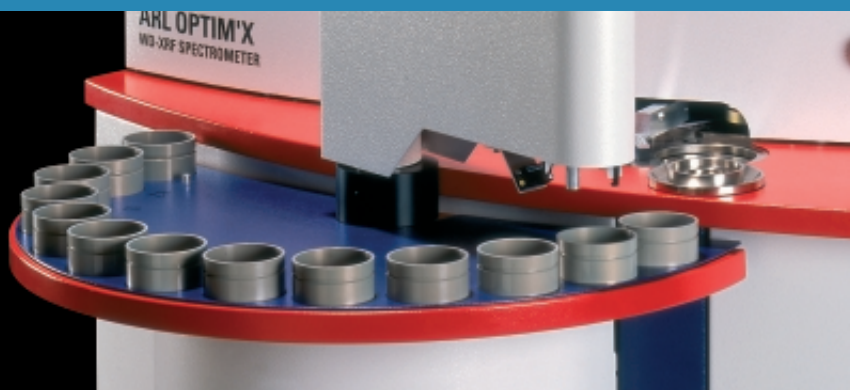


ARL OPTIM'X
X-Ray Fluorescence Spectrometer



Optimized Performance for Your Application

ARL OPTIM'X

Optimized Performance for your Application.

The wavelength dispersive X-ray fluorescence (WDXRF) technique is one of the most versatile analytical methods for the chemical analysis of solids and liquids. Elements from beryllium to uranium can be analyzed in a wide variety of samples with accuracy, precision and reliability. The technique and the analytical methods are mature enough to establish clear qualitative and quantitative characterization of diversified materials. Modern technological developments have helped to include WDXRF into reference methods for analytical laboratories (ASTM and ISO norms for example) by virtue of their simplicity, flexibility, affordability and reliability. The cost per analysis is clearly advantageous over many traditional wet chemical and other spectroscopic methods.

A compact and independent WDXRF instrument

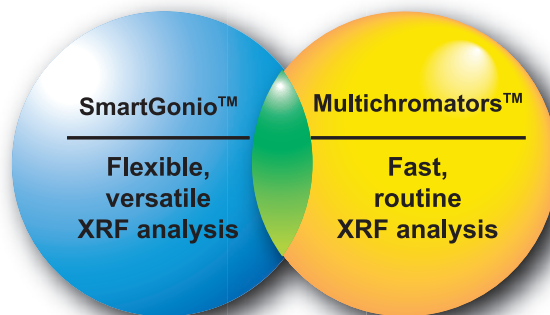
Continuing its tradition of innovation and leadership in WDXRF, Thermo Electron Corporation presents a new compact instrument, the ARL OPTIM'X, with the following salient analytical features:

- Unique WDXRF platform with sequential and/or simultaneous capabilities
- Element coverage from fluorine to uranium, depending on configuration
- Closely coupled optics for increased intensity (210% higher than conventional geometry)
- Multichromators™ for fast analysis;
- Unique compact SmartGonio™ for sequential analysis
- Sequential-simultaneous configuration blending speed to analytical flexibility
- High precision (short term and long term repeatability) thanks to temperature regulation of spectrometer and crystals
- Superior spectral resolution from low Z elements to heavy elements (~15 eV at $\text{CaK}\alpha$)

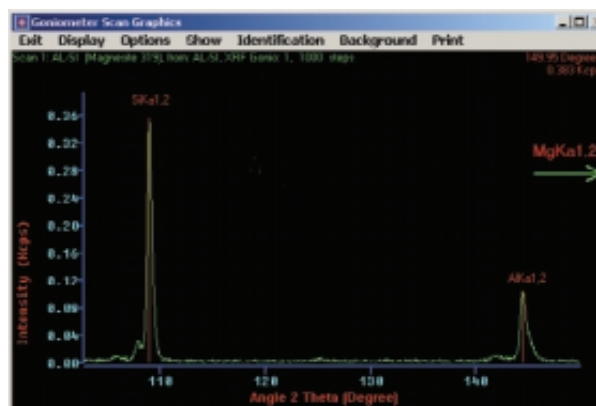
- Optimum configuration for specific applications with simplified operation (ISO or ASTM standards compliance)
- Stand alone and autonomous operation without water cooling
- No gas supply required (depending on the configuration)
- Direct and simple introduction of the sample
- Automatic analysis of batches with sample changer
- Small footprint.

Configuration for speed and flexibility

- Up to 8 elements simultaneously using 4 Multichromators™
- Sequential analysis with the SmartGonio™
- Sequential-simultaneous analysis: SmartGonio™ and 2 elements simultaneously on one Multichromator™



Configuration selected according to application needs



Excellent resolution: Si and Al peaks are free from any interference despite the presence of 55% of Mg in this magnesite sample

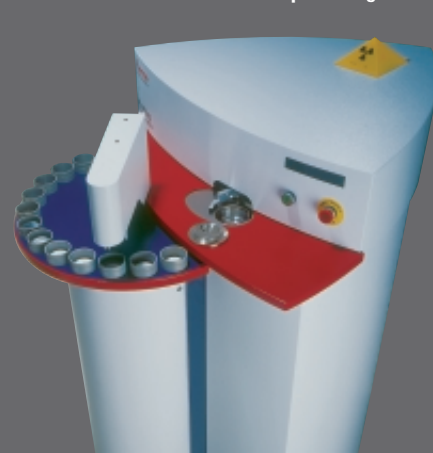
Cassettes for manual loading of solids



Cells for liquids and loose powder analysis



ARL OPTIM'X with its sample changer



Fast qualitative analysis

When a SmartGonio™ is fitted, two forms of digital scanning are available. Step scanning provides precise definition of peaks with a resolution of 0.001°. For rapid qualitative analysis, continuous digital scanning allows fast acquisition of spectra at speeds up to 320°/min. Peaks identification is automatic.

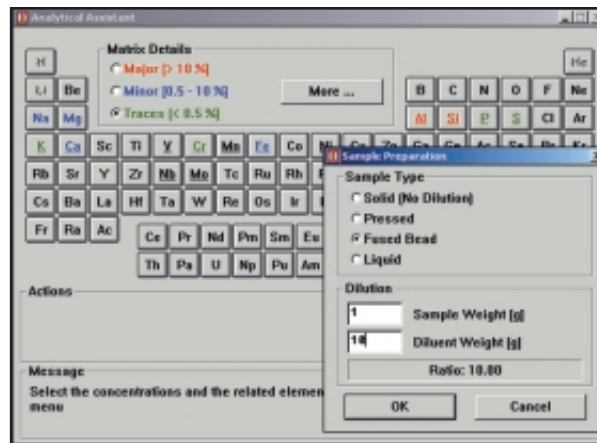
Quantitative analysis made easy

Analytical programs and calibrations are defined with the help of the on-line Analytical Assistant. Calibration curves are built using the multi-variable regression (MVR) program.

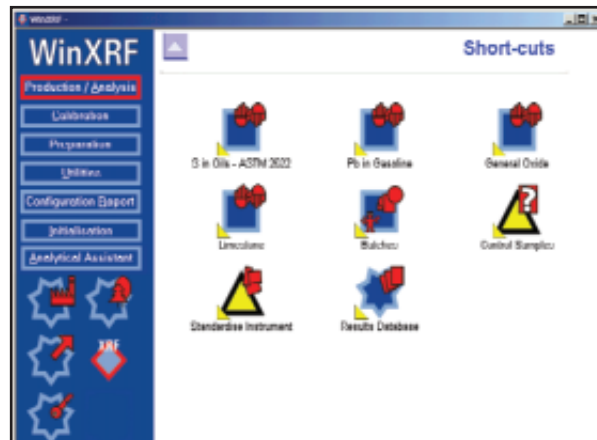
Correction models serve to minimize the influence of interfering elements in multicomponent matrices and to achieve better accuracy of analysis. These models are:

- Line overlap correction
- Additive correction on intensities
- Additive correction on concentrations
- Lucas-Tooth: Multiplicative correction on intensities
- Lachance-Trail: Multiplicative correction on concentrations
- Lachance-Trail+/Lachance-Trail AC: Multiplicative and additive corrections on concentrations
- Comprehensive Lachance (COLA) with 3 term alphas to be used with the optional NBSGSC fundamental parameters program, which can simulate analytical calibrations for homogeneous materials. Interelement correction factors (theoretical alphas) are calculated and used as known coefficients in the MVR. This minimizes the number of standards necessary to produce calibrations and improves the accuracy of analysis.

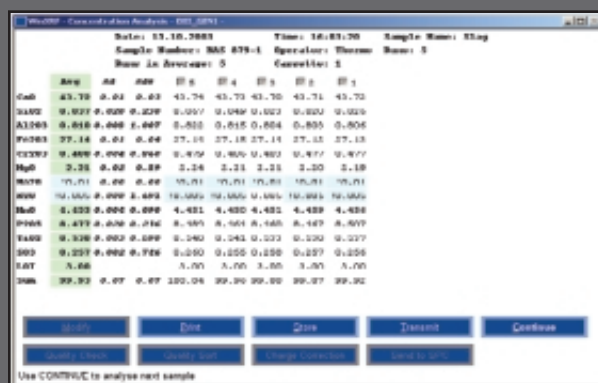
In addition, ex-works calibrations can be delivered for various materials such as various oxides through the General Oxide calibration, several metal matrices, ferro-alloys and others for which analytical specifications are available on request.



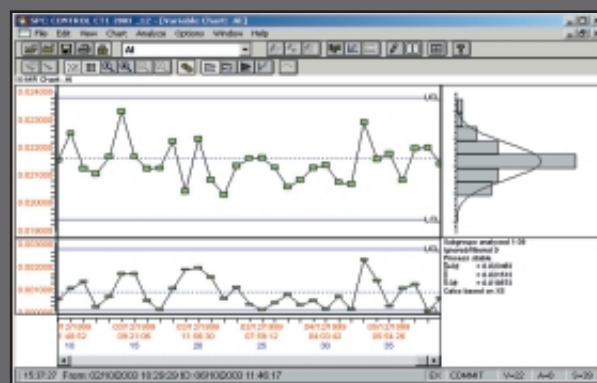
The Analytical Assistant helps definition of analytical programs, calibrations and instrument use



Easy navigation and comfortable operation



Quantitative analysis - Typical results presentation with flagged values



Statistical Process Control - Typical screen

Optimized for specific applications

- Petrochemical industry – analysis of S (ISO 14596 or ASTM D2622), Pb (ASTM D5059) or other elements in gasoline and oils

The calibration curve for sulfur in oils and gasoline can be easily obtained for concentrations ranging from ppm levels up to 5% (see Fig. 1). The excellent limit of detection of 1.4 ppm in 100s (or 1 ppm in 200s) is achieved. This good result is proved by the reproducibility test shown in Table 1. Separate Application Notes XRF-701 and XRF-706 give additional details

- Major and minor oxides in raw materials such as limestone, sand, feldspar, bauxite, magnesite and other mining applications as well as clinker and raw meal. The ARL OPTIM'X shows excellent repeatability of analysis for such types of materials (see Table 2).

As the calibration curve (Fig. 2) proves, the analysis of Na can be carried out without problem either with the SmartGonio™ or with a fixed channel. Additional data can be found in separate Application Notes XRF-702 and XRF-705

- Major and minor oxides in products such as sanitary ceramics, refractories, slags and sinters (more details in separate Application Notes XRF-703 and XRF-704)
- Glass, paints, paper, ferro-alloys, silicon, metal sheets and other products where a few major and minor elements need to be monitored
- Food industry for major and minor nutrients and other regulated elements. Typical concentration ranges and the excellent limits of detection in milk powders are listed in Table 3 below

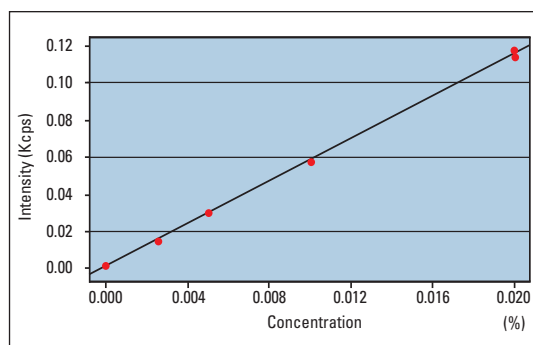


Fig. 1: Calibration curve for S in oils and gasoline (zoom on the low concentration level range)

Sample	25ppm	100ppm
Cell 1	25.4	100.6
Cell 2	25.7	100.7
Cell 3	26.4	101.8
Cell 4	26	102.3
Cell 5	25	98.4
Cell 6	25.9	100.5
Cell 7	26.7	101.5
Average	25.9	100.8
Std. Dev.	0.58	1.27

Table 1: Excellent reproducibility obtained for analysis of sulfur in oils (120s)

Run nr	Al ₂ O ₃	CaO	Fe ₂ O ₃	K ₂ O	MgO	P ₂ O ₅	SO ₃	SiO ₂
1	0.329	50.41	0.303	0.116	2.76	0.014	0.036	2.68
2	0.328	50.44	0.303	0.117	2.77	0.015	0.036	2.68
3	0.328	50.45	0.304	0.116	2.74	0.014	0.036	2.68
4	0.324	50.41	0.305	0.117	2.76	0.014	0.036	2.69
5	0.326	50.36	0.301	0.117	2.75	0.014	0.036	2.68
6	0.327	50.38	0.301	0.116	2.74	0.014	0.035	2.69
7	0.327	50.41	0.302	0.116	2.74	0.014	0.036	2.68
AVG	0.327	50.41	0.303	0.116	2.75	0.014	0.036	2.68
Sd.Dev.	0.0015	0.029	0.0014	0.0005	0.011	0.0003	0.0003	0.005

Table 2: Repeatability test for a limestone sample (pressed powder, 100 s counting time)

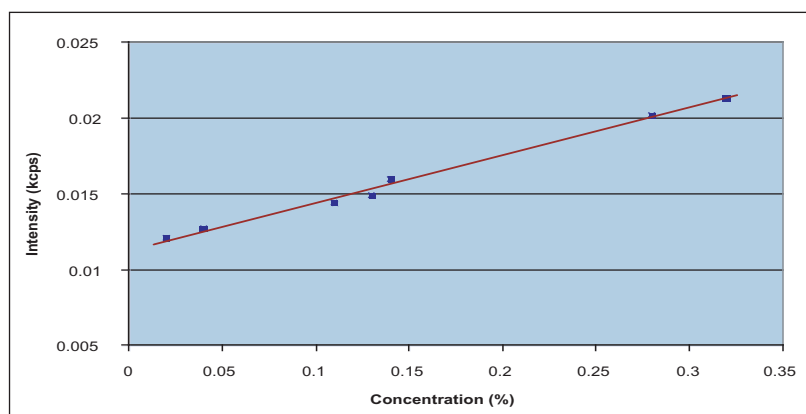


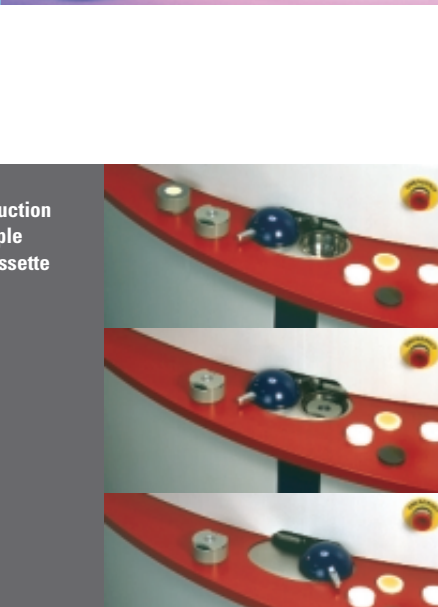
Fig. 2: Calibration curve for Na using fusion beads of oxides. Standard error of estimate is 0.011% in a range from 0.02% to 0.32%

Table 3: Limits of detection (LoD) in milk powders prepared as pressed pellets (*cumulated counting time of SmartGonio™ for Na and Mg)

Element	Analytical device	Typical ranges	LoD (ppm in 60s)
Na	Fixed channel	0 – 0.03 %	20 ppm*
Mg	Fixed channel	0 – 0.12 %	11 ppm*
P	SmartGonio™	0 – 1.1 %	4.4 ppm
K	SmartGonio™	0 – 1 %	2 ppm
Ca	SmartGonio™	0 – 1.6 %	10 ppm
Fe	SmartGonio™	0 – 0.33 %	2.1 ppm
Cu	SmartGonio™	0 – 0.012 %	0.6 ppm
Zn	SmartGonio™	0 – 0.2 %	2 ppm
Cl	SmartGonio™	0 – 0.48 %	10 ppm
Mn	SmartGonio™	0 – 0.0023 %	1.2 ppm
Se	SmartGonio™	0 – 3.4 ppm	0.24 ppm



LARGE VARIETY OF SAMPLES
 Many different types of samples can be analyzed on the ARL OPTIM'X: conductive or non-conductive solids, liquids, loose powders, pressed pellets, fusion beads, pastes. However the instrument configuration is optimized for your specific application.



Manual introduction
 of a solid sample
 placed in a cassette

Data Handling: WinXRF

Designed for Windows® XP Professional,
the comprehensive and user-friendly
WinXRF analytical software supports
spectrometer operation and data handling.

Some of its salient features are:

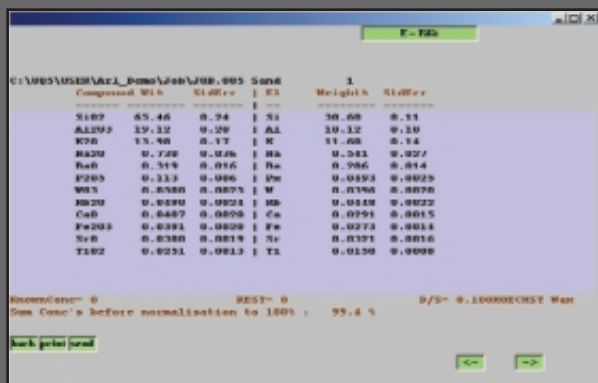
- Graphical user interface featuring navigation, operation and display through HTML pages using Internet Explorer®
- Analytical Assistant helping the operator in defining analytical programs, calibrations and basic operations of the instrument
- Simple routine analysis mode through hot key operation or software shortcuts leading to analysis method templates
- Unattended use through batch commands and sequences
- Correction for curved background
- Variable counting time on peak and background positions
- Automatic choice of analytical program according to the intensity or concentration response
- Type standardization to reach ultimate analytical accuracy
- User-defined result presentation with abnormal values marked with flag and color
- Quality check & quality sort
- Editing and validation of results with audit trail protected by password
- Recalculation of concentration results for verification or update purpose, saves analysis time
- Fast and accurate calibration curve determination through multi-variable regression (MVR) facility
- Post-processing functions performed while the instrument is analyzing, e.g. results storage and retrieval or statistics and export (e.g. to Excel spreadsheet)
- SPC-Basic: instrument control with on-line integrated SPC (Statistical Process Control) package

- Audit trail of drift correction, type standardization update and calibration changes
- Monitoring and logging of instrument alarms and status with graphical display tools
- Password protection with up to 8 different access levels
- Remote diagnostics through modem connection.

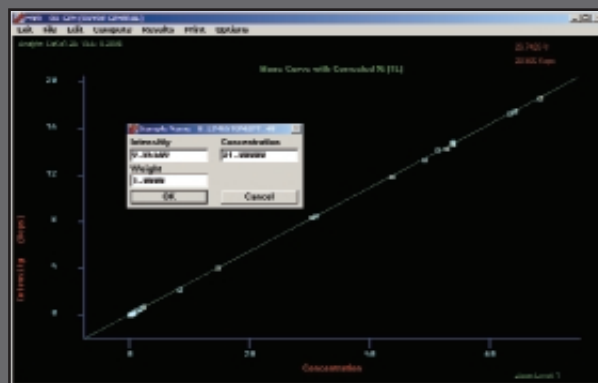
Main software options

- **ARLnet:** Package of results transmission solutions via LAN Local Area Network to up to 18 destinations. Includes among others: TCP/IP computer task – to – computer task transmission, Netfile transmission of results to files on local or network disks and printing on network printers
- **Compac:** transmission of results to up to 5 computers via serial lines
- **Remote:** remote display of results to up to 8 remote printers or terminals via serial lines
- **NBSGSC:** program for theoretical alphas generation
- **Charge correction:** Calculation of furnace charge additions
- **Metaverage:** Average of sample analyses according to pre-configured schemes
- **SPC-Full:** integrated Statistical Process Control software for instrument quality assurance and production process control. Fully on-line (bi-directional) with automatic evaluation and SPC test result feedback to the operator
- **Printing of reports of stored analytical results** according to a variety of Thermo Electron or user defined formats
- **Remote Sample Definition:** Reception of sample identification and analysis parameters from third party application software (e.g. ARL ARMS or process computer)
- **Sentry:** allows a simplified sample registration including bar code support and powerful sample batch entry capabilities

- OEM Mode: connection to an external process computer for automation purposes
- Translation of WinXRF texts into any language supported by Windows® XP Professional
- OptiQuant™: Adaptation of the renowned UniQuant® package to the ARL OPTIM'X spectrometer. OptiQuant™ provides "standardless" analysis for up to 73 elements when specific standards are not available, or when samples can only be obtained in small quantities or as irregular shapes. Additionally OptiQuant™ calculates the balance of unanalyzed elements present in the sample, e.g. organic and ultralight elements. The OptiQuant™ optional package is fully calibrated and pre-installed in the factory using two fixed channels for Na and Mg and the SmartGonio™. Hence it is ready to be used right after installation of the instrument at the customer's site. Stable samples for setting-up and maintenance over time are included.



« Standardless » analysis through OptiQuant™

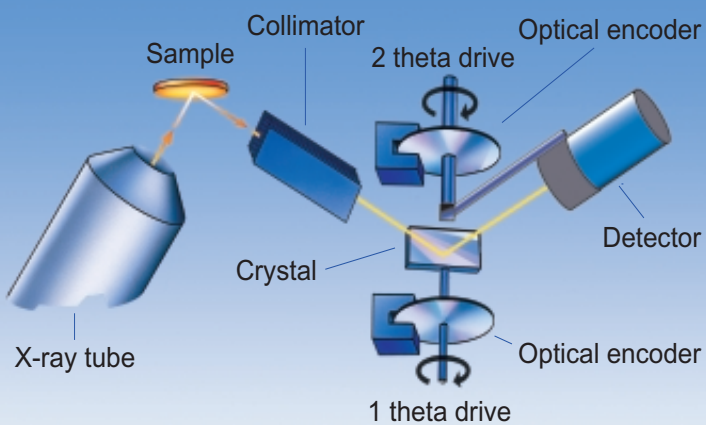


MVR calibration curve: real concentrations vs. intensities



Exclusive SmartGonio™

- Quantitative analysis of any element from F to Fe or Al to Zn (with one detector fitted)
- Quantitative analysis of any element from Al to U (with two detectors fitted)
- Angular positioning to ensure $\theta / 2\theta$ relationship between crystal and detector is achieved through Moiré fringe optical encoders:
 - no friction
 - no wear with time!
- Temperature regulation of crystals for best analytical stability
- Closest coupling with X-ray tube provides optimized sensitivity



SmartGonio™
principle of
operation

Specifications for the ARL OPTIM'X

Element range	Fluorine (Z=9) to uranium(Z=92)
Spectrometer environment	Vacuum or air for solids, helium for liquids and loose powders
Spectrometer design	Analysis devices contained in a vacuum chamber made of grey cast iron and temperature controlled
Spectrometer arrangement	X-ray tube inclined at 66° under sample
Spectrometer capacity	Simultaneous configuration: Four Multichromators™ Sim-seq configuration: One SmartGonio™ + one Multichromator™ Each Multichromator™ is composed of two fixed channels
X-ray excitation	Air cooled Rh anode end window tube with thin Be window (0.075 mm). 50 W power providing excitation similar to 200 W thanks to ultra close coupling and large solid angle irradiation. Other anodes available on request. Solid-state high frequency generator of maximum voltage 50 kV and maximum current 2 mA (combinations chosen to be less than 50W). Max. line voltage variation: 230V -15% to +10%. Stability: ± 0.0002% per 1% variation
Multichromator™	Fixed channel using multiple curved crystal optics. Sealed detectors available for all elements from sodium (Z=11). Flow proportional or scintillation detectors also available depending on element. Dual pulse height integration to discriminate and correct for 2nd order peaks. A Multichromator™ is composed of two fixed channels, but some elements can only be fitted as single channel monochromator
SmartGonio™	Fully automatic, gearless, microprocessor controlled compact goniometer using optical encoders. Total angle range: 0°-150° 2θ (Flow proportional counter: 17°-150°, Scintillation counter: 0°-90°). Continuous digital scans: from 0.25°/min to 320°/min
Counting electronics	Multi-channel analyzer to discriminate peaks of higher energies. Digital Automatic Gain Control (AGC) for pulse shrinking correction. Automatic dead time correction ensures linearity of response up to 2 Mcps on flow proportional counter and 1.5 Mcps on scintillation counter
Sample loading	Basic: 1 position for cassette or liquid cell. Optional: 13 position autosampler
Sample holders	Sample cassettes with maximum size of sample: height 26 mm, diameter 52 mm. Liquid cell: height 22 mm, external diameter 40 mm. Exposed opening: 29 mm diameter (basic). Rotation of sample holder in analysis position: 6 to 60 rpm
Dimensions and weight	H 126 cm, W 88 cm, D 82 cm with basic sample changer. System weight: approximately 250 kg
Laboratory information	Optional phone service support through modem connection
Power requirements:	1.5 kVA single phase
Safety standards:	Electrical and protection: IEC 1010-1, IEC 950 Radiation (fully protected system): ORaP (CH) 414.501 and BGB1.I. norms Electro-magnetic immunity: CENELEC EN 50081-2 + EN 50082-2 (industrial)

Thermo Electron Corporation reserves the right to vary these specifications without prior notice

In addition to these offices, Thermo Electron Corporation maintains a network of representative organizations throughout the world.

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