Engine Polygraph® (enginepolygraph.com)

Diagnostic Report v6.50

Upper Engine	5
Volumetric Eff. Score	10
Valve Seating	1
Lower Engine	8
Rumble	8
Scrape	5

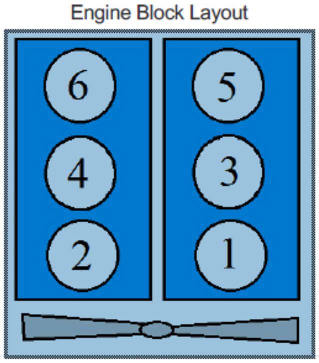
1	2	3	4	5	6	7	8	9	10

Issues

Abnormal Observations	possibly caused by..	Confidence	suggestions...
Diesel engine misfire with fuel; significant blow-by. (Black smoke in exhaust?).	Blow-by during compression stroke from carbon 'freezing' compression rings, thus preventing adequate compression to ignite fuel resulting in misfires.	76%	Suggest you try a fuel (Oxytane) or oil Carbon cleaner to see if that will 'free up' the compression rings. If you do this, run the vehicle hard for several hours. If that doesn't fix it, a 'ring job' might be needed.
At least one flat Exhaust cylinder and no large Exhaust peak. Crankcase looks good.	Injector plugged or not working; misfire with no fuel. OBDII codes P0171 and P0174 are common when injector is plugged.	73%	Fuel treatment to clean injectors (Oxytane) or replace injector(s).

GM 3.6L V6 VVT DI Physical Layout

Engine Block Layout



V6-Right-Alt

Cylinder	Adj1	Adj2
1	3	
2	4	
3	5	1
4	6	2
5	3	
6	4	

Cyl Layout & Firing Adjacency

Bank	Cyl	Firing Order
1	1	a
1	3	c
1	5	e
2	2	b
2	4	d
2	6	f

Adjacent Cylinder Pairs of Head Gasket Concern	Risk Level
Adjacent Cylinders on Bank 1 are simultaneously in Power & Intake strokes	Raised
Adjacent Cylinders on Bank 2 are simultaneously in Compression & Intake strokes	Raised

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Contents

A newer version of this document might be available on our website: www.EnginePolygraph.com .

Introduction

The Engine Polygraph® (www.EnginePolygraph.com) is an application 'in the cloud' to store the FirstLook® sensor output (signatures) from an engine for future reference and optionally, to request an engine analysis report. A SenX signature (Fig. 1) is a record of voltage from one or more piezoelectric sensors (FLS) recording pressure changes (pulses) from an exhaust sensor and a crankcase sensor and optionally additional parts of an internal combustion engine. The value to these signatures is that internal combustion engines repeat firing in the cylinders of the engine in a regular fashion. If everything is working well in the engine the pulses repeat in very regular waveforms; however, engine problems usually present variations that repeat every engine cycle (two revolutions for 4-stroke engines).

The user may request an analysis (report) of the data in view of the engine model identified and parameters of the test conditions. Currently the report choices are 1-page Assessment, Assessment, Diagnostic, or none. The Engine Polygraph® reports automate many of the steps that a user would perform manually in interpreting a 'signature': a pair of SenX waveforms from an internal combustion engine, one from the exhaust stream and the second from the oil dipstick tube.

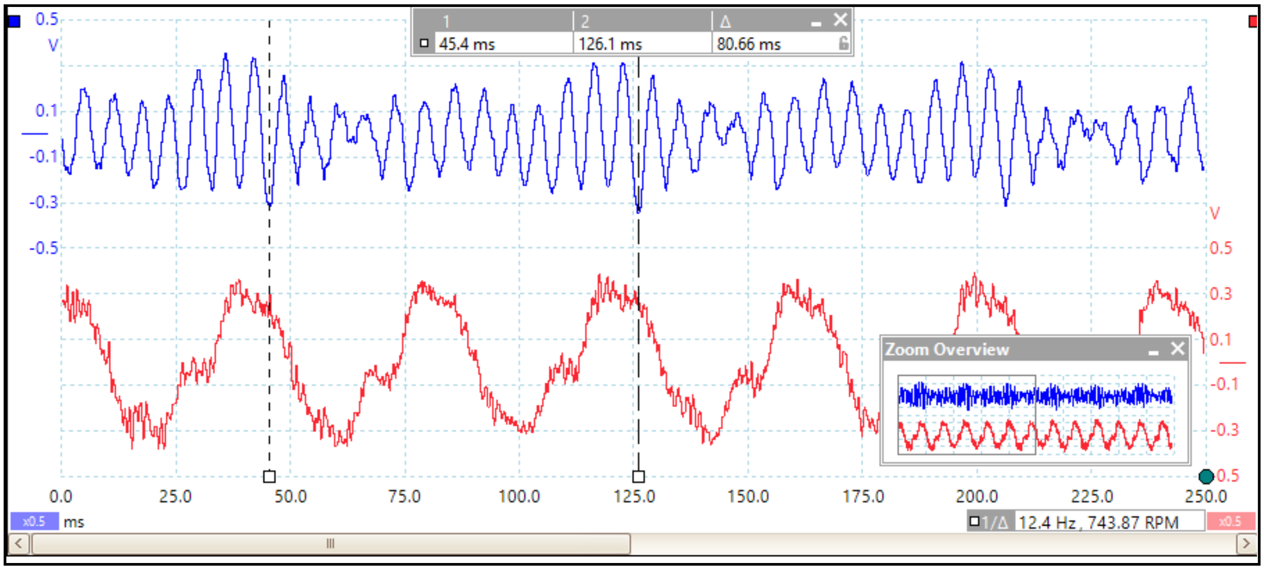

Figure 1: A SenX Signature using a PicoScope PC Oscilloscope

The above signature is from the exhaust (red) and a ‘trigger file’ from a spark plug induction clamp (blue) from a 6 year old, V6 engine. The vertical dashed bars mark the boundaries of a 720° full 2 rotations of the crankshaft which took 80.66 ms, indicating that the engine was running at idle of 1487.7 rpm. (You might notice that the oscilloscope indicates the rpm as 743.87 in the lower right corner. But we know that we have a 4-stroke engine requiring 2 rotations for all cylinders to fire once and this is a V6, so the rpm is twice the frequency of the 4-stroke frequency.) The cylinders are very regular.

Why are the signatures important?

In a 4-stroke engine, each cylinder of a well-running engine fires once during two rotations of the crankshaft (every 720°); in a 2-stroke engine, every cylinder fires once during one rotation of the crankshaft (360°).

In an engine with a problem of ‘physical integrity’, one or more (usually one) cylinder outputs an abnormal pressure, resulting in an irregular pulse that is quite obvious. We use the term, ‘physical integrity’ to refer to the head gasket, valves, pistons, rings, cylinders, fuel delivery, or ignition. Depending on where the signature is taken and the nature of the abnormality, the problem can often be identified. In this way, an engine with a mechanical problem can be diagnosed. [If the engine has tripped an OBD code AND the engine shows physical component compromise, the problem might not be correctly identified by the code. Most codes assume that the engine has no mechanical problems (no loss of physical integrity) but might have sensor problems, or ancillary control system problems. If the engine **has** mechanical problems, the code may well be erroneous.]

Over time, wear and tear on the engine will cause less-than-failure variation from cylinder to cylinder. Most engines are not 'broken', but many are dirty (carbon buildup) or parts wearing out. The cylinder that is changing the most is typically the one that will fail first. That is why it is important to 'look back' at the signatures of an engine over time to identify if one (or a few) cylinders are degrading and might need attention. By looking at the rate of degradation, one can estimate the future time of failure. In this way, the sensor data can be used for 'predictive failure' to give you the option of preventative maintenance/repair or retirement. You may want to watch the videos on the SenX Technology website: www.senxtech.com.

Engine Polygraph Reports

Engine reports are produced from analysis of certain signatures. There are currently two reports available for selection. The Engine Polygraph® reports automate many of the steps that a user would perform manually in interpreting a 'signature': a pair of SenX waveforms from an internal combustion engine, one from the exhaust stream and the second from the oil dipstick tube.

The **1-pg Assessment** report is a short, one page report showing the 'highlights' of the more complete Assessment report for readers not needing the textual narratives associated with the report content.

The **Assessment** report (and the **1-pg Assessment)** is an analysis of a signature with simultaneous 'exhaust' and 'oil tube' pressure sensor readings that calculates 'scores' with values from 1 (very good) to 9 (very poor) ranking 6 quality 'measures'. The scores are generated from a mathematical model 'trained' with examples of data from engines with assignments made by experts. The report is available as a PDF, and if the Owner is a subscriber to Engine Angel, the results are stored in the database to show time-series graphics of the scores over time.

In addition, both versions of the Assessment report contain graphical representations of the PicoScope data: The **model graphics** of the exhaust and crankcase pressure changes over one engine cycle between the red, solid bars with the cylinders segmented by red, dashed vertical lines. The low frequency pressure changes are displayed in green lines over the complete, black waveform that includes the higher frequencies detected. The **points graphs** show key variables from each cylinder to represent the similarity of the cylinders (inside the green is good; outside the yellow is getting pretty bad. The **profile graphs** plot the pressure over time for each cylinder.

The scores are: an overall engine score and scores for the upper engine (valves, injectors, head gasket, ignition), engine volumetric efficiency score, and a score for valve seating leakage; and scores for the lower engine (rings, pistons, cylinder walls), rumble (humming), and scraping (high frequency screeching). The overall score is indicating the current state of the engine and a measure of risk that one of the monitored components will fail soon – it is NOT a measure of the remaining life of the vehicle although that is related.

The Assessment report contents are described in a separate document, EP Assessment Report, available for download from www.EnginePolygraph.com.

The **Diagnostic** report is an analysis of the data from a ‘Signature’ file of data, data about the engine model being tested, and some test conditions data. The report evaluates the ‘physical integrity’ of the engine AND an Expert System evaluates ‘Abnormal Observations’ detected to produce a list of possible causes of the Abnormal Observations along with a confidence that the indicated cause is correct and suggestions that might remedy the problem.

Currently, the system will produce reports for signatures with ***exhaust*** and ***oil tube*** sensors in the specified engine running condition (cold-crank, idle, or load). Optionally, a channel can be assigned to the ***trigger*** sensor (usually a clamp inductor to detect current in a spark-plug firing or an injector signal for a specific cylinder). A fourth channel can be assigned to another sensor (e.g., an intake manifold or vacuum line); however, any additional waveforms will only be displayed on the report. It is not (currently) included in the engine analysis for the report.

The Diagnostic report displays information about the engine model that is being analyzed. This includes an engine block diagram, firing order, cylinder adjacency and bank location, and the cylinder offset diagram relating the stroke of each cylinder as the crankshaft rotates through the firing cycle. In addition, distinctive engine technologies and common problems are listed as they become known to PFT.

Search and Retrieval of Reports

Previously processed reports can be displayed from the Assessments tab, as shown in Fig. 2, below:

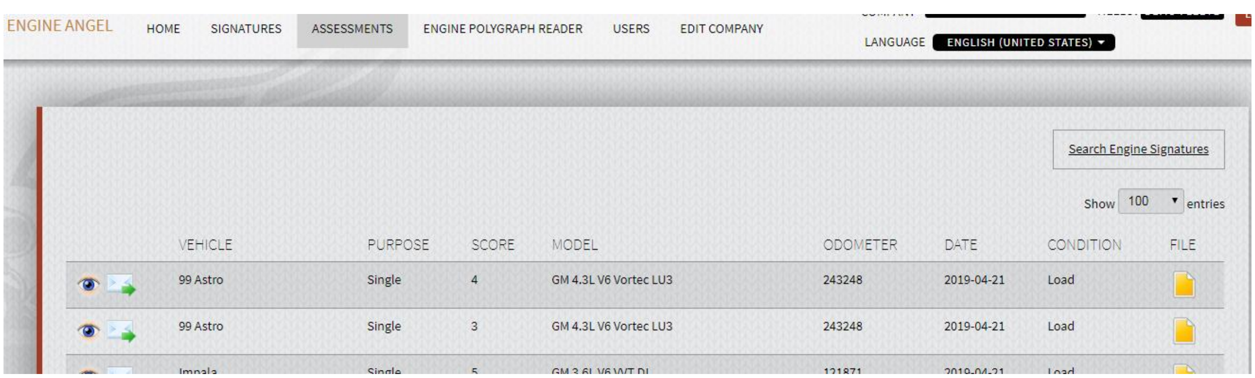

Figure 2: Engine Polygraph Assessments screen

A report can be in a ‘processing’ state, indicating that the report request has been sent to, but not yet processed by the system. Once the assessment has been received (usually in less than 2 minutes), the signature is shown with the **View** and **Email** options. The View button will start a ‘download’ process to your workstation for local storage and viewing. The email option allows easy email capability to send the PDF report as an attachment to a provided email address.

If the submitted signature does not have data that can generate a meaningful report, the system will produce a PDF ‘Exception’ report describing the issue and suggesting corrective action. You will not be charged for a request that results in this circumstance. The most common reason for inadequate data in the signature file for a meaningful report is that the PC oscilloscope settings might not be appropriate for the engine you are working with. Please review the Appendix: ***PicoScope Startup Settings*** if you want more information. (This is applicable only if you do not use the downloadable EPReader application to simplify data collection.)

Diagnostic Report

The Diagnostic report includes all of the pages from the assessment report and incorporates several new sections. The new sections are the result of applying rules associated with various abnormal observations detected from this signature. The process considers a set of issues (engine problems) and looks for abnormal observations detected from the signature normally associated with a particular engine problem. At the conclusion of the consideration of an engine problem, the system generates a confidence measure indicating the confidence that the engine is presenting the specific issue.

Description of Vehicle and Test conditions:

The first two pages of the Diagnostic report are the same as the first two pages from the Assessment report.

Engine Polygraph Report

http://www.EnginePolygraph.com

Vehicle ID : 192

Owner	VehOwner
Engine	S60
Serial Number	
Engine Condition	Load
Purpose	Single
Odometer	330491
Date	2019-12-15 06:57:37 PM

Assessment 8

RPM	1500 (1504)
Engine Temperature	190 F
Engine Polygraph name	b83b168c-bbcb-4380-8503-08f02522da1c.psdata
User's file name	192 1500.psdata
Engine Polygraph Report	Diagnostic
Source	pft01JWM
User's comments	testing

Figure 3: First page of the Diagnostic Report showing vehicle, engine, engine status and test conditions data.

The first page of the Diagnostic report shows the user inputs for the Signature that was analyzed for this report along with the overall assessment score. The RPM value may contain two numbers: the user input estimate when provided, and an RPM contained within parentheses calculated from the signature. (See Fig. 3.)

The analysis program might detect some warnings about the data collected and if so, these are warnings reported in the format as shown in Fig. 4.

Warnings

Abnormal Observations	possibly caused by..	suggestions...
High differences between cycles	Engine might have experienced a transition between operating phases.	You might want to rerun the Signature to get a more consistent result.
Low exhaust pressure. Check leakage	Exhaust sensor might not be well placed; Sensor hose might be accidentally squeezed shut by the clamp or cramped shut. Also possible that there is a leak in the exhaust system.	Check Exhaust sensor position and clamp location; Wrap wet cloth around any exhaust leakage in the exhaust system.
		You might want to rerun the Signature to get a more consistent result.

Figure 4: Warnings that might affect the accuracy of the Diagnostic report results.

Engine scores for the six categories.

The scores for the components are presented: the Upper Engine (valves, gaskets, injectors, and ignition) with Volumetric Efficiency and Valve Seating; the Lower Engine (rings, pistons, and cylinder walls) with 'Rumble' (relatively low frequency vibrations from the crankcase) and Scrape (high frequency vibrations often associated with metal-on-metal with inadequate lubrication). The Upper Engine score, the Volumetric Efficiency score, and the Valve Seating are obtained from the exhaust sensor; the Lower Engine scores are derived from the oil tube sensor.

In Fig 5, we list the scores along with a description of what the score suggests relative to the condition of the engine. Below that is a table of descriptions of what the scores refer to.

The two major categories are: Upper Engine score and Lower Engine score. These scores show how the model evaluates the data obtained for the engine relative to the associated components' physical condition: wear or failure. The vibration frequency measures in each category relate more to carbon buildup or adjustments (e.g. valve lash adjustment affecting volumetric efficiency.

Engine Polygraph Assessment

Version Test 6.0

Upper Engine	8	Very poor upper engine mechanical condition
Volumetric Eff. Score	1	Valve lash very good; no sign of carbon buildup
Valve Seating	3	Good exhaust valve seating
Lower Engine	8	Very poor lower engine mechanical condition
Rumble	8	Considerable hum or 'rumble' detected in the crankcase
Scrape	8	Considerable sign of lubrication problems in the crankcase
1 2 3 4 5 6 7 8 9 10		

Upper Engine	Upper engine mechanical condition (injectors, valves, head gasket, etc.)
Volumetric Eff. Score	Parts affecting the rate of air exchange through the engine
Valve Seating	Parts affecting tightness of the exhaust valves closure
Lower Engine	Lower engine mechanical condition (pistons, rings, cyl walls, PCV valve, etc.)
Rumble	Hum in the crankcase
Scrape	Screeching in the crankcase indicating poor lubrication

Figure 5:The Assessment scores with descriptions of conclusions and below, a table of definitions of the scores

The color-coding scale is shown on the page to allow for variation in the display and printing tones.

Issues

The next section of the diagnostic report contains the major conclusions of applying the diagnostic rules to the data analysis results from the signature for this engine.

VehOwner **192**
S60 **2019-12-15 06:57:37 PM**
192 1500.psdata
http://www.EnginePolygraph.com

Issues

Abnormal Observations	possibly caused by..	Confidence	suggestions...
At least one flat Exhaust cylinder and no large Exhaust peak. Crankcase looks good.	Injector plugged or not working; misfire with no fuel. OBDII codes P0171 and P0174 are common when injector is plugged.	111%	Fuel treatment to clean injectors (Oxytane) or replace injector(s).
Blue smoke: Emitted when the engine is burning oil, sometimes be accompanied by oil coming out of the end of the exhaust pipe	Misfire possibly due to poor/broken Oil Control ring allowing oil in cylinder for poor (or no) combustion. Blue smoke in exhaust?	111%	Is oil consumption high? If 'yes', probably need to inspect/replace oil control ring(s).
Excessive engine oil consumption?			
Misfire with fuel; are there blue puffs of smoke in the exhaust?			

CAUTION: Analysis and conclusions presented are based upon historical data backed by technician expert analysis. Because one or more faults may be responsible for the patterns in the signature, the list of faults, possible causes and recommended fixes are the best we can provide given our current accuracy level. These results are not guaranteed or warranted to be completely accurate, as the system is still undergoing development, and should be considered a guide to help identify possible causes of engine problems. PFT, Inc. is not responsible for any charges, repairs or losses as a result of a technician relying solely or in part on the EP analysis.

Figure 6: Example list of Issues (Abnormal Observations, Possible Causes, and Suggestions for action from a DD S60 diesel engine

Predictive Fleet Technologies, Inc. does not guarantee or warranty the complete interpretation of the data from this signature data. The conclusions are good faith interpretations of the data based on experience and on expert mechanic input. Predictive Fleet Technologies, Inc. presents the good faith conclusions from the rules and the suggestions for remedy but does not guarantee that the engine will be “fixed” by following the suggestions. See Fig. 6.

Those issues that have a confidence greater than zero are sorted so that the most likely issues are first. The top three issues (assuming there are at least three issues) will be listed on the issues page. Each issue will have one or more abnormal observations that were present and are the cause indicated in the “possibly caused by…” column to the right of the “abnormal observations”. The third column associated with each issue is the calculated confidence that the system generates by considering the severity of the observations associated with this cause relative to all of the abnormal observations presented in the signature. The final column associated with the cause contains one or more suggestions to remedy the issue identified.

The **Abnormal Observations** are descriptive statements:

a. of sensory data interpreted with the identified engine model specifications and user-input engine condition during data collection, OR
b. a question to the reader about observations not detected by sensors but possibly observable by the reader. If your answer is 'yes', the confidence that the associated Cause is correct would be increased; if 'no', the confidence in this conclusion (Cause) would be decreased.

The '**probably caused by**' column contains a description of possible flaws (causes) in the engine that align with the Abnormal Observations leading to each conclusion.

The **Confidence** estimate is a percentage of the Abnormal Observations and the severities that point to this Cause compared to all of the Abnormal Observations detected by this analysis. There is no guarantee that there is not another cause occurring during this test that might be the real cause of the problem(s). As time goes by, PFT will be fine-tuning existing rules between Observations and Causes and will increase the scope of the Causes investigated as we gain new insights from customer feedback.

The **Suggestions** column provides our suggestion to the technician/mechanic to address the possible cause aligned with it. We do not warrant that implementation of the suggestion will provide the solution desired, but it is a well-intentioned suggestion for consideration.

CAUTION: Analysis and conclusions presented are based upon historical data backed by technician expert analysis. Because one or more faults may be responsible for the patterns in the signature, the list of faults, possible causes and recommended fixes are the best we can provide given our current accuracy level. These results are not guaranteed or warranted to be completely accurate, as the system is still undergoing development, and should be considered a guide to help identify possible causes of engine problems. PFT, Inc. is not responsible for any charges, repairs or losses as a result of a technician relying solely or in part on the EP analysis. Indeed, PFT would appreciate feedback on results that you see that conflicts with the derived conclusions. In this way, we can improve the usefulness of Engine Polygraph. Any improvement implemented is immediately available to all users of the system.

Considered Causes

The '**Considered Causes'** that are in use in the current version of the software are listed here. Only Considered Causes that have expected impacts that are consistent with the Abnormal Observations from the signature data are displayed on the reports as Issues, described earlier in this document. The Considered Causes are separated into two sets: one for cold-crank ('c-c') tests and the second set for 'hot-engines' (idle or load). The specific Causes that are considered will increase over time and the accuracy will improve from partner and customer feedback and corresponding improvement of the rules. (See Fig. 7 for some of the Causes considered.)

	Possible Causes - cold-crank
1	Engine is turning from the starter - a cold-crank (c-c). Unknown if the fuel pump fuse has been removed, accelerator depressed to the floor, or other method to accomplish the c-c was used.
2	Compression rings not forming tight seal with cylinder liners, often due to carbon 'caking' in the ring grooves.
3	Cylinder sleeve scored or ruptured.
4	Piston out-of-round, cracked piston, or piston with detonation hole.
5	Exhaust valve leak - Possibilities: Carbon preventing good seal, chipped valve head, bent valve stem.
6	Intake valve leak - Possibilities: Carbon preventing good seal, chipped valve head, bent valve stem.
7	Gasket rupture between adjacent cylinders; compression in one can push into intake or power stroke of the other.
8	Gasket failure between coolant and cylinder.
9	Gasket failure between coolant and oil gallery.
10	Gasket leak from cylinder to engine exterior.
11	Intake valve leak - Possibilities: Carbon preventing good seal, chipped valve head, bent valve stem.

	Possible Causes - hot engine	Ignition
18	Enlarged injector pintle opening allowing increased, unintended fuel in one or more cylinders	All
19	Fuel delivery problem for all cylinders.	All
20	Injector weak - possibly dirty; might be injector failing. P0300 - P0308 indicate misfire by possible dirty injector. www.germanformula.com/top-causes-of-a-clogged-fuel-injector/	All
21	Injector plugged or not working; misfire with no fuel. OBDII codes P0171 and P0174 are common when injector is plugged.	All
22	No spark; gummed or cracked plug, wire short/broken, distributor or Coil on Top	Spark
23	Misfire with fuel; Head gasket leaking between adjacent cylinders in Power and Intake strokes. Partially burnt gasses from Power stroke get pushed into vacuum of the neighboring Intake cylinder reducing O2 available for its Power stroke. Either or both can have misfires with unburnt fuel flashing in exhaust.	All
24	Coolant leaking to exterior through head gasket.	All
25	Gasket failure: cylinder compression leak to exterior.	All
26	Compression leak to crankcase through oil gallery.	All
27	Compromised head gasket allowing coolant into the cylinder during Intake and heat to coolant during power stroke.	All
28	Head gasket failure allowing coolant into the crankcase. Damage likely more severe if synthetic oil due to water forming acids with the oil.	All
29	Oil leak from oil gallery to outside engine through head gasket failure.	All
30	Oil leak from oil gallery to outside engine through head gasket failure. Overhead Camshaft in danger with too little oil.	All
31	Piston with detonation hole, crack, or out-of-round	All
32	Crankshaft bearings	All

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33	Intermittent Valve cam and sprocket wear	All
34	Valve cam(s) requiring lubrication (worn)	All
35	Worn cam lobe(s)	All
36	Intercooler too cold can condense humid air and provide water to the cylinders upon intake, reducing power, fuel economy, and causing corrosion.	All
37	Intercooler failure lowering boost pressure and can cause detonation in cylinders, turbo whines.	All
38	Lubrication issue - cylinder wall(s) dry	All
39	Cylinder wall(s) scored causing air to blow down into the crankcase on compression, depleting O2 resulting in incomplete combustion.	All
40	Large vacuum in crankcase during one cylinder intake stroke caused by crankcase gases pulled into the Intake stroke probably around the pistons due to compression rings caked into one position by carbon deposits keeping them in the compression/power position. The slow engine speed allows more vapor to be pulled from the crankcase into the cylinder. At higher speed, this big dip may disappear.	All
41	Large vacuum in crankcase during one cylinder intake stroke caused by crankcase gases pulled into the Intake stroke probably around the pistons due to compression rings caked into one position by carbon deposits keeping them in the compression/power position.	All
44	Misfire possibly due to poor/broken Oil Control ring allowing oil in cylinder for poor (or no) combustion. Blue smoke in exhaust?	Diesel
45	Reverse blow-by during compression stroke from carbon 'freezing' compression rings preventing adequate compression so air/fuel is too rich resulting in poor combustion and probably black smoke.	Spark
46	Misfire possibly due to poor/broken Oil Control ring allowing oil in cylinder for poor (or no) combustion. The oil can foul the spark plug. Blue smoke in exhaust?	Spark
47	Carbon deposit on the lip of the valve cap or valve seat in the head can allow gases to leak under the high pressure of the Power stroke. This will result in a drop of this Exhaust stroke pressure at the exhaust pipe. If the intake valve (also) has a Carbon deposit, the intake of the next cylinder will get the Power stroke partially burnt gases, reducing the O2 content of that later Power stroke and so, its Exhaust stroke.	All
48	Intake valve or valve spring broken. After this intake, much compression is lost, pushed back to intake manifold. Power is more like another intake stroke; exhaust will be very weak but might push a little fuel into exhaust for a small increased pulse.	Diesel

Figure 7: Partial list of Causes considered in the diagnosis of an engine. The list will grow over time.

If you determine that an engine you have worked on has an issue (cause) not listed on this report, please notify us so we might be able to include that cause for future consideration. If you tell us the vehicle and engine, date, and the username associated with the signature, we can analyze the signature data ourselves and hopefully generate rules that will produce your observed result.

Engine Model Background Data

This section is identical to the Engine Model Background Data section from the Assessment report. The information comes from the data that we have in our Engine Model database under the Engine Model selected by the user. This page provides some important information that might be useful for your consideration in how to take action as a result of this report. (See Fig. 8.)

The first section contains Engine Features: Ignition method (diesel or spark), Firing Order and cylinder-to-bank assignment which are provided by PFT when known.

Engine Technologies are listed engine technologies identified for the indicated engine model design by the National Insurance Crime Bureau (NICB). Only those considered relevant to Signature analysis are listed.

Common Engine Flaws for an Engine Model and time-period are listed for the user's consideration. These are made known to PFT through manufacturer communications or mechanic blogs.

We have not done a complete edit of this data and so cannot be held responsible for any inaccuracies. We believe it may be helpful in your evaluation of our diagnosis and suggestions.

Engine Model Background

Engine Features
Spark ignition
Firing Order: 1-2-3-4-5-6
Cylinders organized in 2 banks

Distinctive Engine Technologies
DOHC=Double Overhead Camshaft (CAM-DOHC)
Direct Injection (Fuel Delivery-DI)
Variable Valve Timing - Phase & Lift (VVT-Both)
Automated shutoff of engine when stopped and start when foot is off the brake (Auto start/stop)

Reported 'Common' Engine Flaws

Figure 8:Example Diagnostic's report page listing factors about the Engine Model that might be relevant when diagnosing a problem.

Engine Block Layout

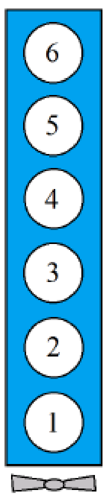
The next page (Fig. 9) provides an illustration of the engine block with the cylinders numbered according to the manufacturer's documentation (or as we have found it in the published literature). In addition, there are two tables:

1. An Adjacency Matrix that lists for each cylinder that cylinder's adjacent cylinder numbers. This is to enable the program to determine which cylinders belong to which bank of the engine.
2. A Cylinder Layout and Firing Adjacency table that provides cylinder location in firing order sequence.

If there are pairs of cylinders that are neighbors that hit are simultaneously in a power and intake stroke, the bank of the engine that exhibits that situation is listed and a value for a "risk level" is indicated to alert the reader to the concern that a gasket rupture between those two cylinders is somewhat more likely that at that situation does not present itself. If an adjacent set of cylinders are simultaneously in a compression and intake stroke. A similar statement is issued with a less severe warning about risk.

S60 Physical Layout

Engine Block Layout



I6

Cylinder	Adj1	Adj2
1	2	
2	1	3
3	2	4
4	3	5
5	4	6
6	5	

Cyl Layout & Firing Adjacency

Bank	Cyl	Firing Order
1	1	a
1	5	b
1	3	c
1	6	d
1	2	e
1	4	f

Adjacent Cylinder Pairs of Head Gasket Concern	Risk Level
Adjacent Cylinders on Bank 1 are simultaneously in Power & Intake strokes	Raised

~ 8 ~

Figure 9:Example Engine Block Layour, Cylinder Adjacency, Bank Alignment and Firing Order.

Cylinder Offset diagram

Fig. 10 illustrates the stroke of each cylinder throughout one engine cycle of one or two rotations, depending on how many strokes this engine uses. (The most typical situation is that one cycle requires 720° rotation of the crankshaft for each cylinder to fire once. The horizontal axis starts when cylinder one is at top dead center (TDC) after ignition has been started. The rows represent the cylinders in firing sequence order, but also showing the cylinder number as specified by the manufacturer. In the lower part of the diagram, the cylinder primarily responsible for creating pressure in the three compartments of the engine at any instant (crankshaft rotation) is listed.

This diagram can give insight as to the source of abnormal observations, when things are happening in a cylinder that are "abnormal" and so may be helpful in determining a cause.

Cylinder Offset Diagram

Firing Order:		1	5	3	6	2	4						
crankshaft rotation		0 to 180°			180 to 360			360 to 540			540 to 720		
		60	120	180	240	300	360	420	480	540	600	660	720
Fire Seq. 1	Cyl # 1	Power Stroke			Exhaust Stroke			Intake Stroke			Compression Stroke		
Fire Seq. 2	Cyl # 5	Comp Stroke		Power Stroke			Exhaust Stroke			Intake Stroke			
Fire Seq. 3	Cyl # 3		Compression Stroke			Power Stroke			Exhaust Stroke			Intake Stroke	
Fire Seq. 4	Cyl # 6	Intake Stroke			Compression Stroke			Power Stroke			Exhaust Stroke		
Fire Seq. 5	Cyl # 2	Exhaust Stroke		Intake Stroke			Compression Stroke			Power Stroke			
Fire Seq. 6	Cyl # 4		Exhaust Stroke			Intake Stroke			Compression Stroke			Power Stroke	

	trigger pulse	+1	+2	+3		
Exhaust pulses	#2 exhaust	#4 exhaust	#1 exhaust	#5 exhaust	#3 exhaust	#6 exhaust
Crankcase pulses	#1 crankcase	#5 crankcase	#3 crankcase	#6 crankcase	#2 crankcase	#4 crankcase
intake vacuum pulses	#6 intake	#2 intake	#4 intake	#1 intake	#5 intake	#3 intake

Figure 10: Cylinder Offset table showing the relationship of cylinder identification by the manufacturer and the crankcase angular rotation to each cylinder's stroke. Below that, we show which cylinders are designed to contribute to pressure at three major locations (exhaust, crankcase, and intake manifold)..

Engine Integrity diagram (Points)

The Engine Integrity Diagram shows values of key parameters for each cylinder. The cylinders are named alphabetically (a, b, c, etc.) in firing order sequence with unknown starting cylinder location. We call this the *Engine Integrity diagram* because if the points are close together, the engine has high integrity since all cylinders have similar operating parameters. (We are making the assumption that an engine would not have all cylinders in equally **bad** condition.) The green radius is would contain the points for most engines with score of 3 or better; the yellow circle would contain the points for most engines with scores 6 or better. The voltage is directly proportional to the pressure. (See Fig. 11.)

In the Exhaust graphic, the cylinder Duration is the number of milliseconds the exhaust from the cylinder takes to pass the exhaust sensor. (The Profile chart below might allow easier interpretation of the number of ms.) If the difference between the fastest and slowest cylinders exceeds 4 ms, the engine is running 'rough'. The vertical axis of the Exhaust chart shows the maximum voltage (pressure) observed by the sensor during the exhaust stroke for each cylinder. As you might expect, a cylinder with high exhaust output had a very successful power stroke and so the exhaust cycle should be fast due to the temperature of the power stroke. (So it will show in the upper left of the cluster.) Similarly, low voltage implies low cylinder output (cooler) and so a slower exhaust cycle; such a cylinder would present in the lower right of the cluster.)

In the Crankcase chart, the x-axis is the voltage range for each cylinder (maximum minus minimum) whereas the vertical axis is the minimum voltage. Severe blow-by exhibits as a very large dip in the minimum voltage associated with the cylinder vacuum of the intake stroke.

Pairs of cylinders very close to each other indicate a very good engine. If a cylinder or two are higher and to the left of the circle center, that is no problem, but one very low or far to the right are signs of big trouble.

Each cylinder in firing order is assigned a unique color that can be used to 'see' the same cylinder on the various graphics.

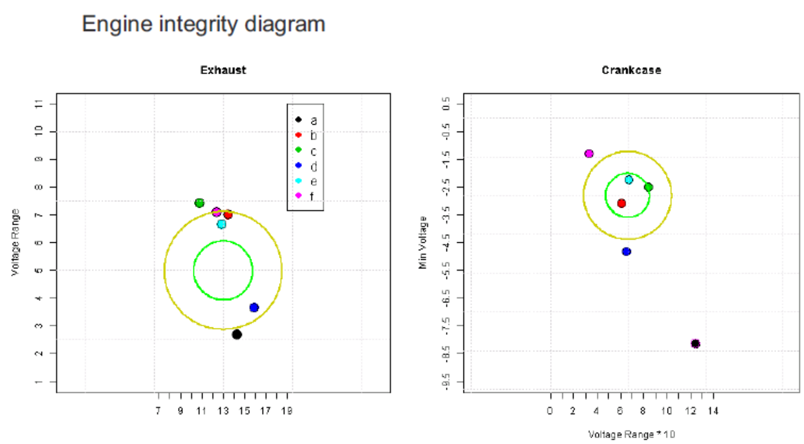


Figure 11: Engine Integrity diagram showing the (dis)similarity of the value of parameters for each cylinder derived from the Signature data.

Cylinder Profiles

The cylinder profiles plot the pressure (voltage) from the sensors on the y-axis for each of the cylinders during the interval (720°/number of cylinders) of its major contribution of the cycle. The x-axis is the time in milliseconds from the start of the stroke as determined from our analysis. So each cylinder profile begins at 0 and goes to the right until the next cylinder takes over back at the origin. (See Fig. 12.)

The Exhaust Profiles show each cylinder's exhaust 'smoothed' voltages (pressure) for its section of the cycle. The cylinders are identified in firing order with colors; the legend shows the cylinder letter identifier with the assigned color. In a good engine, the profile lines are very similar. The starting point for each exhaust profile curve is mainly driven by the opening of the exhaust valve for the cylinder. Notice the 'severe' misfire (cylinder a of firing order in black) in the exhaust profile of Fig 12.

The Crankcase Profiles show the crankcase pressure from all cylinder actions during each cylinder's section of the cycle. These lines are usually arranged in pairs since the crankcase patterns repeat every 360° so each cylinder in the first 360° should have a match in the second 360°. Cylinders with differing blow-by will not be aligned together, or an intake manifold that has significant carbon buildup can cause the pairing to be ruined as the PCV valve can allow the vacuum variation to affect the crankcase pressure.

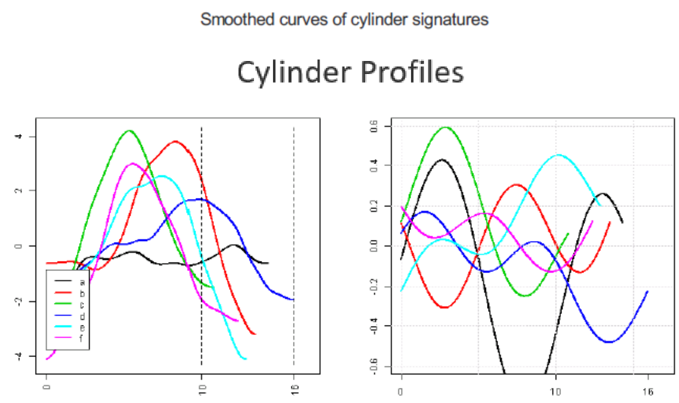


Figure 12: The Profiles graphics for the exhaust and crankcase for each cylinder.

Using a different engine's report, we illustrate the use of the colors for matching specific cylinders across the graphics. (See Fig. 13.)

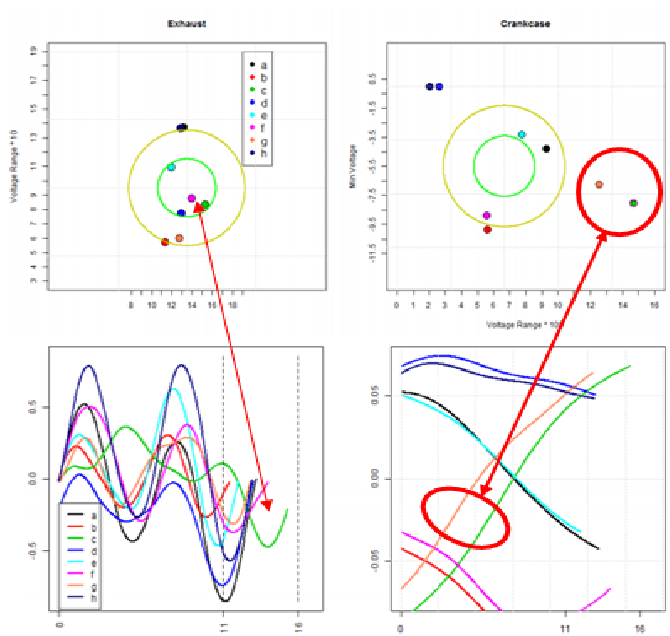


Figure 13: Illustration of using colors to relate data from differing graphics by cylinder.

Polygraph Model

The models are the oscilloscope outputs (black lines) for the exhaust and crankcase (oil tube) sensors. (Additional sensors might have been collected that will be displayed below the Exhaust and Crankcase charts). The green lines are the base curves with the high frequencies removed, we call them the 'pressure' curves. The cylinder assignments are made from the 'smoothed' curves in the exhaust signature and from that, the durations (in milliseconds) are obtained. High frequencies in the exhaust are used to provide the Volumetric Efficiency score and Valve Seating scores.

The solid vertical lines mark the start and end of engine cycles: 720° for a 4-stroke engine and 360° for a 2-stroke engine. The blue numbers below the signatures are the times in milliseconds for each of the 'cylinder a' strokes for each cycle. (See Fig. 14.)

In the Exhaust model, we mark cylinder boundaries with vertical dashed lines by analyzing properties of the curve. (A cylinder mis-fire might cause that calculation to be in error.) If the engine is running properly, each cylinder's section should be the same duration. The cylinders are identified in the Exhaust Model by lower-case letter in firing-order.

The Crankcase model is displayed simultaneously with the Exhaust model; but recall that the blow-by comes from the previous power stroke to the exhaust and reverse blow-by from its intake stroke.

The table below displays the channel assignments input by the user when the signature was obtained.

Channel	A	B	C	D
Sensor	exhaust	oil tube	none	none

Hot Engine Model

The engine model on the right is a 6-cylinder engine running at about 1500 rpm (2 revolutions take about 80 ms at 1500 rpm for a 4-stroke engine. (Fig. 14)

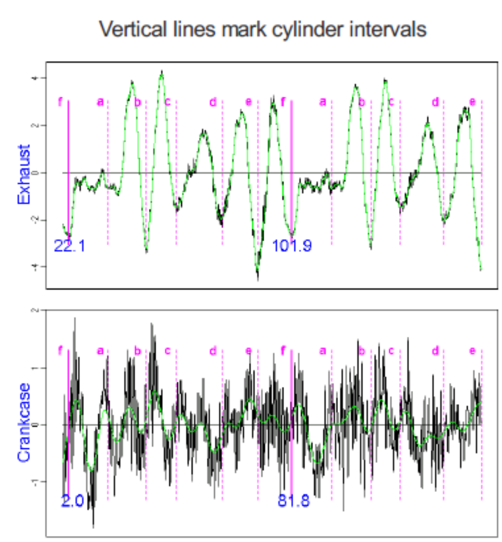


Figure 14: The Polygraph Model of the Pressure vs. vibration in the EP Signature for the subject engine.

Cold Crank (c-c) Model

If the engine is being tested in a 'cold-crank' condition, the engine crankshaft is being rotated by an external engine, probably the starter motor. In this case, there is no ignition nor combustion confounding the airflow as the pistons, valves, and PCV & (if present) ERG valves control the airflow with possible ring and gasket leaks.

The Polygraph Model shown in figure 15 is from a 4-stroke, V6 engine in cold-crank. On the Exhaust Model, we see that the two banks of cylinders have very repeatable pressure and vacuum profiles. The difference between the two banks is a result of the design of the crossover allowing one bank to dominate over the other. For this reason, our analysis first looks at variation of cylinders in each bank before normalizing the results and comparing all cylinders together.

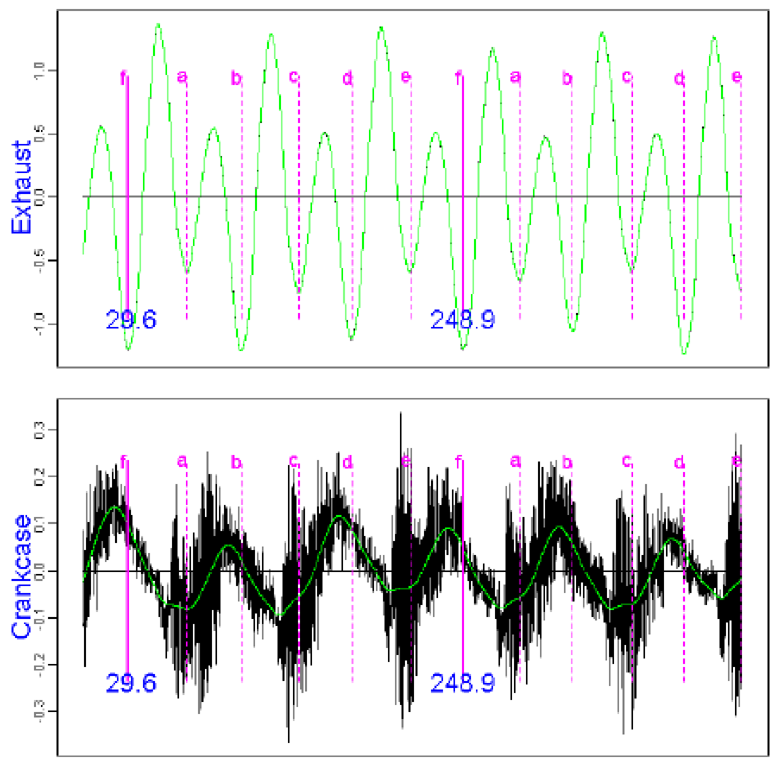


Fig. 15 Model graphic from a V6, 4-stroke cold-crank Engine Polygraph report

In the Crankcase Model, we see the cylinder pairing as the second rotation (cylinders d-e-f) repeat the pattern of a-b-c). But the details of the pairing will depend on the firing order of the cylinders. Also, when we look at the higher frequency activity, there is a noticeable difference between cylinders when the crankcase pressure is increasing vs. the much less intense when pressure is decreasing.

Hot Engine Model with a Trigger Cylinder

The EP Signature of a hot engine with a trigger channel assigned and the trigger cylinder identified includes the graph of the inductor current and highlights the time of the peak current as the ignition in the trigger cylinder specified. The selected current peak amplitude (positive or negative) locates the vertical blue line across all channel graphs. Following the ignition at TDC, the power stroke starts and completes 180° later. Then the trigger cylinder can begin its exhaust. By knowing the trigger cylinder number and time on the graphic, all cylinders of the engine block can be aligned with the firing order.

An additional sensor may be assigned to the 4th channel to get more insight into the engine operation, but the current version of our software will not include the data in the analysis; it will be displayed for visual interpretation.

The table below is shown on the report that contains the cylinder numbers according to the Engine Block table associated with the firing order. The trigger cylinder and its 'peak' in the exhaust graphic are highlighted in red.

Exhaust Segment	a	b	c	d	e	f
Cylinder	6	1	2	3	4	5

Fig. 17 Table of engine cylinder firing order with cylinder number from the Engine Block Diagram.

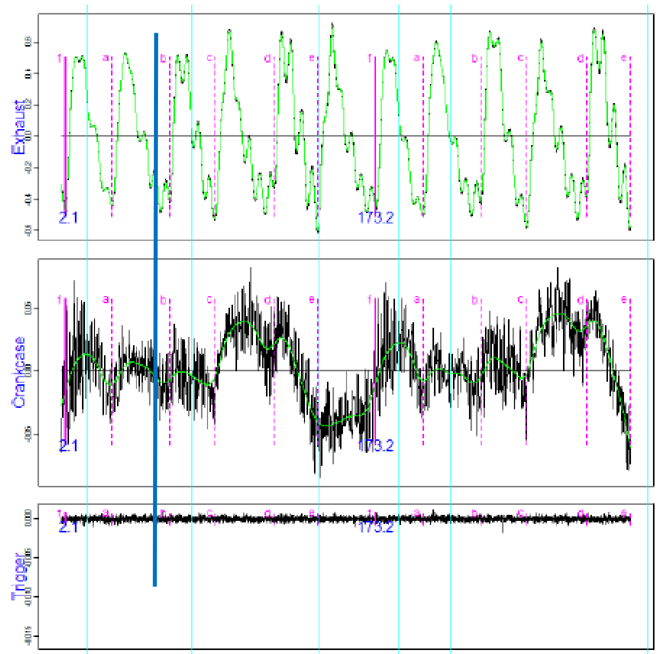


Fig. 16 Model graphic from a V6, 4-stroke hot Engine with a trigger channel and cylinder

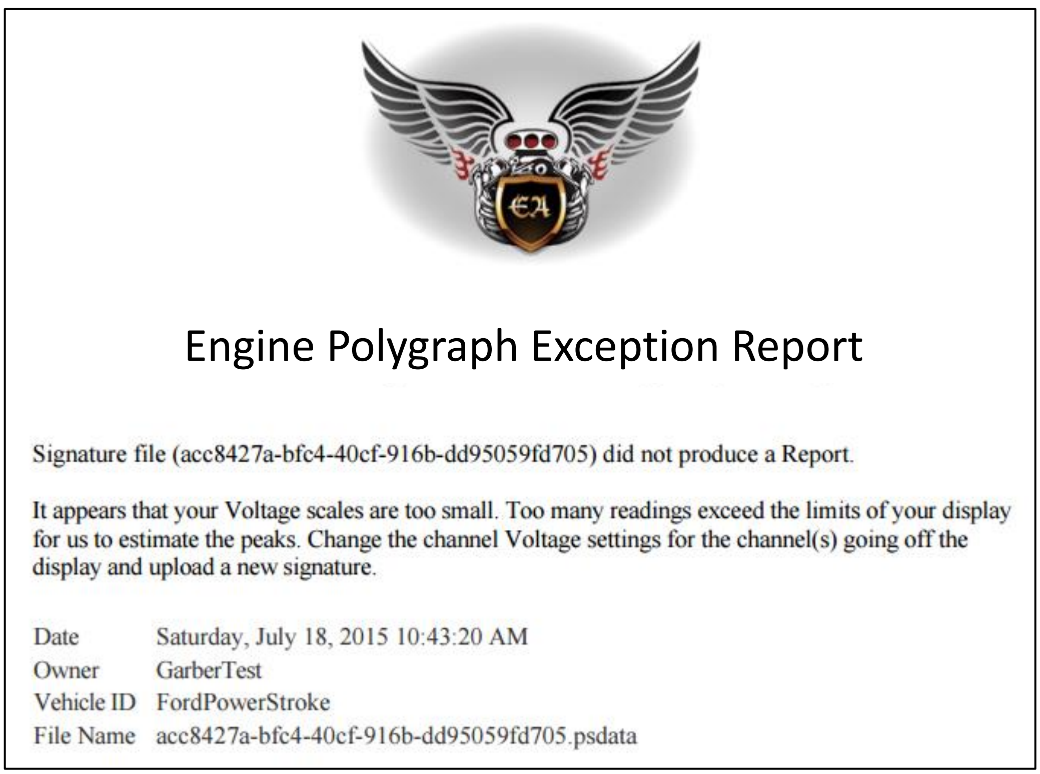
Exception Reports

As mentioned earlier, if the analysis program is unable to reliably provide a useful report from the submitted data, you will receive an Exception report on the Assessments screen. The Exception reports are highlighted as a yellow box. The PDF report is downloaded when you click on the yellow button.

The nature of the problem and corrective action you might be able to take is provided in the report. See Fig. 17 for an example Exception report as it presents on the Assessments page. Fig. 18 has the Exception report for the situation of Fig. 17.

	OWNER	VEHICLE	MANUFACTURER	MODEL	CONFIG	DISP	LOCATION	DATE	ODOMETER	RPM	TEMP	CONDITION	CHANNELA	CHANNE
Exception	GarberTest	FordPowerStroke	Ford	6.7L Power Stroke Scorpion Diesel V8	V8	6.70	Versailles	2015-07-18	69238	1500	170	Load	exhaust	oil tube
View | Email	Jim	KU Buick V6	GM	3800 Buick V6	V6	3.76	1309 Evamar	2015-06-29	56000	1500	160	Load	exhaust	oil tube
View | Email	JWM	225	DD	S60 14L	I6	14.00	eeef	2015-06-23	123456	1500	132	Load	exhaust	oil tube

Figure 15: Assessments page showing a signature that could not be interpreted enough to generate a useful Assessment report.



Engine Polygraph Exception Report

Signature file (acc8427a-bfc4-40cf-916b-dd95059fd705) did not produce a Report.

It appears that your Voltage scales are too small. Too many readings exceed the limits of your display for us to estimate the peaks. Change the channel Voltage settings for the channel(s) going off the display and upload a new signature.

Date	Saturday, July 18, 2015 10:43:20 AM
Owner	GarberTest
Vehicle ID	FordPowerStroke
File Name	acc8427a-bfc4-40cf-916b-dd95059fd705.psdata

Figure 16: Example message presented on the Assessments page when the software is unable to process a submitted signature for analysis.

Warranty and Disclaimers

Predictive Fleet Technologies, Inc. (PFT) warrants the software will work as described. The warranty does not cover any problems with the Internet connection or your common-browser (Internet Explorer, Chrome, or FireFox) compliant workstation (desktop, laptop, or tablet). We will store your signatures, up to 10 meg (typical values are under 200 KB), and maintain them in a searchable and retrievable manner as described in the accompanying document. We use standard security, data and application backup & restore methods to protect your data investments from most natural and criminal events. If data are deleted or changed by people whom you have authorized, we cannot guarantee recovery.

The Engine Polygraph® Assessment report automates many of the steps that a user would perform manually in interpreting a SenX waveform from an internal combustion engine. It requires a waveform of adequate strength and sample frequency generated by the customer's oscilloscope such that meaningful information can be detected from the signal. Meaningful results can be expected only if the testing procedure is correctly followed; e.g., the connections of the cables are reliable, the equipment (oscilloscope, cables, sensors, etc.) work satisfactorily, and the oscilloscope parameters are set to reasonable values of duration (about 4 rotations of the engine crankcase), sampling at about 40kHz per channel).

It is also required that certain inputs to the EnginePolygraph Assessment request be accurate: the engine manufacturer and model must at least have the correct engine configuration & strokes per cycle and the approximate RPM input to the EnginePolygraph application is assumed to be within +/- 10% of the actual value.

The Engine Angel Assessment is NOT designed to measure misfires due to conditions such as poor fuel or irregular ignition. The Engine Angel software looks for defects that are measurable with each engine engines of either cycle (2- or 4-stroke).

The Assessment report uses advanced mathematical methods to classify the cylinder features extracted from the signatures: one from the exhaust and the other from the crankcase, usually via the oil dipstick tube. It is required that the oscilloscope channels are assigned correctly, in alignment with the connections and placement of the FirstLook® sensors. If the exhaust system has holes allowing exhaust to prematurely escape before reaching the sensor, or if particulate filters reduce or 'average' the pressure at the sensor to a very distorted level, meaningful results will not be achieved. Upon receiving a meaningful signature file, the Assessment report will display the results of a 'supervised learning' software to classify the condition of the engine's 'upper' and 'lower' components based on observation of many other engines. The measures of volumetric efficiency and valve seating condition are based on other methods. These classifications will likely improve over time and newer versions (as displayed on the report) will provide those improved results when available to you, the customer.

It is up to you to decide what action you should take based on the Assessment report. The recommendations we make are based on feedback from others' experiences. PFT is not liable for damages resulting from the implementations of such recommendations; we provide them to you for your judgment in decisions on what to do.

THERE IS NO WARRANTY OF MERCHANTABILITY. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTION HEREIN. THERE ARE NO WARRANTIES EXPRESSED OR IMPLIED OR ANY AFFIRMATION OF FACT OR REPRESENTATION EXCEPT AS SET FORTH HEREIN.

REMEDY

If you suspect that there has been an error in the storage, indexing, assessment or retrieval of your data, please contact us immediately at support@PredictiveFleetTechnologies.com and/or contact us by phone: 1-833-364-2645. We will work with you to understand what happened and what recovery plan we can put in place.

In no event shall PFT be liable for damages of any nature, including incidental or consequential damages, including but not limited to any damages resulting from non-conformity, defect in design or workmanship.

Neither PFT nor its affiliates shall be liable to the subscriber of this product or third parties for damages, losses, costs, or expenses incurred by the subscriber or third parties as a result of: accident, misuse, or abuse of this product or unauthorized modifications, repairs, or alterations to this product, or failure to strictly comply with PFT's operating and maintenance instructions.

Contact Us

Learn more about us at www.PredictiveFleetTechnologies.com, www.EnginePolygraph.com, www.EngineAngel.com, and www.SenXTech.com.

For specific questions about the Engine Polygraph® functionality, please email us at support@PredictiveFleetTechnologies.com or call us at 1-833-364-2645.

[1] SenX is a trademark of SenX Technology, Inc., Midland. MI
[2] PFT, Engine Angel, Engine Polygraph and EnginePolygraph are trademarks of Predictive Fleet Technologies, Inc., Inc., Midland, MI

Appendix 1: Glossary

Engine Polygraph® Glossary

Abnormal Observations	Abnormal Observations are values obtained in the analysis of the data that are outside the 'very good' limits determined for the engine and operating conditions. When outside the limit, a value is 'binned' within 3 grades worse either above or below the limit. (See 'Possible Causes')
Administrator	An administrator is an employee of a company (customer of EnginePolygraph) who has authority to pay for EnginePolygraph subscriptions, add new users of EnginePolygraph for the company, and to change the authorizations of the users of EnginePolygraph.
Predictive Fleet Technologies	Predictive Fleet Technologies is the name of the company that developed, supports, and operates the Engine Polygraph® software .
Assessment report	Assessment is the analysis of a 'Load' condition signature with simultaneous 'exhaust' and 'oil tube' sensor recordings that calculates 'scores' with values from 1 (very good) to 9 (very poor). The information is available as a PDF, and if the Owner is a subscriber to Engine Angel, in the database for time series graphics of the scores over time.
CHANNEL x	The channel identifier tells which of several SenX FirstLook® sensors is attached to which channel on the oscilloscope. The options for where to place the SenX first look sensor are provided in a pull-down.
COMMENTS	Comments are free text entries on a signature index to help retrieve them in the future.
Company	A company is the paying customer of an Predictive Fleet Technologies subscription. It typically is a vehicle maintenance/repair facility. It may have one or more locations, but multiple locations should each have their own subscription unless their customer vehicles are serviced at multiple locations.
CONDITION	The condition of an engine describes the state of the engine during a single signature file. The values are obtained from a pull-down, including idle, load, and cold crank (c-c). Idle is typically under 1000 RPM, load is about 1500 RPM; cold crank occurs when the engine is turning over under the power of the starter.
Confidence	Confidence (that a specific Cause is present in this engine at the time of the signature) is assigned based on the number and severity of the Abnormal Observations attributed to a Cause compared to the total number and severity of all Abnormal Observations identified from this signature.
CONFIG or Engine Configuration	Config is short for configuration. The configuration of an engine describes the number of cylinders in the orientation of the cylinders with respect to each other. Its value is obtained from the EngineAngel database for the selected engine model. (E.G., V6 or I4)
Cylinder Adjacency table	Cylinder Adjacency table shows which cylinders are adjacent according to the Engine Block Layout
Cylinder Offset Diagram	A graphical representation of the stroke each cylinder is in at any angle of rotation during its engine cycle.
DATE	Date is short for 'measurement date'. The measurement date is the date when the associated 'signature' file was created using an Engine Polygraph sensor.

Diagnostic report	The Diagnostic report is an analysis of the data from a 'Signature' file of data, data about the engine model being tested, and some test conditions data. The report evaluates the 'physical integrity' of the engine AND an Expert System evaluates 'Abnormal Observations' detected to produce a list of possible causes of the Abnormal Observations along with a confidence that the indicated cause is correct and suggestions that might remedy the problem.
DISP or Displacement	Disp is short for displacement. The displacement of an engine is the volume swept out as the pistons move up and down one time for each cylinder. It is provided by the system from the Engine Model database and reported in liters.
Distributor	A company that typically sells SenX FirstLook® sensors and kits who have an agreement with Predictive Fleet Technologies to offer their customers 'Price Keys' with special pricing and terms for the customer and with commission terms that Predictive Fleet Technologies promises to pay the distributor.
Engine Angel	Engine Angel® is the name of the software produced by PFT to analyze the Signatures and other vehicle data. See www.EngineAngel.com .
Engine Angel Assessment?	The Engine Angel Assessment is a question asking if the system should generate an Assessment. There is the normal charge for the Fleet Engine Angel account if the Owner is an Engine Angel subscriber, or the EnginePolygraph subscriber's account will be charged if the Owner is not an Engine Angel subscriber to SenX Assessments.
Engine Angel Subscriber	Engine Angel Subscriber is a checkbox filled by the system when it recognizes the Owner you have input as the same as the Fleet ID in Engine Angel. This causes new adds (when the Vehicle ID is known as belonging to the Fleet ID) to analyzed by Engine Angel and the Assessment data sent to the Fleet ID database of Engine Angel.
Engine Block Layout	An Engine Block Layout is a diagram of the specified Engine Model with cylinder numbering as known to PFT.
Engine Features	Ignition method, Firing Order and cylinder-to-bank assignment are provided by PFT when known.
Engine Flaws	Common Engine Flaws for an Engine Model and time-period are listed for the user's consideration when made know to PFT through manufacturer communications or mechanic blogs.
Engine Poly Purpose	Engine Poly Purpose is a selection from a pull-down to indicate the purpose of this signature: ***Single*** if it is a 'one-off'; ***Before*** if it is preliminary to a planned 'procedure'; ***After*** if it follows a procedure; or ***Base*** if it is an 'as-new' signature for future reference for deterioration.
Engine Polygraph	Engine Polygraph® is a trademark for the use of EnginePolygraph.com to compare the 'before repair/treatment' with an 'after repair/treatment' to demonstrate the effectiveness of the work done. URL is www.EnginePolygraph.com.
Engine Technologies	Distinctive Engine Technologies are listed engine technologies identified for the indicated engine model design by the National Insurance Crime Bureau (NICB). Only those considered relevant to Signature analysis are listed.
EP Reader	EP Reader is a PC software to aid in the reliable collection of engine signatures for analysis and reports provided by the Engine Polygraph and Engine Angel Internet applications.
FILE	File is the name of the file created by the oscilloscope. It contains the details of the waveform generated by the FirstLook® sensor.
FirstLook	FirstLook® is the registered trade name of the sensor product produced by SenX. Often referred to as 'FLS'.

Fleet ID	Fleet ID is the identifier of the Fleet that owns the Vehicle being tested as known in the Engine Angel application.
Identified as Valid	A 'yes or no' assignment for each Possible Remedy indicating if **all** the Abnormal Observations assigned to a given Cause are detected for this signature. If 'yes', a Confidence is assigned based on the number and severity of the Abnormal Observations attributed to this Cause compared to the total number and severity of all Abnormal Observations identified from this signature.
LOCATION	Location is a description for the shop or garage where the signatures are collected.
MANUFACTURER	Manufacturer is the name/acronym of the **engine** manufacturer. It is selected from a pull down list. Although most of the engine manufacturers can be determined from the vehicle brand/manufacturer, buyouts and joint ventures can 'cloud the waters'. In rare cases, you may need to search the internet to pin down unusual situations.
MODEL	Model is an identifier of the **engine** model manufactured by the selected engine manufacturer. It is selected from a pull-down list of the models previously made by the Engine Manufacturer.
ODOMETER	On the vehicle odometer at the time of the visit when the signatures are taken. It is quite important that either kilometers or miles are consistently used for all vehicles maintained by the company.
oscilloscope	An oscilloscope is an instrument that converts the analog signals to a voltage from the FirstLook® sensor to a digital value that is recorded in the file.
OWNER	The owner **Owner** identifies the vehicle owner or Fleet name. NOTE: If the name you enter in the Owner field is the name for a Fleet that has a subscription to Engine Angel Fleet Management software and has requested that your company provide reports, the Fleet name will appear in the Fleet field and the Engine Angel Subscriber box will be checked.
Polygraph	Engine Polygraph® is a trademark for the use of EnginePolygraph.com to compare the 'before repair/treatment' with an 'after repair/treatment' to demonstrate the effectiveness of the work done.
Possible Cause	A Possible Cause is text describing a defect in an engine component that manifests itself by a set of Abnormal Observations. An engine might have multiple defects so a Confidence is calculated estimating the relative likelihood that each Possible Cause detected is actually present. Each Possible Cause may be related to multiple Suggestions.
Predictive Fleet Technologies	A Company that assembles hardware kits and manufacturer data and provides access to associated software to Assess and Diagnose I.C. engines and Manage Fleets of Vehicles. www.PredictiveFleetTechnologies.com
Report Selection	Parameter selected from a pull-down list to specify the report desired from the signature: ***Assessment***, ***Diagnostic***, or ***none*** (when storage of the signature is all that is desired for the submitted signature.
RPM	RPM is the number of revolutions per minute of the engine while the signature is being recorded in the file.
RPM Source	1. Some engines (many diesel engines) have an electronic speed control by means of a computer attached to the Electronic Control Module (ECM). If you use such a capability, enter the rpm that you had set as the controlled engine speed in the **RPM** value AND choose 'Set RPM' from the **RPM Source** pulldown. 2. If you have more than two channels on your PicoScope and an induction clamp to enclose a spark plug wire or COT (depending on your engine's technology), you will want to leave the **RPM** value blank or 0 AND select 'Spark trigger' from the **RPM Source**

	pulldown. Then chose a channel (usually 'C') on the PicoScope for the input of the induction clamp cable and set the value for that Channel on the screen to 'trigger'. In such a case, the signal will be analyzed to achieve an accurate RPM. 3. If you have an accurate tachometer, you may input the **RPM** value you will run the engine at while the data is being collected. It will be important that the value you provide will be within 15% of the actual value or you may get an erroneous analysis. In this case, select 'Guess' from the **RPM Source** pulldown. 4. If you do not have an accurate **RPM** value, leave the value field blank or 0 AND select 'None' from the **RPM Source** pulldown. In this case, an estimate will be provided from the **Condition** option you select [Load, Idle, c-c (Cold-crank)] and the number of cylinders in the engine. Often this estimate is accurate enough to give a good analysis, but this is the least reliable of the options.
Rumble	The EP score assigned to the relative intensity of vibrations in a low frequency range in the crankcase when engine speed is 1500 RPM
Scrape	The EP score assigned to the relative intensity of vibrations of high frequencies in the crankcase when engine speed is 1500 RPM
Send Assessment to:	This box allows the user to specify an email address as the destination of the PDF Assessment report.
SenX	SenX® is the registered trade name of the company that manufactures the FirstLook® sensors.
Serial Number	Serial Number is the engine manufacturer's serial number provided by the Engine Angel Engine table IF the Owner is an Engine Angel subscriber and the Vehicle is registered in that Engine Angel Engine table.
Signature	A signature is the name of one or more waveforms taken simultaneously with FirstLook® sensors from a specific engine under given operating conditions in one file.
Signature index	The signature index is a set of attributes describing the vehicle, owner, operating condition with date and location to allow easy retrieval in the future.
Suggestion	Each Possible Cause may be assigned multiple Suggested Remedies. A Suggested Remedy may correct or influence more than one Possible Cause and hence, multiple Abnormal Observations.
TEMP or Engine Temperature	Temp is short for the temperature of the engine coolant at the time the signature is taken. It is important that the temperature always be reported in either degrees Celsius or degrees Fahrenheit in a given one shop.
Trigger Cylinder	The cylinder number (according to the OEM's engine block layout) of the cylinder you have placed a trigger to identify that cylinder on the EP graphics and the firing sequence of the test engine. You must also identify the channel that contains the trigger signals to the PicoScope.
USER	User is the identifier of a person authorized to access the EnginePolygraph system. Users are added and authorizations given by a specific group of users called Administrators.
Upload File	The Choose File button prompts a window for the search of the User terminal's attached storage devices to identify the signature recorded by the oscilloscope. The result is to store the selected file in the EnginePolygraph database for later reference.

VEHICLE	Vehicle is the identifier of the chassis containing the engine that is being serviced and whose signature is being recorded. In the case of a fleet vehicle, is commonly the identifier painted on the vendor or door of the vehicle; in the case of personal automobiles or pickups, it might be the license plate number or other unique identifier.