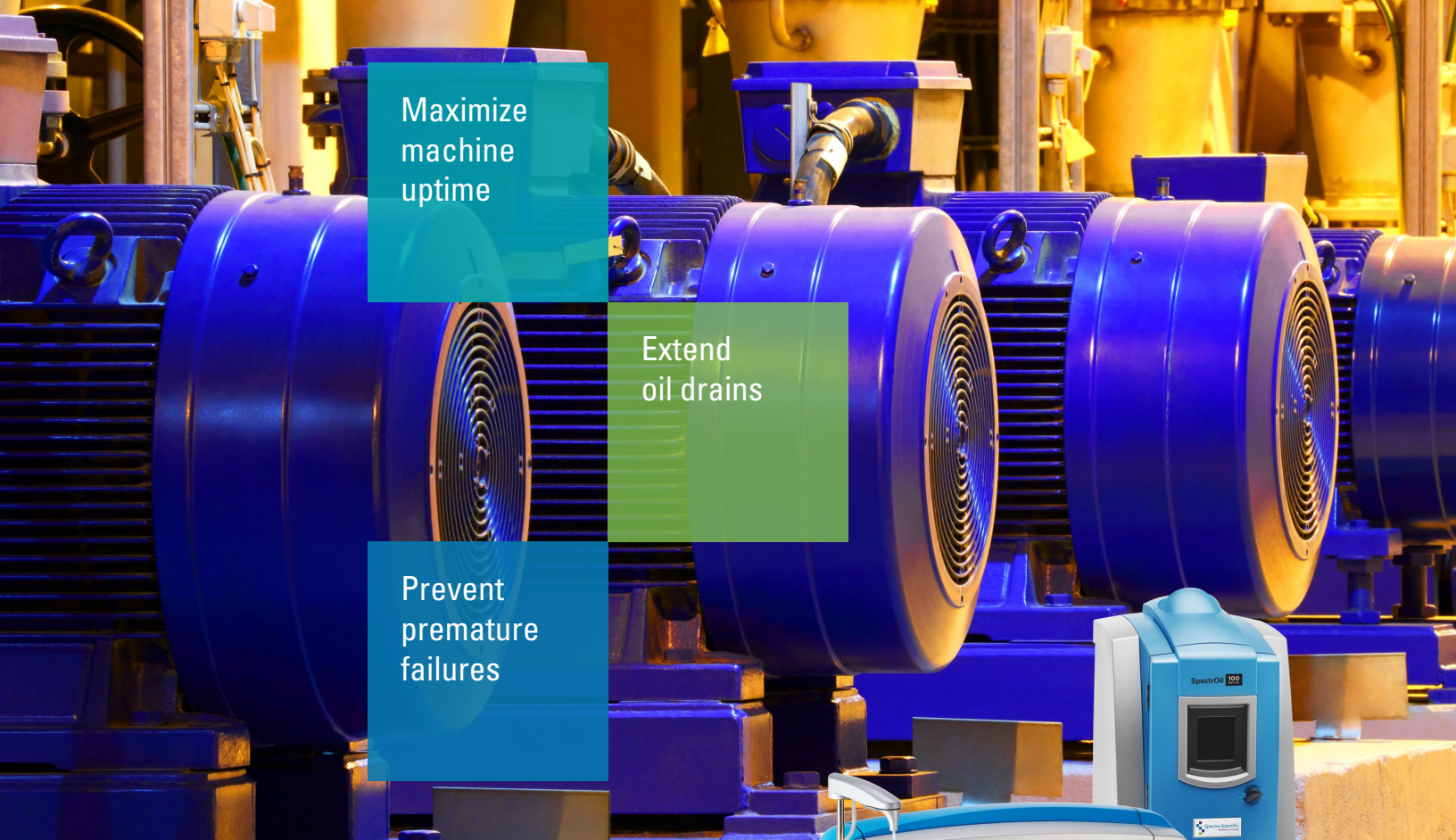


Solutions for Power Generation and Industrial Plants



Maximize
machine
uptime

Extend
oil drains

Prevent
premature
failures



In-service Oil Analysis for Machine Condition Monitoring

Since the reliable operation of high value, fixed assets is critical to all industrial plants, predictive maintenance programs are implemented to manage machinery uptime.

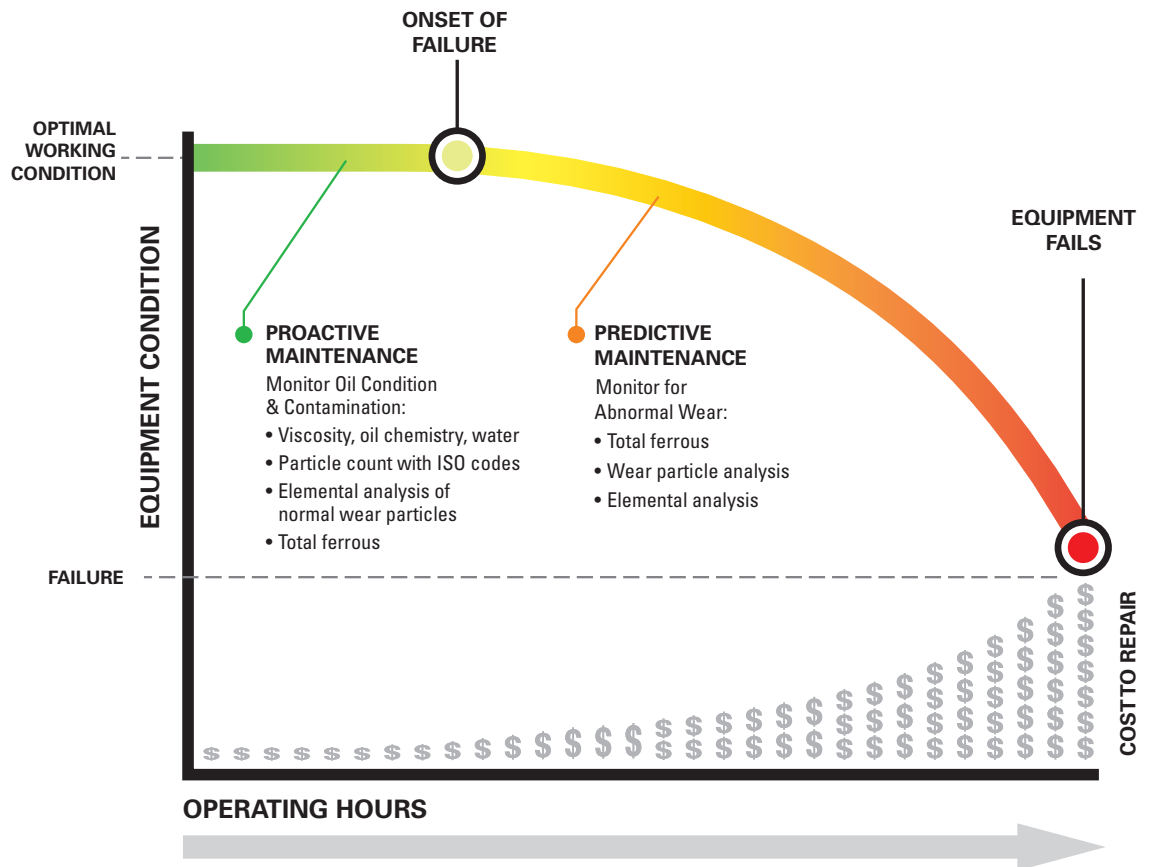
In-service oil analysis is a key machine condition monitoring technique for Condition Based Maintenance (CBM) and Reliability programs. It complements vibration analysis, thermography and other predictive maintenance technologies. In the time it takes external laboratories to return oil sample results, machinery condition can change significantly. On-site oil analysis eliminates this wait and enables immediate decision making.

Corrosion and wear cause surface degradation of the lubricated surfaces in machinery and are the root causes of most mechanically-induced equipment downtime. Corrosion is caused by water or other fluids reacting with metal surfaces, while wear is caused by surface abrasion, adhesion and fatigue.

Oil analysis provides early indications of equipment wear and identifies the root causes of corrosion.

The P-F Curve (Potential-Failure Curve) illustrates how in-service oil analysis provides critical information on machine condition in both Proactive and Predictive Maintenance periods.

In the Proactive period, oil condition and contamination monitoring help prevent the onset of the root causes of machine failure. In the Predictive period, monitoring the increasing severity of wear particles allows maintenance work orders to be executed for component replacement or repair before catastrophic failure.



As part of a proactive maintenance program, on-site oil analysis delivers rapid results with immediate decision making to:

- Lower operating costs
- Reduce unscheduled downtime
- Increase machine availability
- Extend equipment life
- Decrease total lifecycle equipment costs
- Provide immediate retest capability

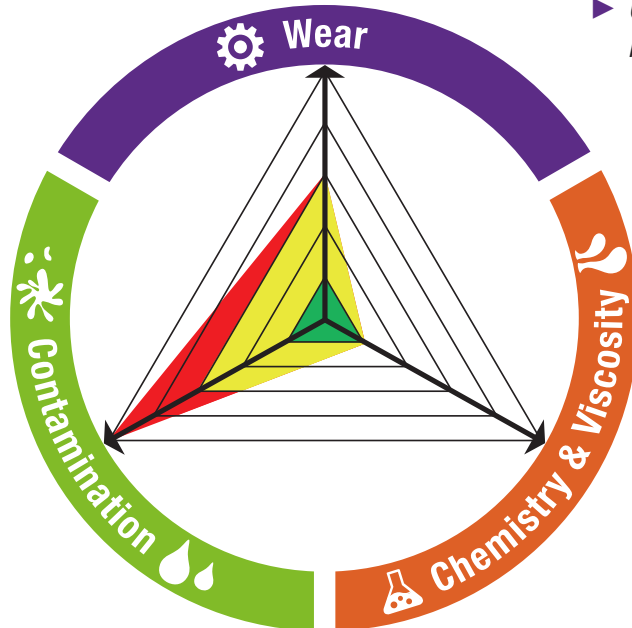
Trivector™ – oil and machine health simplified

The TriVector™ is a simple representation of the integrity of the lubrication system and the health of the machine itself. The Trivector indicates the degree of health in each vector. Each vector is a representation of Alarm Limits based on underlying parameters, such as viscosity, water contamination, acid number, oxidation, total ferrous, particle count and ISO code, large ferrous particle count, etc.

The following questions can be answered:



- ▶ *Is the oil dry?*
- ▶ *Is the oil clean/free of dirt?*



- ▶ *Is the machine healthy?*
- ▶ *Can I predict when the machinery will fail?*

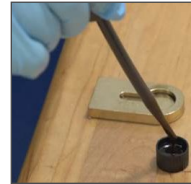
- ▶ *Is it the right oil?*
- ▶ *Is the oil fit for use?*

*Trivector is a trademark of Emerson Process Systems

MiniLab Series

4 simple tests and less than 15 minutes to comprehensive oil analysis

Can be operated on-site by plant staff; no chemist required.



ELEMENTAL ANALYSIS

The elemental analyzer provides measurement of 24 elements to identify individual contaminants, wear metals and the elemental composition of additives.



PARTICLE COUNT AND FERROUS MONITOR

The direct imaging particle counter and ferrous monitor provides particle counts and ISO codes, wear classification, ferrous particle counts & size distribution, and total ferrous measurement.



VISCOSITY

The portable viscometer provides high accuracy 40°C kinematic viscosity measurements.





Trivector reports on machinery health

Easy to interpret results with Trivector sample and trend reports.

Observations:
 Particle count (SD) >4) is severely high. Particle count (SD >6) is severely high.
Diagnostics:
 • Secondary sources include filter bypass or clogged filter.
 • Suspect source of particulate to be dirt, dust ingestion, or soft contaminants.
 • Wearing components are also suspected.
Recommended Actions:
 • Clean system oil by filtration or centrifuging.

Additional Recommendations:

25 Sep 2018

Oil	Shell Tellus 46	Sample ID	180625121256	180625121221	180625147709	180625114702	180625131832
Note	Sampled on	25 Sep 2018	29 Aug 2018	29 Jul 2018	29 Jun 2018	29 May 2018	29 May 2018
	Revised on	25 Sep 2018	29 Aug 2018	29 Jul 2018	29 Jun 2018	29 May 2018	29 May 2018
	In Total						
	In Oil						
	Type (p. 8.)						
Iron	ppm	<1.00	1.48	<1.00	<1.00	<1.00	<1.00
Lead	ppm	<1.00	6.74	3.61	2.44	<1.00	<1.00
Copper	ppm	<1.00	3.91	2.11	<1.00	<1.00	<1.00
Tin	ppm	1.43	9.13	18.33	6.63	1.43	
Fe Wear Severity Index		0.00	0.00	0.00	0.00	0.00	
Chromium	ppm	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
Nickel	ppm	<1.00	1.70	1.10	<1.00	<1.00	<1.00
Aluminum	ppm	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
Titanium	ppm	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
Silver	ppm	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
Antimony	ppm	0.00	0.00	0.00	0.00	0.00	
Calcium	ppm	0.34	4.87	3.57	7.57	0.34	
Manganese	ppm	1.47	7.54	4.54	2.24	1.47	
Silicon	ppm	4.40	7.40	0.23	1.40	4.40	
(SD 4406 Code (>4µm))		19	16	19	16	16	
(SD 4406 Code (>6µm))		14	16	14	14	14	
(SD 4406 Code (>14µm))		3	11	3	11	10	
Iron	ppm	20.72	4.42	6.82	10.22	20.72	
Sodium	ppm	<1.00	2.40	1.40	<1.00	<1.00	
Vanadium	ppm	<1.00	2.15	6.85	<1.00	<1.00	
Potassium	ppm	0.38	3.58	6.88	1.78	0.38	
TAN	mg/KOH/g	0.38	3.22	0.78	0.54	0.38	
Oxidation	ppm	0.90	1.44	0.90	0.84	0.90	
Visc ID	ppm	101.2	98.8				
Molybdenum	ppm	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
Barium	ppm	21.68	58.98	71.38	62.18	21.68	
Magnesium	ppm	1.07	13.37	11.17	9.97	1.07	
Phosphorus	ppm	210.89	68.33	36.82	86.23	210.89	
Zinc	ppm	3.08	9.62	15.52	3.36	3.08	
Barium	ppm	<1.00	12.63	17.33	8.03	<1.00	



CHEMICAL ANALYSIS

The infrared spectrometer measures Total Acid Number (TAN), oxidation and water for machinery oils and hydraulics.



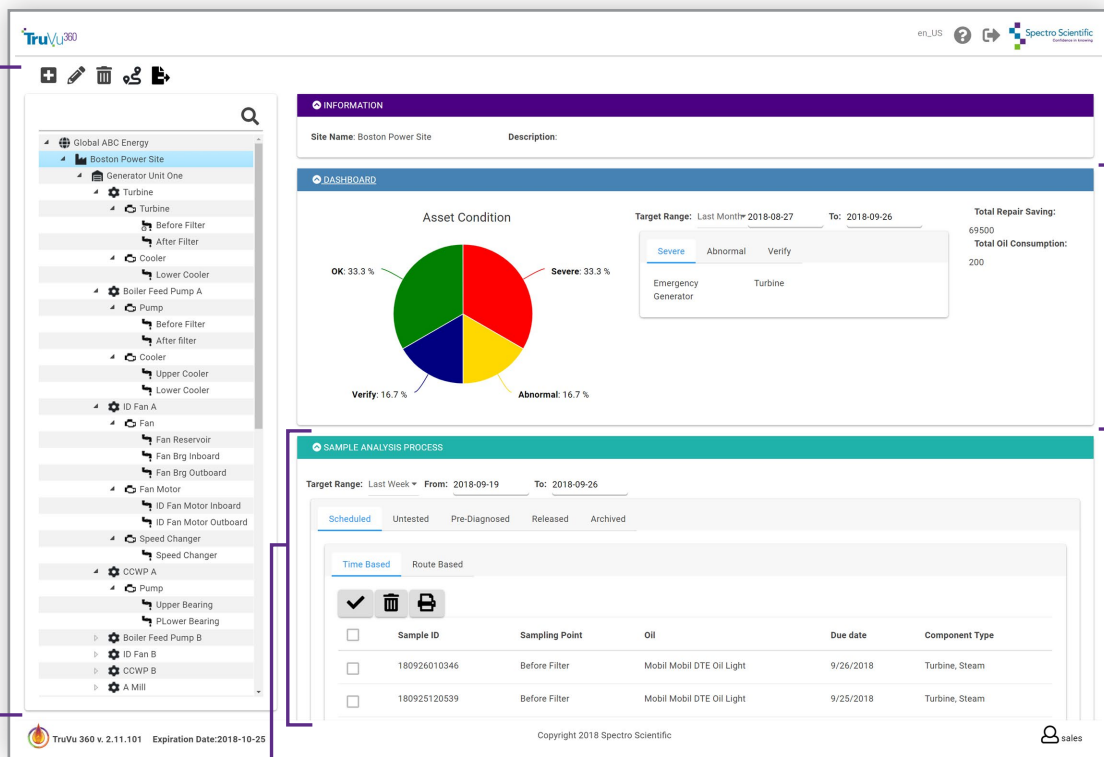
MiniLab Series Software

The TruVu 360 software is a browser-based platform installed on a company network, a local PC or accessed using the Spectro Scientific Cloud Hosting Service. The TruVu 360 Device Console can be installed on a local PC along with the MiniLab instrument software.

TruVu 360 delivers a best practice for the on-site oil analysis process and it provides performance dashboards at the asset, plant and corporate level.

It unifies asset trending of oil condition, chemistry and machinery wear with automated diagnostics and recommended maintenance actions, and it provides maintenance and oil savings tracking for assets.

The Diagnostics Sets can be adapted to users' asset requirements including both automatic diagnostics or user editable functions at the individual asset level.



TruVu 360 Enterprise cloud software

ASSET & TOOL BAR

- Create asset database with provided templates of component types.
- Customize your own or import existing asset structure.
- Assign pre-configured alarm limits that can be adjusted at the component level based upon operating history.
- Assess alarm trends to refine alarm limits.

SAMPLE ANALYSIS PROCESS

- Track samples that are planned, in process and tested.
- Review results and software-generated observations, diagnostics and recommendations.
- Add additional notes and observations before sample report is released.

DASHBOARD

Dashboards bring visibility of lubricant management and savings at the asset, plant and corporate level:

- Oil analysis results by category
- Total repair savings
- Total oil consumption

- 1 Sample list from TruVu 360
- 2 Test
- 3 Upload test results
- 4 Trivector chart from rules engine

The screenshot shows the TruVu 360 Device Console interface. At the top, it displays the navigation path: POWER GENERATION → PHILADELPHIA → UNIT ONE → UNIT 1 TURBINE > TURBINE THRUST BEARING > AFTER FILTER. The main interface is divided into several sections:

- Instrument Control (Left):** Contains five control panels for ELEMENTAL ANALYSIS, VISCOSITY, INFRARED, and PARTICLE ANALYSIS, each with play and stop buttons.
- Test Results (Center):**
 - ELEMENTAL ANALYSIS:** Lists various elements like Aluminum (Al), Antimony (Sb), Cadmium (Cd), etc., with their respective values.
 - VISCOSITY:** Shows ISO 4/6/14 and v40 values.
 - INFRARED:** Shows Total Acid, PPM Water, and Oxidation values.
 - PARTICLE ANALYSIS:** Shows ISO 4/6/14, Cnts >4, >6, >14, Total Fe, % Large Ferrucous, Fe Wear Severity Index, Cutting >20, Sliding >20, Fatigue >20, and Oxide >20 values.
 - MANUAL PROPERTIES:** Shows Flash Point as N/A.
- Results Display (Right):** Features a Trivector chart and three images labeled Image 1, Image 2, and Image 3, showing different views of the bearing.

Instrument Control

Results Display

TruVu 360 Device Console

The report is for the Boston Power Site, Generator Unit One, specifically for the Boiler Feed Pump A Pump Before Filter. It includes a Trivector chart and a table of test results.

Sample ID	180925121255	180925121221	180925114709	180925114702	180925131632
Iron ppm	<1.00	1.48	<1.00	<1.00	<1.00
Lead ppm	<1.00	6.74	4.54	2.44	<1.00
Copper ppm	<1.00	3.81	2.11	<1.00	<1.00
Tin ppm	1.43	9.13	18.33	6.63	1.43
Fe Wear Severity Index	0.00	0.00	0.00	0.00	0.00
Chromium ppm	<1.00	<1.00	<1.00	<1.00	<1.00
Nickel ppm	<1.00	1.70	1.10	<1.00	<1.00
Aluminum ppm	<1.00	<1.00	<1.00	<1.00	<1.00
Titanium ppm	<1.00	<1.00	<1.00	<1.00	<1.00
Silver ppm	<1.00	<1.00	<1.00	<1.00	<1.00
Antimony ppm	0.00	0.00	0.00	0.00	0.00
Cadmium ppm	0.34	4.87	3.57	7.37	0.34
Manganese ppm	1.47	7.94	6.54	2.24	1.47
Silicon ppm	4.40	7.60	3.22	1.40	4.40
ISO 4406 Code (>4µm)	19	16	19	15	16
ISO 4406 Code (>6µm)	1	1	1	1	1
ISO 4406 Code (>14µm)	1	1	1	1	1
ML Contamination Boron ppm	20.72	4.42	6.82	10.22	20.72
Sodium ppm	<1.00	2.40	1.40	<1.00	<1.00
Vanadium ppm	<1.00	2.15	6.65	<1.00	<1.00
Potassium ppm	0.38	5.58	4.68	1.78	0.38
TAN mg/KOH/g	0.38	3.22	0.78	0.54	0.38
Oxidation abn/m2	0.90	1.44	0.90	0.84	0.90
ML Chemistry Visc 40 cSt	101.2	98.8			
Molybdenum ppm	<1.00	<1.00	<1.00	<1.00	<1.00
Calcium ppm	21.68	58.98	71.38	62.18	21.68
Magnesium ppm	1.07	13.37	11.17	9.97	1.07
Phosphorus ppm	210.89	68.33	36.82	86.23	210.89
Zinc ppm	3.26	8.62	15.52	3.36	3.26
Barium ppm	<1.00	12.63	17.33	8.03	<1.00

TruVu 360 report

Reports

Trend reports are automatically generated including observations and recommended actions based upon alarm limit sets employed. Manual review and edits can be made before report release and automatic distribution.

The screenshot shows a trending chart and a table of historical sample data. The table includes columns for Parameter, Trivector, Sample, and Parameter.

Parameter	Trivector	Sample	Parameter
drawingDate		180925121255	drawingDate
machineLife		180925121221	machineLife
alarmCode		180925114709	alarmCode
iron	Wear	180925114702	iron
lead	Wear	180925131632	lead
chromium	Wear		chromium
nickel	Wear		nickel
aluminum	Wear		aluminum
tin	Wear		tin
antimony	Wear		antimony
cadmium	Wear		cadmium
manganese	Wear		manganese
silicon	Wear		silicon
boron	Contamination		boron
sodium	Contamination		sodium
vanadium	Contamination		vanadium
potassium	Contamination		potassium
iso 4406 code (>4µm)	Contamination		iso 4406 code (>4µm)

TruVu 360 trending chart and historical sample data

MiniLab Evolution

5200 MiniLab vs MiniLab 153

The MiniLab Series is the next generation of Trivector on-site oil analyzers replacing the 5200 MiniLab.

	5200 MINILAB	MINILAB 153
Wear	Large Ferrous content, trending only	Total ferrous particle content (ppm)
	Wear Debris Analysis (WDA) (Optional)	Image import from any file for attachment to sample report
		Automatic wear particle shape classification, count & distribution
		Large Ferrous content, ppm
Contamination	Particle count & distribution, ISO codes	Particle count & distribution, ISO codes
	Emulsified water only	Dissolved water (ppm)
		Free water (ppm)
		Glycol contamination for engine oils
		Contaminate elements: Si, Na
Chemistry	Dynamic viscosity @ room temperature	Kinematic viscosity @ 40°C
	Dielectric, trending only	Fluid Integrity index, trending only
		Oxidation
		Total Acid Number (TAN)
		Nitration, Sulfation, Anti-wear additive, Total Base Number (TBN), and soot for engine oils
		Additive elements: Ca, P, Zn, Mg, Ba, Mo
Application	Typical mineral and synthetic lubricant and hydraulics oils for industrial rotating machinery. Not suitable for backup generators.	Mineral and synthetic lubricant and hydraulics for industrial rotating machinery, plus engine oil for backup generators and ground fleet, and special lubricants such as phosphate esters and PAG.

Oil library database

The MiniLab Series includes an extensive industrial oil library database to analyze in-service oils as a variety of lubricants and fluids are used in industrial equipment. The following fluid categories can be tested:

FLUIDS	ELEMENTAL	CHEMISTRY	PARTICLE COUNT & FERROUS	VISCOSITY
Mineral oil based Hydraulic fluids and lubricants	Y	Y	Y	Y
Synthetic hydrocarbon based hydraulic fluids and lubricants	Y	Y	Y	Y
Ester-based Lubricant blends	Y	Y	Y	Y
Oil Soluble Polyglycols (OSP)	Y	Y	Y	Y
Organic Esters (OE)	Y	Y	Y	Y
Phosphate Esters (Fyrquel/Skydrol)	Y	Y	Y ¹	Y
Polyalkylene Glycols (PAG)	Y	Y	Y ¹	Y
Poly Alpha Olefins (PAO)	Y	Y	Y	Y
Polyinternal Olefins	Y	Y	Y	Y
Polyol Esters (POE)	Y	Y	Y	Y
Grease	Y	Y ²	N	N
Mineral Transformer Oil	Y	N	Y	Y

1: Require factory installed Skydrol tube and fitting kits and compatible solvent 2: Oxidation and water (absorbance units) for trending

Typical limits for machinery

Factory libraries of component types, reference oils and alarm limits are provided and additional parameters and limits can be added by the user.

ADAPTIVE RULES ENGINE (BETA) - DIAGNOSTIC STATEMENTS		
Turbine, Steam		
TriVector	Parameter	Diagnostic
Wear	Iron	Suspect source to be wear of shaft, reduction gear
Wear	Lead	Suspect source to be wear of bearings, piping, or s
Wear	Copper	Suspect source to be wear of bearings, bushings, o
Wear	Tin	Suspect source to be wear of shaft, reduction gear
Wear	Total Ferrous	Suspect source to be wear of shaft, reduction gear
Wear	Large Iron	Suspect source to be wear of shaft, reduction gear
Wear	Fe Wear Severity Index	Suspect source to be wear of shaft, reduction gear
Contamination	Boron	Suspect source to be contamination from lubrican
Contamination	Silicon	Suspect source to be contamination from dirt, dus
Contamination	Water, ppm	Suspect source to be water ingress from labyrinth
Contamination	ISO 4406 Code (>4µm)	Suspect source of particulate to be dirt, dust Ingre Secondary sources include filter bypass or clogge
Contamination	ISO 4406 Code (>6µm)	Suspect source of particulate to be dirt, dust Ingre Secondary sources include filter bypass or clogge
Contamination	ISO 4406 Code (>14µm)	Suspect source of particulate to be dirt, dust Ingre Secondary sources include filter bypass or clogge
Chemistry	Calcium	Suspect contamination from lubricant additives m
Chemistry	Phosphorus	Suspect contamination from lubricant additives m system.
Chemistry	Zinc	Suspect contamination from lubricant additives m
Chemistry	TAN	Suspect TAN increase due to overheating, additive localized hot spots.
Chemistry	Oxidation	Suspect oxidation rise due to overheating, localize
Chemistry	Visc 40	Oil may be contaminated, severely degraded or had

ADAPTIVE RULE ENGINE (BETA)						
Turbine, Steam						
Parameter	Limit Type	Abnormal	Severe	Reference Value	Maintenance Actions (Abnormal)	Maintenance Actions (Severe)
Iron	Absolute	5	10		• Monitor. Resample at half of normal sampling frequency.	• Investigate equipment urgently.
Lead	Absolute	3	5		• Monitor. Resample at half of normal sampling frequency.	• Investigate equipment urgently.
Copper	Absolute	2	5		• Monitor. Resample at half of normal sampling frequency.	• Investigate equipment urgently.
Tin	Absolute	5	10		• Monitor. Resample at half of normal sampling frequency.	• Investigate equipment urgently.
Total Ferrous	Absolute	10	20		• Monitor. Resample at half of normal sampling frequency.	• Investigate equipment urgently.
Large Iron	Absolute	0.1	0.2		• Monitor. Resample at half of normal sampling frequency.	• Investigate equipment urgently.
Fe Wear Severity Index	Absolute	1	4		• Monitor. Resample at half of normal sampling frequency.	• Investigate equipment urgently.
Boron	Absolute	15	20		• Monitor. Resample at half of normal sampling frequency.	• Investigate equipment urgently.
Silicon	Absolute	5	10		• Monitor. Resample at half of normal sampling frequency.	• Investigate equipment urgently.
Water, ppm	Absolute	100	200		• Monitor. Resample at half of normal sampling frequency. Check integrity of seals, breather, or cooler system coupling.	• Install a water removal system (vacuum dehydration) system. Check integrity of seals, breather, or cooler system coupling.
ISO 4406 Code (>4µm)	Absolute	17	18		• Monitor. Resample at half of normal sampling frequency.	• Clean system oil by filtration or centrifuging.
ISO 4406 Code (>6µm)	Absolute	14	15		• Monitor. Resample at half of normal sampling frequency.	• Clean system oil by filtration or centrifuging.
ISO 4406 Code (>14µm)	Absolute	11	12		• Monitor. Resample at half of normal sampling frequency.	• Clean system oil by filtration or centrifuging.
Calcium	Absolute	15	20		• Feed and bleed reservoir with correct lubricant.	• Change oil with approved lubricant. Check seal integrity.
Phosphorus	Absolute	100	200		• Monitor. Resample at half of normal sampling frequency.	• Change oil with approved lubricant. Check seal integrity.
Zinc	Absolute	10	25		• Monitor. Consider feed and bleed. Resample at half of normal	• Investigate equipment urgently.

TruVu 360 limit table grouped by Trivector parameters

Particle analysis and wearing mechanism

With total ferrous, large ferrous total particle counts and ISO codes, wear particle counts users can make informed decisions to identify oil drain points, corrosive wear and the onset of a serious abnormal machine wear mechanism.

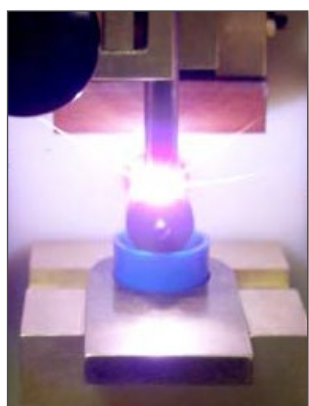
MONITORING	TOTAL Fe, ppm	LARGE FERROUS CONTENT, ppm	LASERNET LARGE PARTICLES >20 µm	LASERNET CLASSIFIER
	Establish constant wear rate	Dynamic equilibrium levels	Dynamic equilibrium levels	Dynamic equilibrium levels
Oil change interval	Reaches limit level	NA	NA	NA
Onset of corrosive wear	Increase in rate	No change	No change	No change
Transition into abnormal wear mode	Increase in rate	Increase	Increase	Increase – cutting/sliding/fatigue
Ongoing severe wear mechanism (breakdown shear mixed layer)	Same or decrease in rate	Increase	Increase	Increase – cutting /sliding/ fatigue
Temporary wear rate change due to increased load and speed	Increase in rate	No change	No change	No change
Onset of external contamination	No change	No change	Increase	Increase – non-metallic
3 Body abrasive mechanism iron	No change	Increase	Increase	Increase – cutting/sliding
3 Body abrasive mechanism non-ferrous (copper, aluminum)	No change	No change	Increase	Increase – cutting/sliding
Onset of rolling contact failure	No change	Increase	Increase	Increase – fatigue

Elemental Analysis

-  > Wear particle by metal type
-  > Contamination ID by source
-  > Oil additive levels



SpectroOil 100 Series instrument can be purchased separately.



Sample consumed using RDE technology is optically analyzed with AE spectroscopy to detect elements.

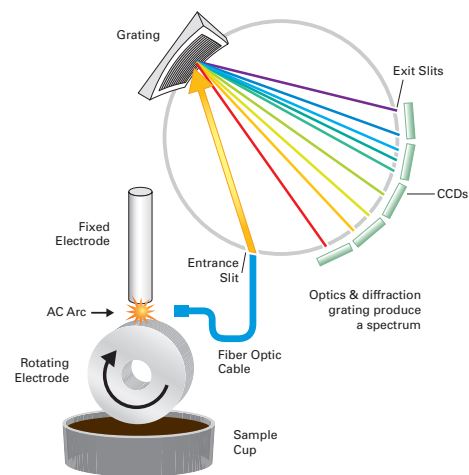
The SpectroOil 100 Series analyzes small particulate wear, lubricant additives and contaminants for trace quantities of elements dissolved or suspended as fine particles. Using the proven rotating disc electrode (RDE) technique, the SpectroOil 100 Series has become the workhorse of industrial, commercial and military oil analysis laboratories requiring rapid analysis of wear metals, contaminants and additives in lubricants.

Coolant, wash-down water and JOAP calibrations are available in addition to in-service lubricating oil and hydraulic fluid analysis.

- Measures ppm levels of up to 32 elements in less than 30 seconds
- Easy to operate – no sample preparation, gases, coolants or solvents needed
- Compliant with ASTM D6595 for used oil analysis

On-site oil analysis provides greater insight into contaminant sources by linking elemental parameters with the probable source:

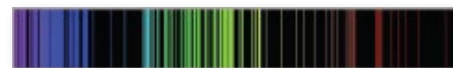
ELEMENT	Oil Chemistry – metallic additives possible sources
Sodium	Corrosion inhibitor additive, also indicates coolant leak into oil, can also be road salt, sea water, ingested dirt
Boron	Corrosion inhibitor additive, antiwear/antioxidant additive; can indicate coolant leak, grease contamination
Magnesium	Detergent/dispersive additive, can also be alloying element in steels
Calcium	Detergent/dispersant additive, alkaline reserve additive for high sulfur fueled engines, can be grease contamination,
Molybdenum	Solid/liquid antiwear additive, alloy in bearing and piston rings
Barium	Corrosion inhibitors, detergents, rust inhibitors
Zinc	Antiwear, corrosion inhibitors, anti-oxidants, alloying element for bearings, thrust washers, galvanized cases
Phosphorus	Antiwear, corrosion inhibitors, anti-oxidants additives, EP additives



SpectroOil 100 Series rotating disc electrode optical emission spectrometer schematic



Emission spectrum of hydrogen



Emission spectrum of iron

Particle Count and Ferrous Monitor

The LaserNet 200 Series provides particle counts and codes, large wear particle classification and ferrous wear monitoring.

- Particle count, size distribution and codes (ISO 4406, NAS 1638, NAVAIR 01-1A-17, SAE AS 4059, GOST, ASTM D6786, HAL, and user defined bins)
- Differentiates contaminants (silica and fibers from machine wear metal)
- Classifies wear particles, stores images, and reports particle count for each wear type of Cutting, Sliding, Fatigue, Fibers and Nonmetallics
- Ferrous Monitor measures total ferrous content in the sample and large ferrous
- Widest range up to 5,000,000 particles/ml
- Test oil viscosity up to ISO320 without dilution
- Images through dark fluids containing up to 2% soot
- Error corrections for water and air bubbles

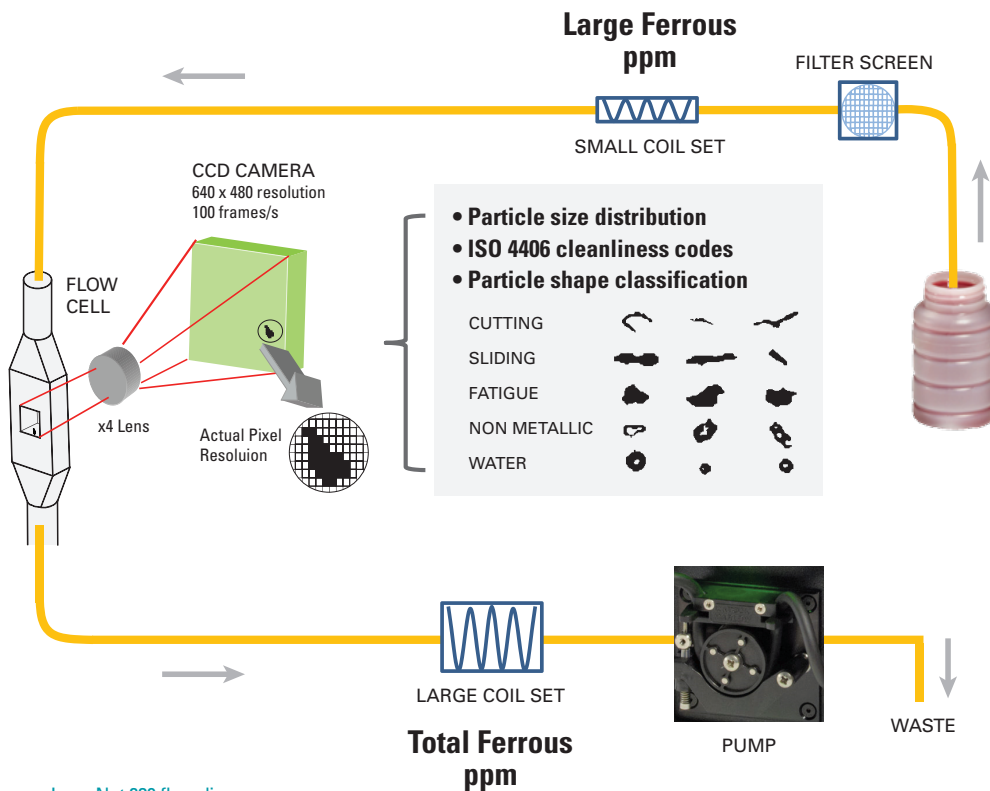
Options include configurations without the ferrous monitor and wear classification.

- Ferrous content
- Wear particle shape

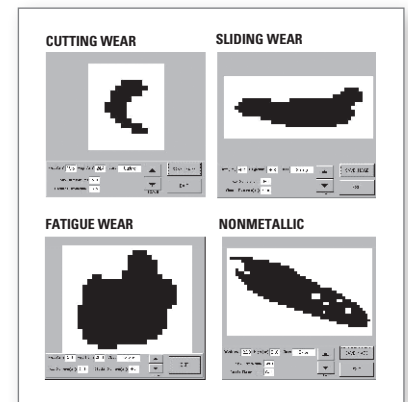
- Particle count and codes



LaserNet 200 Series instrument can be purchased separately.



LaserNet 230 flow diagram





> Water



> TAN
> TBN

- > Oxidation
- > Nitration
- > Sulfation
- > Soot
- > Additive depletion
- > Glycol

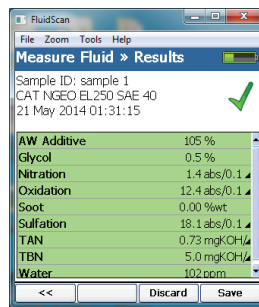
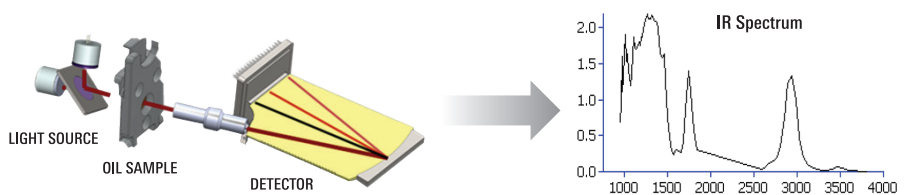


FluidScan 1000 Series handheld infrared spectrometer can be purchased separately.

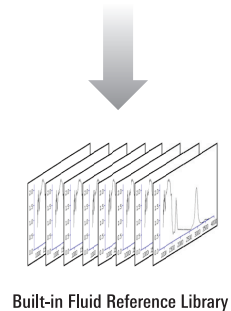
Chemical Analysis

The FluidScan® 1000 Series oil chemistry analyzer determines when in-service oil is no longer fit for use due to oil degradation or the ingress of water or glycol. It is fast and easy to use, with just one drop of oil needed for the sample and less than one minute for test results. The analyzer includes an extensive oil library; additional oils can be added by the user.

- Compliant to ASTM D7889 "Standard Test Method for Field Determination of In-service Fluid Properties Using IR Spectroscopy"
- High correlation to TAN and TBN laboratory tests conducted with ASTM D664 and D4739
- Patented, Comprehensive Water Measurement option extends range to 6.5%. (Included with all MiniLab systems.)
- Fluid Integrity Index



Measured Fluid Properties

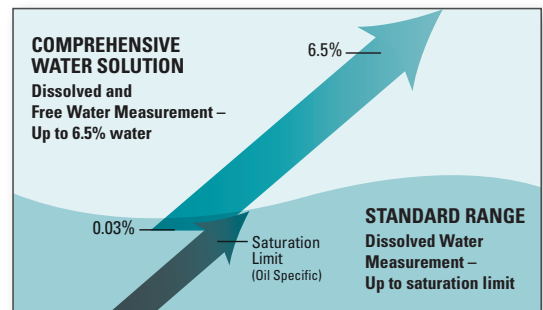


Built-in Fluid Reference Library

The oil library contains various categories of fluids. The industrial library provided with the MiniLab series includes the Comprehensive Water Solution and the Industrial Fluid Oil Library.

CATEGORY	Industrial Fluid Library
ASTM EP Gear/Hydro	✓
ASTM Petroleum Crankcase	✓
ASTM Polyol Ester	✓
BIODIESEL FEEDSTOCK	
CHILLER	✓
ENGINE	✓
ENGINE-HEAVY DUTY	
ENGINE-HFO	
ENGINE-NAT GAS	
ETHANOL IN GASOLINE	
FAME	
FAME in DIESEL	
GEAR-PRESSURE	✓
GEAR-SPLASH	✓
HEAT TRANSFER	✓
HYDRAULIC	✓
HYDRAULIC-FIRE RESISTANT	✓
SLIDEWAY	✓
TRANSMISSION	
TURBINE-AERO	✓
TURBINE-CCGT	✓
TURBINE-STEAM	✓

FluidScan operating principle



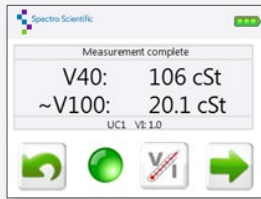
Water measurement range

Viscosity

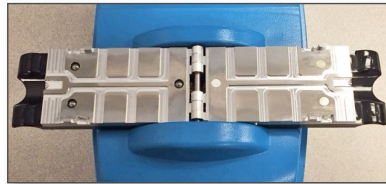
The MiniVisc 3000 Series provides fast, accurate 40°C kinematic viscosity measurements for easy detection of viscosity variations caused by contamination, mix-up and oil degradation.

- Solvent free, portable, and easy to use
- Viscosity range 1-700 cSt @40°C
- Accuracy +/- 3% to NIST viscosity standards
- Fast results: ISO 15 ~10 seconds, ISO 320 ~ 3 minutes

For machinery oils, the 40°C kinematic viscosity is used as the reference value. Engine oils operate at higher temperatures than rotating machinery, so they require V100°C kinematic viscosity. The Viscosity Index of an oil is a parameter that relates the V40°C measurement value to the V100°C value. A reference Viscosity Index value can be entered in the viscometer and both the measured V40°C viscosity and the calculated V100°C viscosity values are displayed.



Positive displacement pipette

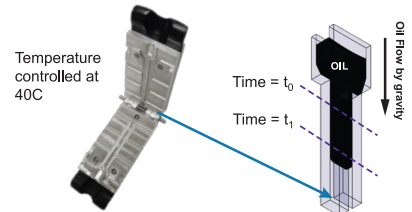


Open the two parallel plates for easy cleaning.

> Viscosity



MiniVisc 3000 Series portable viscometer can be purchased separately.



MiniVisc 3000 Series kinematic viscometer schematic

Total Ferrous

The MiniLab 33 includes the FerroCheck, a portable ferrous analyzer that measures the total ferrous content of a sample. It is easy to operate; simply insert the sample vial with fluid sample to measure.

- Small sample requirement with results in 30 seconds
- No sample preparation and no solvents required to clean
- Measurement range 0-10,000 ppm for oil, 10-150,000 ppm for grease



Grease boat and sample introduction vials

> Wear



FerroCheck 2000 Series portable ferrous analyzer can be purchased separately.

Four MiniLab Options. Which One is for You?

MiniLab 153 – provides a complete oil analysis report with elemental analysis, comprehensive wear particle analysis, solid and water contamination, fluid chemistry and viscosity. It is ideal for large power plants and manufacturing plants with many assets.

MiniLab 53 – provides a Trivector report with comprehensive wear particle analysis, solid and water contamination, fluid chemistry and viscosity.

MiniLab 33 – provides a basic Trivector report with total ferrous wear, fluid chemistry, water in oil and viscosity.

MiniLab 23 – provides basic oil condition information including viscosity, chemistry and water in oil.



MiniLab 153 – 4 tests



MiniLab 53 – 3 tests



MiniLab 33 – 3 tests



MiniLab 23 – 2 tests

	PARAMETER	Elemental	Particle Count and Ferrous	Ferrous	Viscosity	Chemical
		ASTM METHOD D6595	ASTM METHOD D7596	ASTM METHOD D8120	ASTM METHOD D8092	ASTM METHOD D7889
Contamination 	Particle count and ISO codes		✓			
	Non-metallic particle count, distribution and images		✓			
	Sodium and Silicon	✓				
	Total Water					✓
Chemistry & Viscosity 	Viscosity				✓	
	Total Acid Number (TAN)					✓
	Oxidation					✓
	Fluid Integrity					✓
	Total Base Number (TBN), Oxidation, Nitration, and Sulfation for engine oils					✓
	Magnesium, Calcium, Barium, Zinc, Molybdenum, and Phosphorus	✓				
Wear 	Wear particle images and counts		✓			
	Total Ferrous content, ppm		✓	✓		
	Large Ferrous content, ppm		✓			
	Copper, Silver, Chromium, Titanium, Aluminum, Nickel, Iron, Manganese, Lead, Tin, Cadmium, and Vanadium	✓				

ANALYTICAL RANGE AND REPEATABILITY

OUTPUT	ANALYTICAL RANGE	REPEATABILITY
Particle count and size distribution: ISO codes per 4402/4406, other codes selectable	Particle count 4-100 µm	≤ 6% RSD
Large Ferrous, ppm	0.02-5 ppm	≤ 5% RSD
Total Ferrous, ppm	10-2,000 ppm	≤ 5% RSD
Wear particle counts by mode: fatigue, sliding, cutting, non-metallic, fibers	20-100 µm	
40°C Kinematic viscosity, cSt	1-320 cSt at 40°C 320-700 cSt at 40°C	≤ 3% RSD ≤ 5% RSD
Total Acid Number (TAN), mg KOH/g	0-6 mg KOH/g	≤ 3% RSD
Total Base Number (TBN), mg KOH/g	0-70 mg KOH/g	≤ 3% RSD
Oxidation, abs/0.1 mm	0-150	≤ 3% RSD
Nitration, abs/cm	0-50	≤ 3% RSD
Sulfation, abs/0.1 mm	0-75	≤ 3% RSD
Fluid Integrity	Index, varies by oil	≤ 3% RSD
Water, dissolved, ppm	100 ppm-saturation*	≤ 3% RSD
Water, free, ppm	0.03-6.5% (300-65,000 ppm)	≤ 25% RSD
Elemental concentration of 23 elements, ppm	Elemental analysis range and repeatability vary with element	

*Oil specific. RSD = Relative Standard Deviation.

Validation Standards and ASTM Standards

Validation standards are supplied for all MiniLab Series instrumentation. These NIST traceable standards support internal quality programs and compare current instrument performance against factory calibration.

All instruments in the MiniLab Series have an associated ASTM Standard Test Method.



ACCESSORIES & CONSUMABLES

Sample Preparation Equipment

Sample preparation equipment such as the homogenizer, ultrasonic deaerator, electrode sharpener and consumables for 100 samples is included with each MiniLab 153 Standard Accessories Kit.

SAMPLE PREPARATION – 3 SIMPLE STEPS

1. Sharpen electrode
2. Homogenize the sample for water measurement
3. Ultrasonically degas the sample for particle analysis



Consumables

Spectro Scientific consumables are selected and carefully tested with all Spectro Scientific instruments to ensure consistent, repeatable results. Always use Spectro Scientific certified consumables for best results.



SERVICE CONTRACTS AND REPAIR

Spectro Scientific's service offerings for the MiniLab Series include:

- **System Installation & Training** for instrument operation and routine maintenance.
- **Service Contracts** for extended warranty and preventive maintenance.
- **Field Repair** by certified customer service engineers on site.
- **In-house Instrument Calibration, Maintenance, Repair, and Upgrades** performed at our facility near Boston, MA.
- **On-line Training**



MiniLab Series Product Information

For MiniLabs with TruVu 360 Basic, software is provided in a USB/DVD media pack.

For MiniLabs for TruVu 360 Hosted Service, Hosting service and User Licenses are ordered separately.

PART NUMBER	
800-00196	MiniLab 153, 115VAC, 60HZ, with TruVu360 Basic software and Win 10 Pro Workstation
800-00199	MiniLab 153, 220VAC, 50HZ, with TruVu360 Basic software and Win 10 Pro Workstation
800-00161	MiniLab 153, 115VAC, 60HZ, for TruVu360 Hosted Service and Win 10 Pro Workstation
800-00164	MiniLab 153, 220VAC, 50HZ, for TruVu360 Hosted Service and Win 10 Pro Workstation
800-00192	MiniLab 53, 115VAC, 50/60Hz, with TruVu 360 Basic software
800-00193	MiniLab 53, 220VAC, 50/60Hz with TruVu 360 Basic software
800-00165	MiniLab 53, 115VAC, 50/60Hz, for TruVu 360 Hosted Service
800-00166	MiniLab 53, 220VAC, 50/60Hz, for TruVu 360 Hosted Service
800-00188	MiniLab 33, 115VAC, 50/60Hz, with TruVu 360 Basic software
800-00189	MiniLab 33, 220VAC, 50/60Hz, with TruVu 360 Basic software
800-00167	MiniLab 33, 115VAC, 50/60Hz, for TruVu 360 Hosted Service
800-00168	MiniLab 33, 220VAC, 50/60Hz, for TruVu 360 Hosted Service
800-00184	MiniLab 23, 115VAC, 50/60Hz, with TruVu 360 Basic software
800-00185	MiniLab 23, 220VAC, 50/60Hz, with TruVu 360 Basic software
800-00169	MiniLab 23, 115VAC, 50/60Hz, for TruVu 360 Hosted Service
800-00170	MiniLab 23, 220VAC, 50/60Hz, for TruVu 360 Hosted Service
FOR HOSTED SERVICE	
100-00795	Annual TruVu 360 Hosting Service fee on Spectro Scientific Cloud server (per site)
100-00744	TruVu 360 Enterprise user license, 1 year, 1 user
100-00741	TruVu 360 Site user license, 1 year, 1 user
TruVu 360 BASIC OPTIONS	
750-00156	TruVu 360 Basic to Pro license upgrade (perpetual)
100-00886	Additional TruVu 360 Pro Site User license (perpetual)
ACCESSORIES AND CONSUMABLES	
800-00073	MiniLab 153 Standard Accessories Kit
800-00032	MiniLab 153 Consumables Kit for 500 samples
800-00072	MiniLab 53 Standard Accessories Kit
400-00088	MiniLab 53 Consumables Kit for 500 samples
800-00063	MiniLab 33 Standard Accessories Kit
800-00064	MiniLab 33 Consumables Kit for 500 samples
800-00039	MiniLab 23 Standard Accessories Kit
800-00040	MiniLab 23 Consumables Kit for 500 samples
600-00123	MiniLab 153 Validation Standards Kit
600-00122	MiniLab 53 Validation Standards Kit
600-00120	MiniLab 33 Validation Standards Kit
600-00119	MiniLab 23 Validation Standards Kit
FL360	All Libraries License for FluidScan
800-00171	Windows 10 Pro Workstation, with TruVu 360 Device Console installed. 115/220 VAC, 50/60 Hz, 150W

PRODUCT INFORMATION	
Applications	Mineral and synthetic lubricants including gear, engine, hydraulic, turbine, and distillate fuels
Methodology	ASTM D7596, ASTM D7889, ASTM 40831, ASTM D6595
Calibration	Factory calibrated, field calibration not required. Validation and standardization fluids supplied.
OPERATIONAL SPECIFICATIONS	
Environmental Requirements	5-40°C ambient temperature, 10-80% RH non-condensing, 2000 m maximum altitude
Sample Volume	30-50 ml, varies with viscosity
Solvents	LaserNet Flush, lamp oil or odorless kerosene.
USER INTERFACE SPECIFICATIONS	
Software/ Operating System	Personal computer with Windows 10 Pro or Windows 7 Pro, 32 or 64 bit, US English version. Quad core microprocessor speed 2.6 GHz or higher and 8 GB RAM minimum.
POWER REQUIREMENTS	
Power	MiniLab 153: 1 Phase power, 1200 W (max) MiniLab 53/33/23: 1 Phase power, 110 W (max)
MECHANICAL SPECIFICATIONS	
Dimensions (H x W x D)	MiniLab 153: 71 cm x 214 cm x 66 cm (28" x 84" x 26") MiniLab 53: 35 cm x 50 cm x 53 cm (13.8" x 19.7" x 21") MiniLab 33: 14 cm x 69 cm x 48 cm (5.5 x 27" x 19") MiniLab 23: 10 cm x 51 cm x 48 cm (4" x 20" x 19")
Weight	MiniLab 153: 84 kg (185 lbs) MiniLab 53: 14 kg (31 lbs) MiniLab 33: 9 kg (22 lbs) MiniLab 23: 6 kg (14 lbs)
COMPLIANCE	
CE Mark-EMC directive, RoHS	

	TruVu 360 Basic	TruVu 360 Pro	TruVu 360 Hosting Service
License	None	One included with TruVu 360 Pro upgrade	Requires Site User or Enterprise User license
Duration	Perpetual use	Perpetual use	Annual fee
Installation	On Local PC	Local PC or on company network	Hosted by Spectro Scientific
Use case	Single site, No login	Single site/MiniLab, 1 user login per license Pro Site User licenses can be assigned with Site Admin (primary user), Operator, or Reader privileges.	Single or Multiple sites/ MiniLabs Site User licenses can be assigned with Site Admin (primary user), Operator, or Reader privileges. Enterprise Users can access multiple sites.
Email report distribution	None	Allows email notifications	Allows email notifications



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