

Science.

Technology.

Innovation.



The PNNL modular systems represent state of the art technology for in-situ lube and hydraulic oil analysis.

### Available Analytical and Sensor Modules:

- X-Ray Fluorescence Spectrometer
- Non-Dispersive Infra-Red Spectrometer
- Miniature Viscometer
- Particle Detection and Counting Option

**Pacific Northwest  
National Laboratory**  
Operated by Battelle for the  
U.S. Department of Energy



# Modular In-Line Fluid Analysis System

Fully portable systems under development at Pacific Northwest National Laboratory (PNNL) can provide near-real time analytical data related to lubricating oil condition and machine wear materials.

The technology is being developed by PNNL in partnership with Belhaven Corporation and the U.S. Department of Energy.

Depending on configuration, these modular systems can determine oil cleanliness, oxidation status, viscosity, fuel and water contamination, wear metal concentrations and both ferromagnetic and non-ferromagnetic particle mass. Specially developed software provides equipment operators with information about the condition of the lubricating and hydraulic oils as well as the mechanical systems in which they are being used.



The device was designed for installation directly on the engine or machine and becomes an integral part of the lubrication or hydraulic systems. The system can also be used as a portable stand-alone system for analysis in the field. In operation, the system requires no reagents or consumables.

The system monitors and trends fluid contaminants, chemical degradation, and wear metal levels in lubricated machinery including engines, power trains, and hydraulic systems. It then provides system diagnostic and prognostic information to maintenance personnel. This information can be used to schedule maintenance and to make repairs that can prevent later catastrophic damage or failure of expensive engines and drive components.



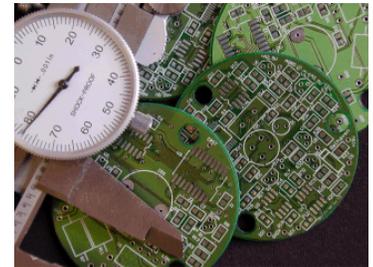
The system shown is designed for analysis of oil from large piston engines. It provides elemental analysis, infrared analysis, and viscosity determination. As shown here it is configured for in-line operation, This system weighs approximately 35 kg and has outside dimensions of approximately 24 cm x 50 cm x 76 cm.

# Performance Specifications

## Elemental Analysis (XRF)

### CT-5000 XRF Specifications

Component	Description / Specification
Main Source	15 mCi <sup>109</sup> Cd in failsafe sealed tungsten source block
Optional Source	10 mCi <sup>241</sup> Am in failsafe sealed tungsten source block
Source Replacement Intervals	<sup>109</sup> Cd source replaced interval: 5 years <sup>241</sup> Am source replacement interval: 30 years
Detector	Thermoelectrically cooled Silicon PIN (2-120 keV)
Multi Channel Analyzer	256 channels
Oil Flow rate	Nominal 60 cc/m
Power Requirements	10 watts @ 12 to 24 volts
Dimensions	Approximately: 20 cm x 26 cm x10 cm



## Detection Levels and Precision for Wear and Contamination Elements in Oil<sup>(a)</sup>

Element	Z	Detection Limit	Typical Caution <sup>(b)</sup>	Element	Z	Detection Limit	Typical Caution <sup>(b)</sup>
Chromium	24	1-3 ppm	40 ppm	Zinc	30	1-3 ppm	25 ppm
Copper	29	5-10 ppm	35 ppm	Tin	50	10 ppm	40 ppm
Iron	26	1-3 ppm	50 ppm	Molybdenum	42	3-5 ppm	(additive)
Nickel	28	5-10 ppm	50 ppm	Titanium	22	3-5 ppm	10 ppm
Lead	82	1-3 ppm	50 ppm	Vanadium	23	5-10 ppm	(additive)
Silver <sup>(c)</sup>	47	1-3 ppm	05 ppm	Antimony	51	1-3 ppm	10 ppm

- (a) 15 mCi <sup>109</sup>Cd source for 3 years unless otherwise specified  
 (b) Typical limits for large industrial diesel engines, or gas turbines  
 (c) Requires <sup>241</sup>Americium source (see specifications below)

## Infrared Analysis Module

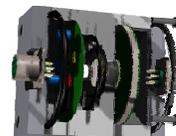
### Non-dispersive infra-red module description and specifications

Parameter	Description or Specification
Spectrum / Bandwidth	4 or 6 channels: 0.8 and 12 microns, longer wavelengths optional
Typical Performance	0.8 microns +/- 0.4% 2.9 microns +/- 0.013% 5.7 microns +/- 0.23% 6-9 microns +/- 0.62%
(Precision by band: average % error)	
Operating Temp.	5 to 40 degrees C
Packaging	Extruded anodized aluminum with integral passive heat exchanger
Power Requirements	80-440 VAC, 45 Watts 12-80 VDC, 45 Watts
Weight (Standard)	6.5 kg
Dimensions	4 channel: 25.4 x 25.4 x 10.0 cm 6 channel: 25.4 x 25.4 x 13 cm
Manufacturing Quality Program	Manufactured and tested under the quality assurance standards of ASME NQA-1 and ANSI Z-540. All calibrated components certified traceable to standards of the National Institute for Standards and Technology.

## Viscometer

### Miniature Viscometer Specifications

Parameter	Specification Value
Oil Flow Range:	Overall: 10 to 100 cc/min: Nominal: 40 to 60 cc/min
Inlet Temperature Range:	180 to 220F
Inlet Pressure Range:	50 to 120PSIG
Measurement Range	Set at factory +/- 10% of center value
Measurement Precision:	0.1cSt (+/- 1% for repeated measures)



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