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Rancid Ranger

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

2013 Ford Ranger *(picture source internet)*

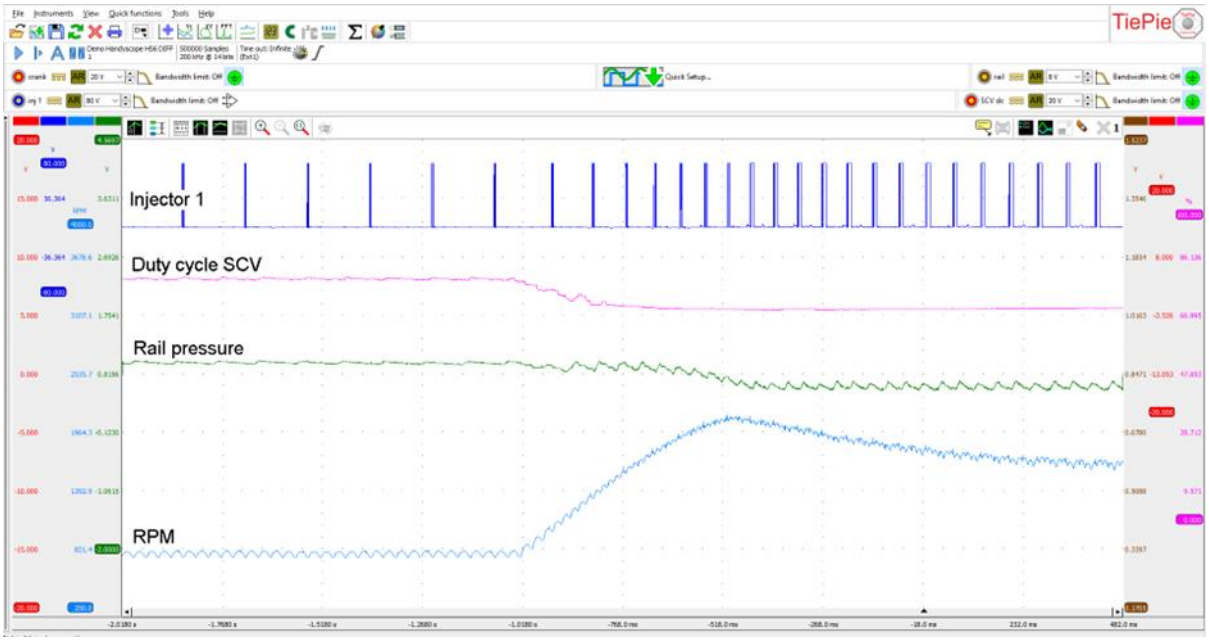
Vehicle

2013 Ford Ranger 3.2Ltr 5cyl common rail Turbo Diesel (P5)

Problem presented to the Technical Help Desk

This vehicle was presented to a workshop which is high up on the ladder in diagnostics, from another workshop.
Originally came in not running (not starting) but we checked pump pressures and could not fault. Now starts OK but has no power.
Could you please assist in diagnosing with the RPM DIFFERENTIATE function of our ATS scope? I suspect a high pressure pump problem.

Recording
The diagnostician posted the below ATS scope recording on the AECS tech support forum.
This recording is from Idle to WOT in the shop and where it is starting to die, it sounded as if it was missing as well.



ATS 6004XM differential/offset scope recording of Inj1, Suction control valve, Rail pressure sensor, and crank shaft sensor.

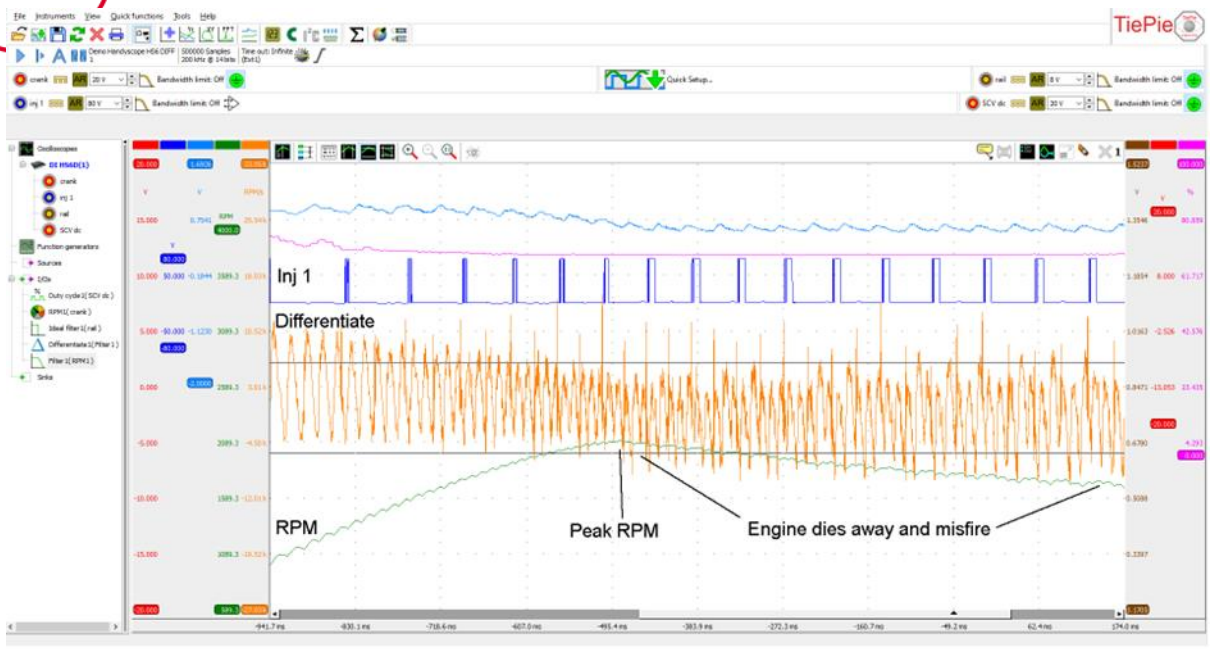
Mathematics

No one likes mathematics (with exceptions), but when the recordings are being modified through the unparalleled calculation capabilities of the ATS scope, some very interesting conclusions can be made. Have a look at what we did below, you will like it if you take the time to digest. It will make you better at your job. Plus it is pure FUN!

Same ATS scope recording but with more math added.

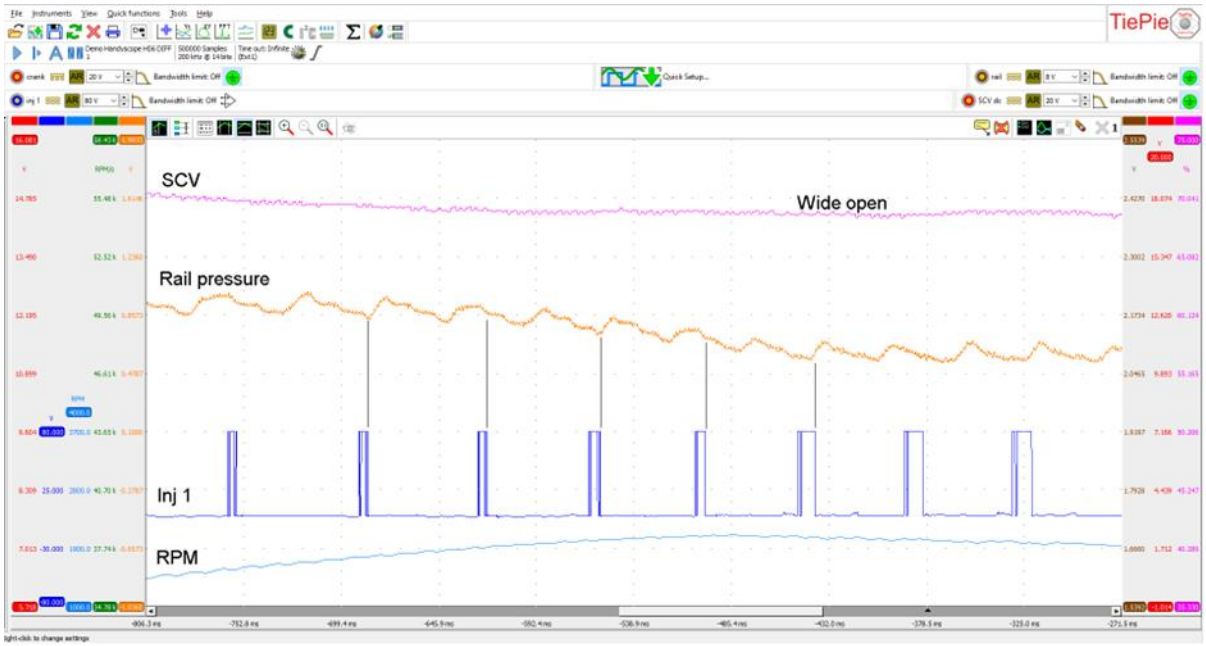
The crankshaft sensor signal is transformed in an RPM line, which shows the speeding up and slowing down of the crankshaft as a result of compression and combustion.
The RPM line can be recalculated into a differentiator, which shows the steepest parts of the RPM line (the biggest changes). The differentiator line is now representing compression energy (slowing the crank shaft) and combustion energy (speeding up of the crank), irrespective of engine speed.

Read!
During Idle you can read in the differentiator line, a clear and steady energy delivery and compression energy. They keep each other in balance, that is why the RPM does not alter much.
However, look at what happens when the accelerator gets depressed. More Diesel gets injected, so energy delivery gets higher, winning from the compression energy. That results in increasing RPM (acceleration on the RPM line).
The compression energy is reduced a little during acceleration as the flywheel distributes more energy during acceleration. However, in the latter part of the Differentiate line you can see that the compression energy used, increases (the lines drop lower), as a result of the Turbo gaining momentum and starting to fill the combustion chamber with more air, making it harder to compress, or taking more effort to bring the piston up.



Same ATS scope recording during misfiring and dying.

In the above picture you see the Combustion energy lower, to the point where the Compression energy has more effect, lowering the RPM after peak RPM. Also visible is that a misfire is occurring and that the rail pressure has dropped to real low and is wavey.



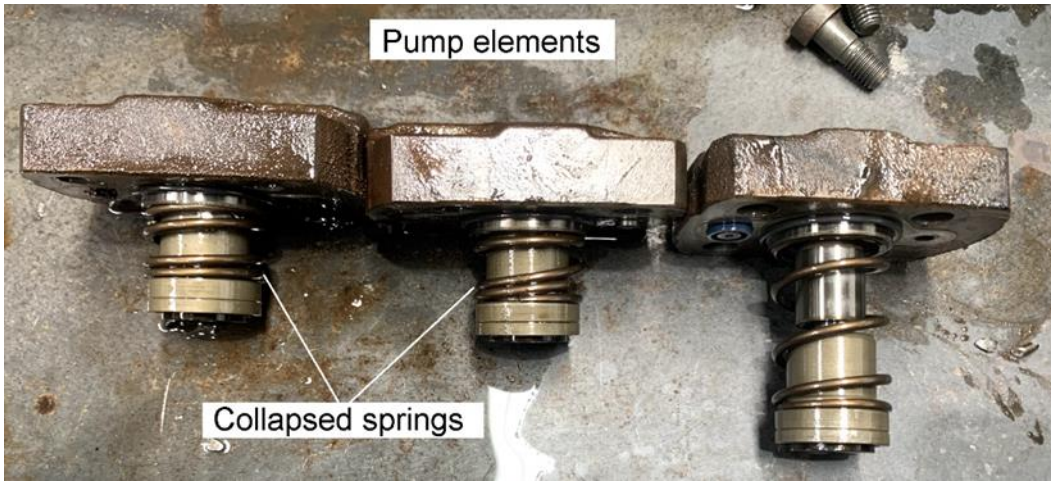
Same ATS scope recording but focussed on the rail pressure.

Rail pressure

When looking for a reason for the misfire and the dying away of the engine, you will have to look at the amount of Diesel entering in the combustion chamber. The amount of Diesel is controlled by rail pressure and injection duration. When the engine gets past Peak RPM in the recording, the injection pulse width has dramatically increased, trying to get all it can out from the rail. The ECU has tried to control the rail pressure up by increasing the SCV opening rate. Yet the rail pressure is dropping, and on top of that is the signal really wavey and not in sync with the injectors, indicating that it is not for example one poor quality injector.

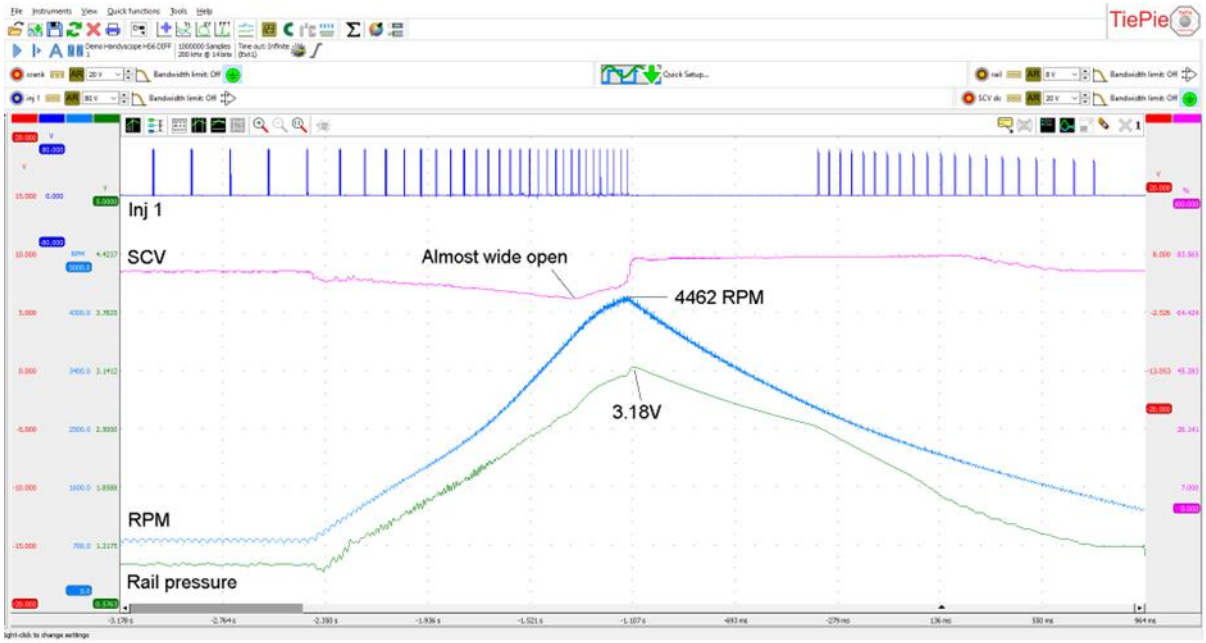
The pump
It must be the pump. The 3-plunger pump on this vehicle is not timed and not running in sync with the injectors. The crank gear has 21 teeth, and the pump gear has 28 teeth. Looking at the recording are the pump elements in sync every 8 revolutions.
We from the help desk suggested that this pump had likely 2 non-working pump elements as in broken springs, or sticky, and likely had to be replaced.

Article
The diagnostician was so kind to post a photo and an after recording for us to use in this article.



Three pump elements from the Ranger, with 2 collapsed springs.

Below is the after recording



ATS scope recording with new pump fitted

Conclusion
With a little automotive mechanical skill, you can read an enormity of valuable information out of one simple recording made during a quick rev-up in the workshop. I am sure that many of you think that a lot of luck is involved in this game, it is NOT. Read it again in detail if you are in that frame of mind!
It requires a healthy dose of thinking power, AECS training, AECS equipment and in this case a little bit of tech support.

The 'how to read' exactly signals like these, is trained in our ATS1-3 (New) scope training, and the DMS series of trainings.

Thank you!

So what equipment was used?

To solve this case this professional diagnostician used:

1) An ATS 500XM scope kit.
2) An updated Launch Auscan3.
3) AECS Training
4) AECS technical support.

ATS 500XM scope
2CH + signal generator
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AECS Automotive Electronic Diagnostic (AED) training Nelson 6 – 7 July 2023
AECS Automotive Electronic Diagnostic (AED) training Hastings 24 – 25 July 2023
AECS Automotive Electronic Diagnostic (AED) training Northland 7 – 8 August 2023
AECS Automotive Electronic Diagnostic (AED) training Dunedin 5 – 6 September 2023

AECS Scope training Auckland 1 - 2 August 2023
AECS Scope training Christchurch 11 - 12 September 2023

It's not rocket science, YOU can do this!

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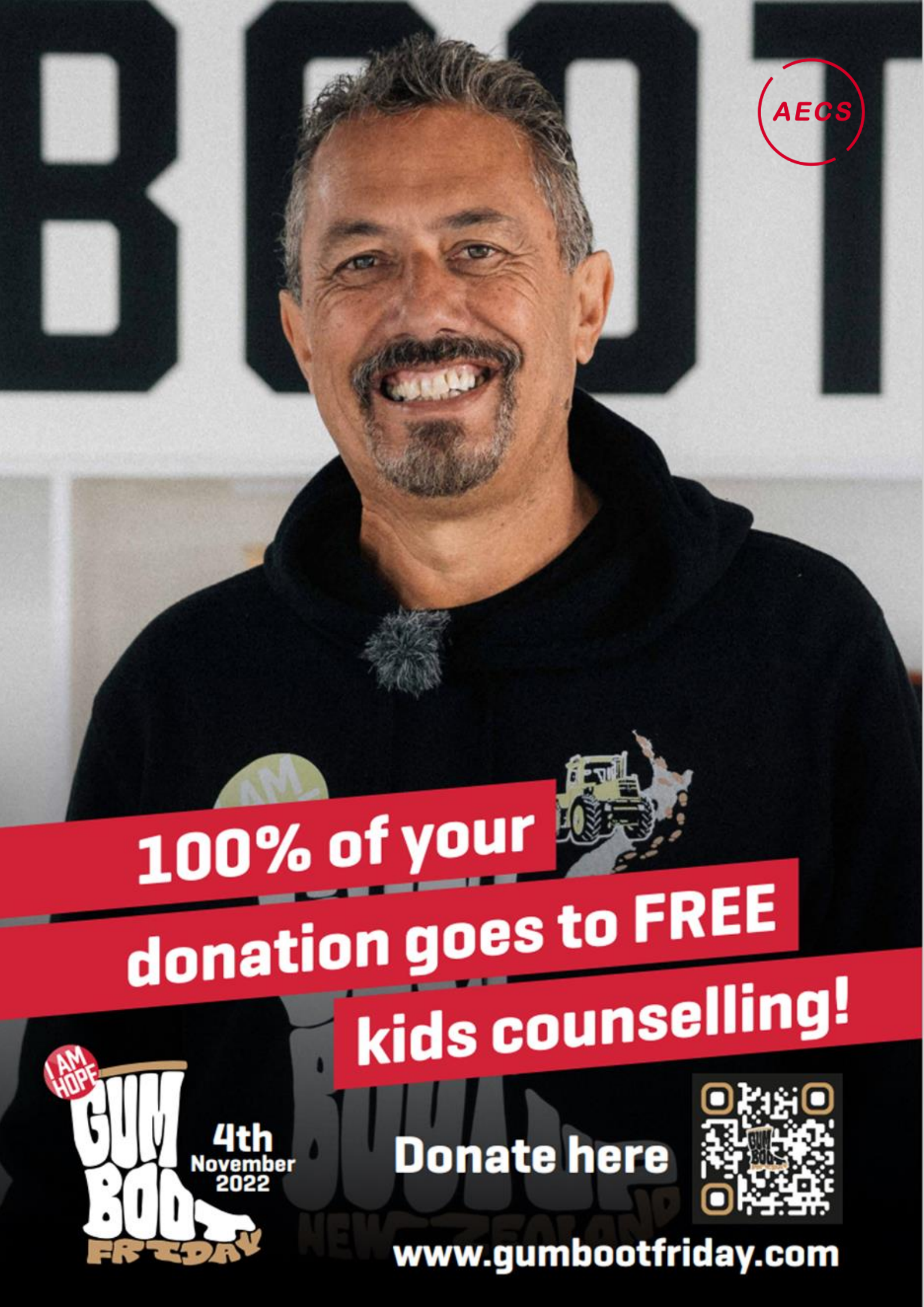
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