

**1. What are the benefits of using RemScan?**

Testimonials from customers discuss a number of benefits. The primary benefit is from rapid measurement of samples in the field and this enables many secondary benefits like:

- Better delineation of spills due to higher sampling frequency.
- Faster decision making enabling faster project closure and completion.
- Higher confidence in decision making based on more frequent and better data.
- All of these result in lower costs – less soil needs to be treated, projects can be closed faster and more efficiently.

**2. Has the RemScan technology been independently validated?**

Yes. RemScan has been in commercial use at many sites around the world since its release in 2012. Satisfied customers include the largest oil companies as well as remediation companies, EPAs and mining companies. There are many testimonials on its operation, and the benefits of using it, and these can be provided on request.

The technology was originally developed and validated in collaboration with the Australian Commonwealth Scientific Industrial Research Organisation (CSIRO). Ziltek co-authored peer reviewed papers on this work including the prestigious Soil Science Society of America Journal (Soil Sci. Soc. Am. J.77:450–460, 2012). Results from an independent evaluation of the technology by Battelle in the USA are also available.

**3. What is the accuracy of the RemScan data compared to accredited laboratory analysis?**

Compared to laboratory analysis for TPH C<sub>10</sub> to C<sub>36</sub>, the typical relative standard deviation (RSD) is around 6% at 10,000 mg/kg TPH and around 16% at 1,000 mg/kg TPH.

**4. Has the instrument performance been verified using an international standard reference soil?**

Yes. RemScan performance has been verified according to the European Reference Material ERM®-CC017.

**5. Are there any soil properties that interfere with the infrared signal?**

Yes. However Ziltek overcomes this by calibrating RemScan for each site. So long as RemScan is used to measure soils for which it has been calibrated, it will provide good levels of accuracy. If there are several distinctly different soil types at a site, a RemScan calibration may be required for each soil type.

Interferences arise from variations in soil properties like particle size, concentration of carbonates or natural organic matter, moisture, etc. By calibrating RemScan for a particular site, the variations of these properties are reduced.

Ziltek is currently working on a universal calibration for RemScan. When this is complete, RemScan can be used to measure a wide range of soils without the need for re-calibration.

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**6. Does the technology work on all soil types?**

Yes. To date, RemScan has been used to measure a wide range of soil types including different types of clays, silts, loams and sands including those with high carbonate and high organic matter.

**7. Does soil moisture interfere with the instrument's accuracy?**

When the *free* moisture content of the soil is less than 5%, the RemScan readings are not affected.

Beyond this *free* moisture level, the accuracy of RemScan predictions deteriorates. In this scenario, RemScan does not provide a TPH reading but instead warns the operator that the moisture content is too high and that the sample needs to be dried prior to measurement. Ziltek can provide several solutions for rapidly drying samples: in many cases air drying will work; in other cases, Ziltek's Portable Drying Unit can be used.

As an example, wet sand contaminated with 10,000 mg/kg diesel will air dry sufficiently on the surface in less than 1 hour at 25 to 30°C. For heavy clays, Ziltek's Portable Drying Unit will dry the surface sufficiently in less than 1 hour.

**8. But won't air drying change the TPH reading because of the loss of volatile compounds?**

It depends on the petroleum source, the ageing of the soil and the air-drying conditions. For example, for diesel, crude and most oil derivatives the loss of volatile compounds in the C<sub>10</sub>+ fraction due to air drying is practically negligible. Therefore it is a sound method to use air drying for contaminants with mainly C<sub>10</sub>+ fractions.

Where the C<sub>6</sub> to C<sub>9</sub> contaminants are the major focus (e.g. fresh gasoline/petrol contamination), it is likely that a significant proportion of the contaminant will be lost during sample handling and drying. In these cases, we recommend using a PID in conjunction with RemScan for comprehensive data analysis. Also, RemScan should measure the soil before the soil has been aerated and directly after exposing the fresh surface.

Because RemScan does not give false negatives, it can be used as a qualitative tool for these lighter fractions. I.e. In most situations, if RemScan gives 'zero' reading for C<sub>10</sub> to C<sub>36</sub>, it is unlikely that there is significant C<sub>6</sub> to C<sub>9</sub> TPH present.

**9. How then should the operator air-dry soils while minimising soil disturbance?**

Simply place the soil sample in a jar lid (or special tamp cup provided with the RemScan kit), firmly tamp the soil using the supplied tamping tool, and leave to air dry at ambient temperature with some air flow. For heavy clays, physical drying tools may be required (Ziltek has a number of tools available).

Please note – RemScan only scans a thin surface of the soil so only the surface needs to be air dried, not the entire bulk sample.

**10. What depth of soil does RemScan measure?**

RemScan measures the surface layer (< 0.1 mm) of the soil sample that is presented.

If you want to measure at various depths in the soil, you can take a sample at each depth and present it to RemScan for measurement. Alternatively, you can use RemScan to make measurements along a length of drill core to provide the TPH readings at various depths in the soil.

So in essence, wherever a soil sample can be collected for standard laboratory analysis, RemScan can also be used to take a measurement.

**11. Do the regulators accept the technology?**

Regulators are encouraging industry to use RemScan to provide supporting data for laboratory analysis, just as they do for XRF and PID instruments. The National Environment Protection (Assessment of Site Contamination) Measure 1999/2013 supports the use of portable infield screening tools.

The US EPA Triad approach describes contaminated site clean-up, and how field instruments like RemScan can increase confidence, accelerate project closure and reduce lab analysis requirements as follows:

*' ... the Triad focuses on data collection methods that can increase spatial coverage for an area without sacrificing sample representativeness or driving up total sampling program costs. The Triad uses a weight of evidence approach to decision-making where appropriate, based on collaborative data sets. Collaborative data sets can contain data from a number of sources, including quantitative and screening analytical methods. ....*

*The use of dynamic work strategies and real-time measurement technologies allows data collection programs and field activities to adapt or adjust to site conditions and analytical results as they are encountered. This, in turn, focuses work on site decision-making needs, and provides a mechanism for responding to unexpected site conditions or data quality problems while the work is underway' - US-EPA Triad Overview - Key Concepts.*

An independent evaluation of the technology was performed by Battelle in the USA on two Department of Defence sites. The results have been published and they showed that RemScan provides high levels of accuracy and repeatability.

**12. Does RemScan measure any other soil properties beside TPH?**

While the current instrument measures TPH only, methods for other soil properties including soil texture are currently under development. Because RemScan is a platform technology, for existing instrument owners it will be simply a matter of purchasing a software upgrade to access any new methods.

**13. What in-field instrument support is available?**

An annual service agreement entitles the instrument owner to a backup service and a return-to-base instrument service annually. A 12 month warranty applies to all parts and software. Certified field technicians will visit site as soon as practicable for instrument related problems and a replacement instrument may be made available during the servicing period.

**14. Is the data easy to access? In what format?**

Yes. Data is collected and stored in the hard drive of the Tablet in .csv file format. This can be exported or copied to a USB.

**15. Is the instrument affected by hot or humid weather?**

The instrument has been tested up to 85% humidity at 35 degrees Celsius and is designed to work in temperatures of up to 50 degrees Celsius. Condensation on the lens is the only consideration that needs to be minimised in extreme weather conditions (including abrupt temperature changes).

**16. Does it replace a Photo Ionisation Detector (PID)?**

No. A PID measures volatile organic compounds (generally  $<C_{10}$  hydrocarbons) in gaseous phase. RemScan is designed to complement the PID in measuring hydrocarbon compounds above  $C_{10}$  in solid phase.

Except for clean-up sites where there is a high proportion of volatile fraction ( $<C_{10}$ ), RemScan is preferred over PID because it has much higher accuracy, repeatability and precision.

**17. Are there any special user training requirements such as those required for XRF use?**

No, there are no licensing requirements for using RemScan.

Ziltek offers a training workshop, including theory and practical after which attendees are issued a certificate of competency.

**18. Do you need to carry hazardous chemicals or gases or soils for instrument calibration such as those required for a PID?**

No. RemScan comes with two inert plastic caps that are each scanned for 1 minute to fully calibrate the instrument. The calibration is performed on start-up and then hourly thereafter – the user is prompted by the software interface. The instrument also self-calibrates internally using a laser to ensure that the hardware mechanisms are optimised.

**19. What if our site target criteria are ‘bands’ or ‘fractions’ of TPH?**

For larger sites with a consistent source of petroleum contamination (e.g. rail yards, refineries) a  $C_{10}$  to  $C_{14}$  number can be accurately derived using RemScan. Representative soil samples can be sent for laboratory analysis and the  $(C_{10} \text{ to } C_{14}) / (C_{10} \text{ to } C_{36})$  percentage can be multiplied by the RemScan output to give a derived value for  $C_{10}$  to  $C_{14}$ .

It is important to note that for validation applications banding is often irrelevant. ie. because RemScan does not give false negatives, if RemScan gives a low or zero reading there are no TPH fractions present.

**20. What is the detection limit of the instrument?**

When RemScan has been calibrated for a particular site, the detection limit is often as low as 70 mg/kg TPH at one standard deviation.

**21. Can you plot the global position of the sampling location?**

The RemScan Tablet contains a GPS location measurement. Whenever a measurement is made with RemScan, it is tagged with the sample ID, depth and GPS location. Photographs and notes can also be associated with each measurement.

**22. Is the instrument intrinsically safe?**

As with most field instruments, RemScan requires a hot work permit for operation in ‘hot’ zones. Alternatively, samples can easily be scanned in ‘cold’ areas.