Automotive Electronic Control Systems

AECS
Training, Equipment and Data for Automotive Diagnostic Specialists

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Technical Newsletter

Jumpy Jeep

Picture sourced from internet)

This article is a true description of an AECS technical help desk problem and how it was solved.

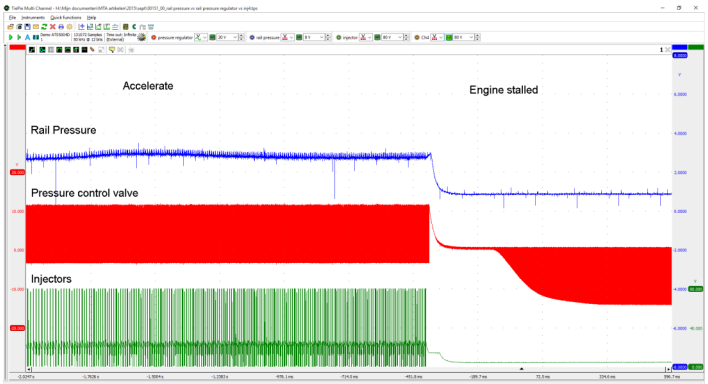
Vehicle

2003 Jeep Grand Cherokee, 2.7 Ltr 5cyl common rail Turbo Diesel engine.

Problem presented to the Helpdesk

This Jeep blows clouds of white smoke under light acceleration and stalls under heavy acceleration or under heavy load. After it has stalled, it starts again straight away but detonates and blows lots of white smoke.

We have scoped the rail pressure sensor, the pressure regulator and an injector.
The injection signal stops just before the engine stalls, but it still has rail pressure and duty cycle to pressure regulator when it stalls.
We have also scoped crank and cam sensors but cannot see anything that could cause this problem.

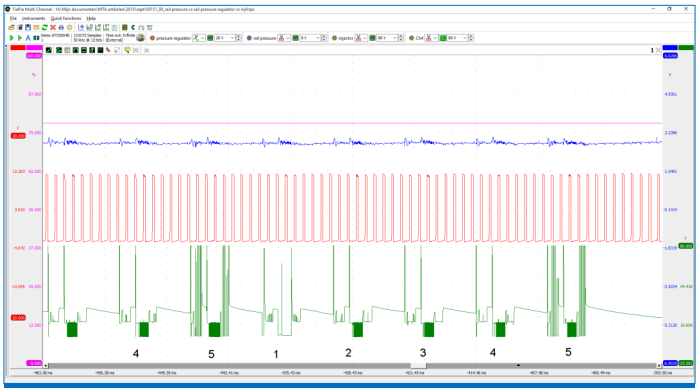


Picture1: ATS 5004D 50Khz recording of Rail pressure sensor, Pressure control valve and injector

Analyse

At first glance can we see in the scope recording that the rail pressure stays present, but that the ECU stops controlling the injectors and instantaneously changes the pressure control valve's position.
Soon after the injection stopped the engine stalled.

Best to zoom in, and see some better detail to see if we can spot any issues.



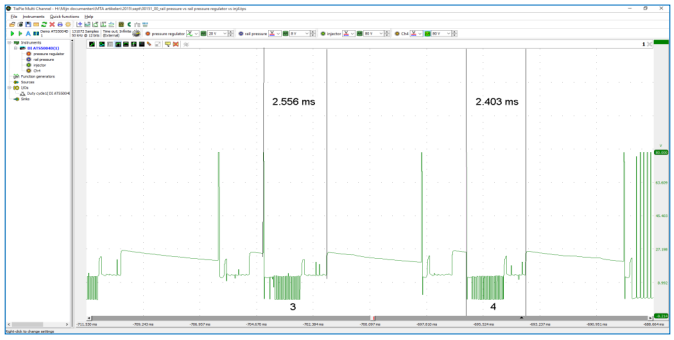
Picture 2: ATS scope pattern zoomed in on the area just before the injection on this 5 cylinder engine stops.

In the zoomed in pattern I have numbered the injection events in firing sequence, not cylinder number. A time measurement between the last 2 injection events shows that the engine is doing 2964 RPM just before it dies completely.
This means that injection did not stop as a result of the crank shaft simply stopping with rotating.

In my view does this indicate a catastrophic problem with the crank/cam shaft sensor signals.
However, the AECS trained diagnostician had already looked at those signals and saw nothing untoward. I trust his opinion.
Best to look at the above pattern again, but now in more detail.

Zoom in more

A much closer look at still the same pattern as above shows a problem:



Picture 3: Zoomed in on injection event 3 and 4

When zoomed in on injection event 3 and comparing it with event 4 a big difference in injector activation time can be seen. Injection duration variations should not be jumping around this much.
Please note: injection event 1 looks different as the scope is connected to that injector; we cover this also in the DMS 1-3 training.

Adaption values

We suggested looking at the adaption values of each injector/cylinder with the scan tool. As we did not trust that, these values were even.

Below you see a sample picture of an adaption injector value screen. This picture has been made with the scan tool connected to a bare 4 cylinder MB ECU (no sensors nor actuators connected).

Data Stream AECS...

V20.50 > Manually Select > SPRINTER > 906/900 > Diesel engine > Right-hand steering >

Name	Value	Unit
Coolant temperature	-40.00	degree C
Current injected quantity	0	mm^3/Hub
Cylinder 1	0	mm^3/Hub
Cylinder 2	0	mm^3/Hub
Cylinder 3	0	mm^3/Hub
Cylinder 4	0	mm^3/Hub
Engine speed	0	rpm
Rail pressure	400.29	bar

1 / 1

New Session Graph Record Print Help

8:46

Sample picture injector adaption values

The adaption values in this Launch Pro3 screen shot are shown in mm3 per stroke fuel quantity and are the correction quantities the ECU makes to keep the engine running stable (equal strength power beats per cylinder).

These values are on top of the injector individual delivery variations, which are coded into the ECU with the Launch when an injector is replaced.

When an ECU finds that adaption values cannot be adjusted any further to keep the engine running smooth, this system will shut down. The injectors are no longer being activated, and the pressure control valve will now do all it can to drop the rail pressure.

The adaption values were 1.8, -2.5, -0.2, -0.6, 2.3!

The vehicle data stated that the adaption value limits are -2.0 to +2.0.

Injectors

It was decided, to pull the injectors out of the cylinder head and inspect them on a test bench.

The diagnostician was so kind to send us a photo of the number 2 injector, beside a good injector:

Number 2 injector (top) beside a serviceable injector

Found it!

The injector nozzle-retaining nut was split and deformed.

The injector-sealing washer allowed combustion pressure to leak past the washer eroding the Nozzle retaining nut, weakening it until it split. The leaking injector washer was letting high-pressure diesel leak from the split nut into the combustion chamber during intake and exhaust stroke, causing the knock and white smoke.

Confirmation

The diagnostician reset the adaption values after five brand new injectors were fitted, and recorded a pattern again.

Picture 4: ATS scope recording of injector, vs rail pressure and pressure control valve after the repair.

To analyse and compare the injector activation duration of each injector you have to zoom in down to just a couple of injection pulses.

Picture 5 After repair scope recording zoomed in.

The measured injection durations do not jump around anymore and showed on the scope:
Cyl 5 - 1.763 ms
Cyl 4 - 1.763 ms
Cyl 3 - 1.762 ms
Cyl 2 - 1.701 ms
Cyl 1 - 1.763 ms

Checking on the scan tool revealed that the adaption values are all close to zero.
The vehicle is running fine and has been returned to the customer.

Conclusion

The leak in the injector could not be seen from the top, looking down on the injector. It was not visible that the exhaust gasses leaked up past the injector washer nor was it visible that the Diesel was pushed into the combustion chamber.
How would you have dealt with this? Would this very profitable job turned into a try this, try that job? Or would perhaps google may have given the answer?
I think that the professional approach of the diagnostician made this job a success.
What else, but your skills, do you have to sell when you own a workshop? Invest in your skills, success will follow automatically.
This diagnostician invested in our training, an ATS scope and our technical support, he runs a successful diagnostic workshop.

Please select your equipment, and technical support provider carefully. There are many equipment providers out there, but where are they when the going gets tough?

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