; Tier 3 engine turbos are less complex and have fewer problems.
- 155 HP had constant turbo issues. Replaced with reman turbos, maybe something with manufacturing.

Diesel Oxidation Catalysts

- Operator error, 100-200 hrs. start seeing issues on smaller units, a complete fail might be 2,000 hrs.
- Not very much failure.
- Could be infinite, resultant damage from something else failing. Turbo loses oil seal and oil gets in DOC and can't get it cleaned out. Turbo fin breaks off and metal gets in system. Hardly ever sees failure.

- Depends on operating conditions.
- Part of DPF, that's what plugs up when you idle too much.
- Varies, had an issue with sensors, \$5,000 repair on each, has been fixed, now life is 3,000 – 4,000 hrs., quite sensitive system, any contamination (dirt or water) compromises the life of. OK if under warranty - worry about once they get out.
- Not too much with DOC, rarely replace on its own.
- Haven't seen any in the last few years.

EGR Valve and EGR Coolers

- 2,000- 4,000 hrs. on any of them, replace under warranty, EGRs don't have a very good life span.
- 700 – 3,500 hrs., those go out a lot.
- 500 – 1,500 hrs., they get sticky in the exhaust.
- A lot of issues, replaced a lot, no specific time, varies a lot; 1,000 hrs., usually get 2,000 hrs. out of them.
- Weird, see EGR failure either early or they last the life of engine. First 1,000 hrs. to within 2,000 hrs. mark.
- 2,000 hrs. on EGR coolers before they crack; 4,500 hrs. on valve; valves get clogged with soot.
- They're the worst, get the dirtiest the fastest.
- Not as many failures on those, around 2,000 hrs. unless they're finicky around 500 hrs. at first.
- Every 10 minutes! Guess every 500 hrs. – 1,000 hrs.
- EGR Valves - have electronic sensor is part of the valve - if sensor fails, we have to replace whole thing, 1,000 hrs.
- Don't see much failure unless you're getting a lot of soot built up.
- We have the most failures with these; if we could eliminate EGR system, would eliminate problems down the line.
- Depends on application, we see a lot of those. We do quite a few on warranty, esp. with tractors that idle a lot.
- Kind of like 100 hrs., have claimed a lot of EGR Coolers under warranty, very few EGR Valves are changed, and if they do, they go 10,000 hrs.
- 800 hrs. for EGR Coolers, those things are junk. 3,500 hrs. for valves are easier; they can be cleaned and put back in.
- When turbo fails, the EGR Cooler fails, manufacturer defect.

NOx Sensors

- Always needing replaced because of contamination.
- Taking exhaust gas and diverting it, lots of wear.
- Not too many problems, sometimes wires rub.
- Varies by use, 10-20 hrs. to 1,000-2,000 hrs., usually in first 500 hrs., depends on maintenance.
- There are two of them, we get those codes pretty often, there's a sensor & module, have to buy both.

- Those fail frequently, could also be something else that took out NOx sensor.
- See a lot of failure due to manufacturer defects, anywhere from 1,500 hrs. and up.
- 1,000 hrs. is generous, go out all the time.
- More frequent - a lot because of debris, get fires that burn wires and the sensors, mice get in and cause problems.
- 50 hrs. - especially. if they don't get DEF in there correctly.
- 500 – 1,000 hrs., we do a lot of those, from heat damage.
- Depending on application, we have a lot of problems with those.
- 100 hrs. on up, all over the board, very similar to EGR Coolers.

Diesel Particulate Filters

- Operator error, start seeing issues on smaller units, a complete fail might be 5,000 hrs.
- Don't have those at Tier 4, unless smallest tractors. (██████)
- None of the tractors have DPFs!! (██████) Big selling point. Older ██████ motors had DPFs, and needed be changed at 5,000 hrs.
- Don't have much issue, engines can clean themselves.
- Regen cycle is sometimes stopped, which causes a problem, big carbon problem and it builds up and clogs filter.
- A few issues, owner fails to do a regen, \$500 in repair, sometimes within 200 hrs.
- Kind of weird, different system than SCR. Fail before SCR, have to go through regen cycle, operators stop regen, plugs up system.
- Ag guys aren't used to running DPF systems, they don't know how to run - want to keep running the engine rather than doing a regen, then DPF gets plugged up.
- Same as EGR valve, if engine is not regenerating properly, have to clean. If cracked, have to replace.
- They do get clogged up, once they start getting clogged, then you have to burn off and/or replace the filter. Idle time is the killer, low idle builds up soot. A lot of shops do forced regens.
- Never know - some had problems at 10 hrs., some never have problems. Most is operator error. If running at idle all the time, probably going to get filter backed up at 100 hrs.
- We do see those get clogged, see some maintenance with those - less with those now. Some never fail, some fail fast, mostly due to operator error.
- Most common operator problem, the engine derate, based on load factor and how hard they run the machine. Construction laying pipe is idled, has more problems with soot with idling. A harder working engine will last longer.
- Should last 4,000 – 5,000 hrs., but start to see issues at 1,500 – 2,000 hrs., if not being run at high RPM.
- What happens is that there is bad mapping with ECU, and lots of soot plugs up - engine wants to do a regen to bake it - so then DPF gets plugged up, and we have to go out. Operator error. Hours are 1,000 or so when tractors are used during harvest with idle speeds.
- We see a lot of those, a few hundred hours to 2,000 hrs.
- If they run it and go through regen cycle, the way they should, recommended at 5,000 hrs., but vineyard and sweet potatoes are idle speed work, so problems show up earlier around 800 hrs.

- The biggest challenge is they're not running at 1,500 RPMs or better, DPF is never burning out, so it has to be taken out and cleaned (baked).

Fuel Injectors

- Those are touchy, we encourage owners to purchase new, not to use reman parts.
- A lot of fuel system failures, because of dust. Much higher volume of injector failures in Bakersfield, hard to keep out fine dust.
- Big issue, [REDACTED] are particular on fuel filters, it's a 5-micron filter, much more precise. [REDACTED] injector, any little piece of dirt will plug up - customer has to have a clean fuel supply.
- Had some issues, mostly with bad fuel.
- Varies, diesel fuel is dirty out of refinery; owners need to test fuel. They can go in 4 hrs. if using dirty fuel; most farmers/construction crews have gravity fed tanks that aren't cleaned, causes problems.
- Pretty good nowadays, along the lines of a turbo.
- Getting hard to come by for replacements & rebuilds. Sometimes we can clean enough to work properly.
- Certain model that we have a lot more problems with, more of a fuel issue - dirty fuel is wiping out electronic fuel injectors - very delicate. Any issue with fuel requires replacement.
- Doing a lot of injectors, varies by hours, 1,000 – 3,000 hrs.
- Not as common of a failure, as far as from an emissions standpoint.
- Usually going after troubled injector, varies engine to engine – mechanical vs high pressure oil vs. electronic.
- Haven't had too many issues, unless fuel is contaminated.
- Good - when they fail it's because the injection pump has failed, or if engine is burning oil, and throws off spray pattern. Not a common component to deal with.
- 10,000 hrs. unless polluted diesel, otherwise pretty good lifespan.
- 800 hrs. on up, modern day equipment is complex with electrical systems.
- We do a lot of those from bad fuel or sediment getting into systems, varies by hours.
- Oh, where do we begin? So varied - smaller tractors used to have them in the head, and now they're very complicated with a lot of specialty tools. Having problems with reman injectors, esp. with large 600 HP injectors, have to be coded into the system - reman injectors just aren't holding up, may clog up at 200 hrs. Smaller HP aren't so bad. This year with all the water and rain, tractors are out in elements, water will get in fuel tanks. Farm workers will run engines and not see sensors, we anticipate more problems coming in this year as engines get used.

DEF Doser/Header/Injector (term depends on manufacturer)

- We change those pretty regularly, 200 hrs.
- They need to figure out a better way, DEF is not friendly to ag, it's very finicky, have to keep it dry, cool, needs a better system, tend to crystallize with moisture. Penetrates into SCR, bad design across the industry.
- All poorly built in the last few years, shortage of them, black market of DEF quality sensors.

- DEF injector can be cleaned, DEF can crystallize if it sits too long. If equipment is just used once/month, DEF fluid crystallizes clogs injector.
- Depends on conditions, how the engine is run and how well the tractor is maintained, if kept out of the weather, they last longer.
- Dosers plug up – we're always cleaning or working on them.
- Depends on type of DEF and how it's stored - can crystallize. Varies quite a bit, very temperamental.
- Some engines have failures right out of gate and some never have issues.
- Hit and miss, a lot of operator error. Problem with putting DEF in tank incorrectly. Hard one to range because it can be brand new with 100 hrs., or all the way up to 5,000 hrs.
- Very common to go bad, hours vary 20 to 300 to 2,000 hrs. Has a new Perkins in shop, DEF header went bad already.
- Huge problems with those. - severe with DEF header - attached to whole electrical network, bring machine down to its knees. Pretty big hit on codes - ranges from 200 – 1,000 hrs., they can just fail whenever, even new machines can have a failure.
- That is the worst component - we have gone through 100 in the last year or two. They don't work like they're supposed to. As it doses DEF into exhaust - could be drizzling outside, and the DEF crystallizes and clogs up the whole system. Not dependable - [REDACTED] builds them. Had lots of issues on all different engines. Have had new tractors less than 100 hrs. have it show up.
- Common problem, we go through every 2,000 – 4,000 hrs., they go bad, DEF pump is the same issue.
- They fault electrically, varies by hours.
- 2,000 hrs., we've had a rash of those, related to DEF overheating in Central Valley.
- That is constant. The last 2 years, we had 60 claims on those under warranty. Mostly vineyard tractors and sweet potato tractors, not going above 1,200 RPM. If tractor is working at high RPM, no problems.
- A lot of issues with header with low hours all the way up (starting at 100 hrs.).
- Those things are junk, we change those things like hot cakes. Have to replace whole assembly, can go out in 200 hrs.
- Manufacturer issues with [REDACTED] on this, change those things constantly, hard to say an accurate number of hours.

DEF Quality Sensors

- This is very common and problematic.
- There was a recall, all were replaced ([REDACTED]).
- Sensor, not too many problems, sometimes fails in 500-800 hrs.
- Lot of failure there, especially with smaller tractors, tremendous failures, 1000 hrs. would be surprising, larger tractors go several thousand hours.
- They're junk, we go through them a lot. 200 - 2,000 hrs. max.
- Very seldom to have failures unless exhaust fluid is contaminated.
- Go out quite a bit, mounted on DEF header, change out sensors, across the board they don't last very well.
- Problems, on IVECO engines on [REDACTED], every 100 HP tractor sold we've replaced. The sensor is sitting in DEF fluid and it's hard on the sensor, corrodes wires, 50 - 1500 hrs.

- Go out any time, doesn't matter the age, mostly depends on owner/operator how they store DEF fluid, if it gets crystallized, it messes with everything.
- Some have problems right out of gate, had a bad batch on a couple of different models. (██████)
- Constant failures, big problem. Some go through every 50 hrs.
- We swap out sensors like underwear, it's crazy, we stock so many of them by now. Every 100 hrs., ridiculous.
- It takes 4 -5 weeks to get part. Sensors aren't individually replaceable, have to replace whole DEF header. (██████)
- Inside the DEF header on our machines - DEF quality sensor is attached pre-post NOx sensor, 200 – 1,000 hrs.
- Initially had problems at 100 - 200 hrs., DEF would get into sensor, now new parts last 3,000 – 4,000 hrs. (██████)
- Those are quite accurate – if someone puts diesel into the DEF tank, the sensor works quite well and prevents further damage down the system. Not a big problem, rarely fail.
- Pain in the butt, 5 – 1,000 hrs.
- Part of the header, failure that would cause to change whole thing.
- Left and right - right out of box, they can be bad.
- They go out a lot, many problems.
- 100 hrs. and up; a lot of issues with DEF quality sensors.
- Part is inside header, same timeline as header, common failure that plagues headers.
- Urea is so hard on them; they don't last very long. If someone gets 1,000 hrs. out of a DEF quality sensor, they're lucky.

Engine Control Unit

- No real problems.
- Not much problem with those, only dealt with a couple.
- Last a long time, the entire life of tractor.
- Not much there for failure, will run as long as engine runs.
- Hardly at all, once in a blue moon. Don't even change when they change engine.
- High spot where rodents like to hang out, depends on where the equipment is stored, sometimes 2,000 hrs., in the front, underneath the battery, ECU will get corroded, or wires get eaten by mice.
- Have done 8 in last 7 years, hours vary on them, they'll spray pressure washers and get problems with electronics.
- Don't usually see failures in those, just depends.
- Pretty robust, very few issues, usually last life of engine or beyond, sometimes swap from old engine.
- Rarely do an ECU.
- Not too much of an issue - but hard to find a replacement, good luck finding one. Can ruin it by hitting something with it, but otherwise can last the engine's lifetime.
- Not as common as a failure, as far as emissions standpoint, usually something else happened.
- Have replaced quite a few, if spraying sulfur hard to keep system clean and keep from corroding.

- Not a failure rate, does what they're supposed to - operator error if they start welding on the equipment.
- No problems unless electrical short.
- Don't have a lot of issues with those on aftertreatment side.
- They could have internal faults, electrical failures, temperatures.
- 100 hrs. and up. A lot of problems with ECUs, start at 100 hrs. on up (certain models on [REDACTED]).

Exhaust Manifold

- No real problems.
- Don't see too many issues – usually just a gasket, not the whole manifold.
- Not a common problem at all.
- Not much there for failure, will run as long as engine runs.
- Last forever, less than 1% failure.
- Sometimes leak, but no real problems.
- Not too many of those, a couple of years ago, had a problem with them cracking, 130 HP range, they were cracking the exhaust manifolds. ([REDACTED]).
- Crack occasionally, but that's about 10,000 hrs.
- Depends on how hot turbo or engine runs. If not cooling properly, it will wipe it out. Depends on maintenance. Doesn't usually crack or go out.
- Not too much problem with that - have to replace sometimes with VGT turbo, stud that breaks. Try to drill out, but whatever bolt they use is super hard, and then drill through manifold. Goes hand-in-hand with turbos.
- Never had to replace. Some have been sold to replace from external accident.
- Rare failure - strenuous loads with heat might crack.
- Not a failure rate, unless oil leaking and iron cracks.
- Lasts the life of unit unless you get a blown turbo.
- Often reuse on another engine.
- Very few failures - gaskets can blow out, but manifolds rarely break.