
HEATH & SHERWOOD
HARD ROCK
SOLUTIONS
SINCE 1927
On Stream Analyzer Systems for Mineral Processing
Heath & Sherwood
The legend continues

Introduction – Topics To Cover

- Why are OSA Systems required
- Sampling Systems required for Analyzers
- OSA System Overview
- What is XRF
- Radiation Safety
- The BOXA-II
- BOXA Benefits and Advantages
- Next Generation – BOXA-III
- Benefits of OSA Systems
- Some $ Numbers

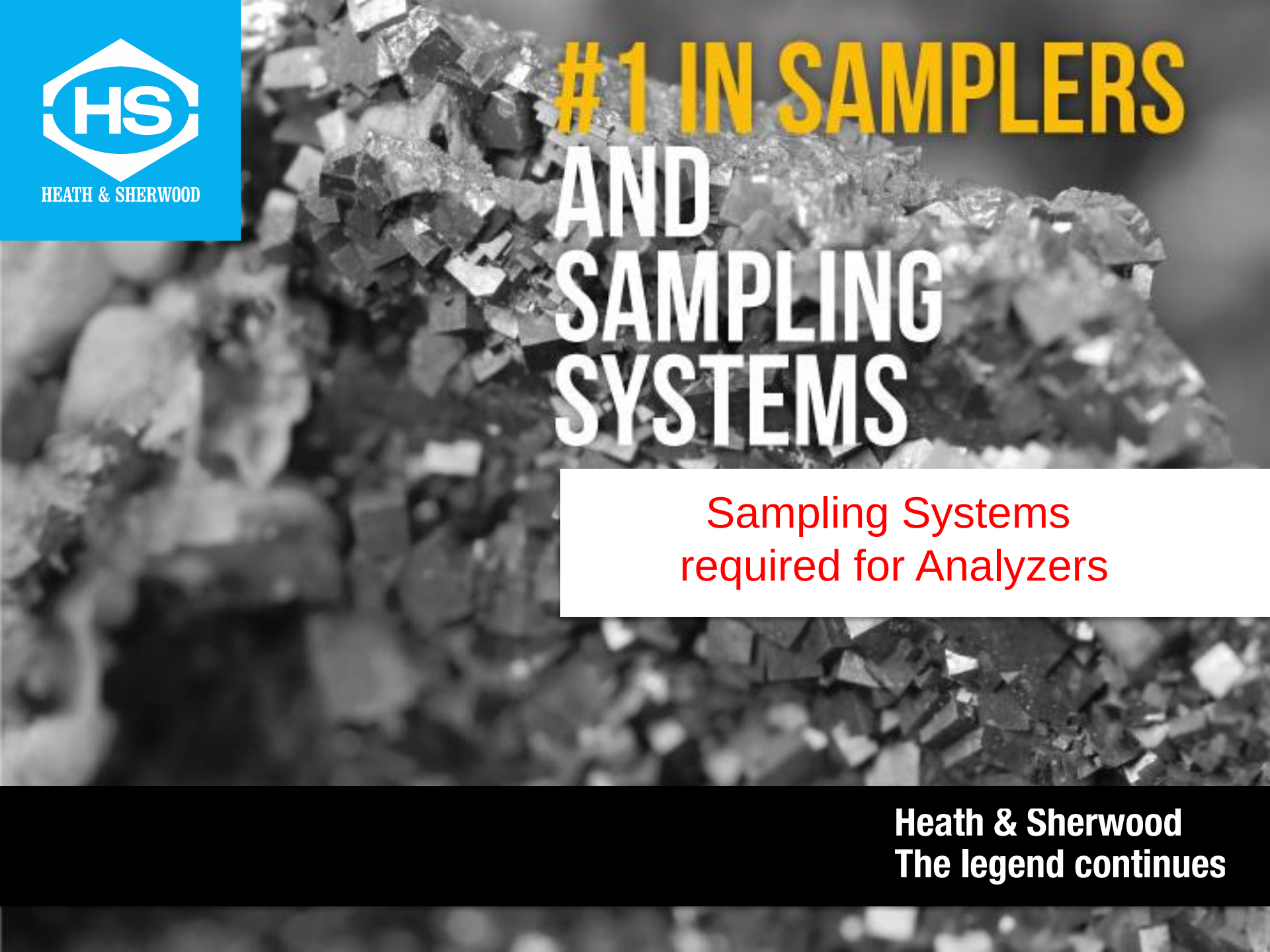

HS
HEATH & SHERWOOD
SHOULDER TO SHOULDER, SOLVING PROBLEMS
Heath & Sherwood
The legend continues

Why are OSA Systems required

- Mineral Processing industry processes ore
- Ore contains metals of interest (Cu, Zn, Ag, …)
- Ore is upgrade to a concentrate in several stages, different circuits
- Each stage requires precise control to maximize a plants profitability (grade vs recovery)
- XRF measures element content (%Cu, %Zn, Ag ppm, …) at different stages which is used for process control

Why are analysis's required

- To control grade and recovery in a flotation circuit (Quality Control)
  - Grade – is the total element content in a sample (feed, conc., tails)
  - Recovery - % of element recovered from the ore
- Some flotation control parameters
  - Assay based control can be implemented for plant optimization
  - Air addition and level controls on flotation cells
  - pH (acidity) of the slurry
  - Density of slurry
  - Amount of flotation chemicals, collectors, frothers, etc.

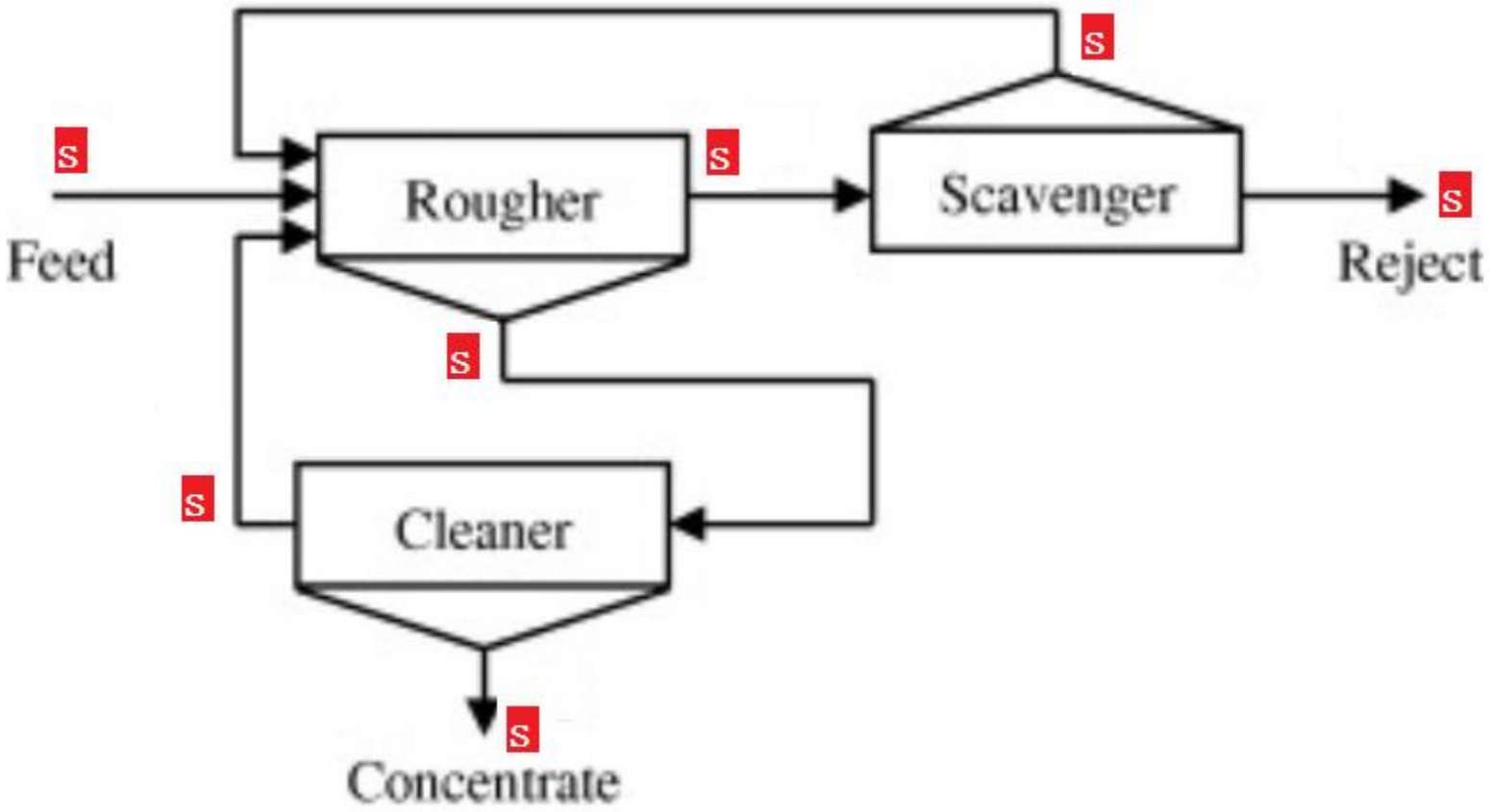


HEATH & SHERWOOD

Sampling Systems required for Analyzers

Heath & Sherwood
The legend continues

Sampling Points



Heath & Sherwood
The legend continues

Decide Type the of Samplers Required

- **Metallurgical Samplers**
  - Metallurgical reconciliation (Feed, Concentrate, Tails)
  - Requires samples that represent actual metal grades
  - Composite samples for laboratory analysis
- **Process Control Samplers**
  - Concentrate and tailings of each stage of the flotation process
  - Requires sampling to verify tendencies in the process
  - Important for maximizing metal recovery
  - Feed for On Stream (OSA) and Particle Size (PSM) Analyzers
  - Requires 8 to 12 m^3/ hr continuous sample
- **IMPORTANT NOTE**
  - Metallurgical Samplers can be used for Process Control but NOT VISA VERSA

Process Control Samplers -Bias Note

- **Process Control Samplers**
  - These kinds of samplers contain a bias
  - This bias changes over time due to changes in feed tonnages, particle size, densities, flow rates, pressure, etc.
  - There can also be a constant bias plus a fluctuating bias
- **NOTE OF INTEREST**
  - There was paper (Measurement Issues In Quality “Control”) presented by Brian Flintoff in1992 at a CMP conference which stated: “Clearly, no bias can be accepted” as it pertains to OSA composition measurements
  - If the sample feed to the OSA is biased, the result is biased!!!
  - Not sure where the idea of PCS came from!

Allowing that the scenario described above is reasonable, and in particular the grade (~±1%) and recovery (~±0.5%) changes could be typical, it is possible to comment on the allowable noise in the OSA composition measurements. Clearly, no bias can be accepted (a most difficult condition to meet in view of matrix, particle size and pulp density effects).

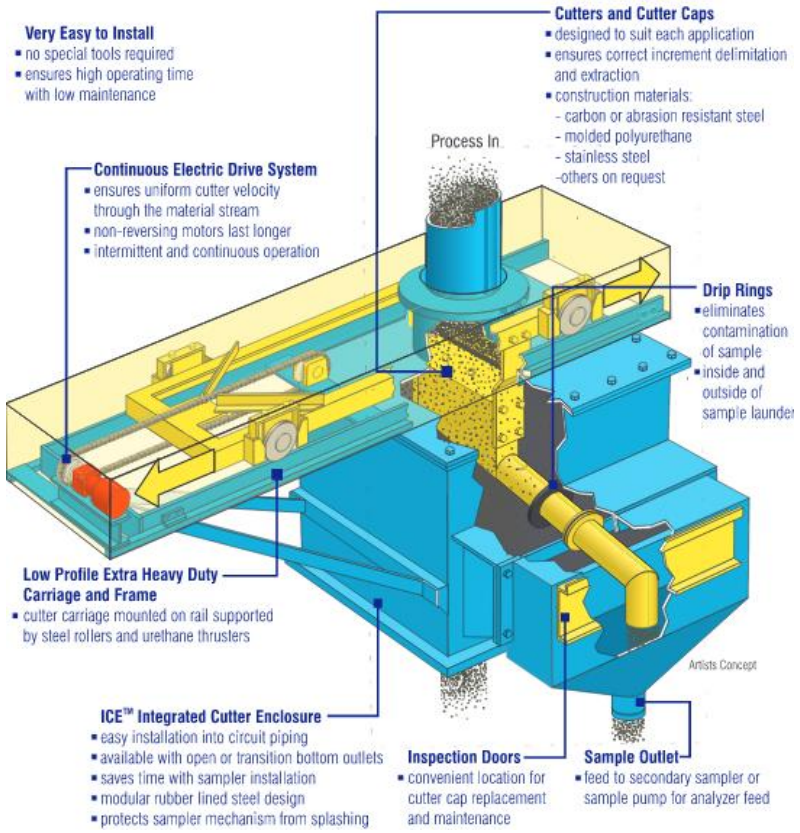
Decide Type the of Samplers Required

- **Proper sampling engineering is required ensure samples are readily available to the OSA and are representative**
- **Sampling systems require periodic maintenance**
- **Sampler cutters can get plugged**
- **Sampling lines and pumps can sand out**
- **These factors affect the OSA and it's assay availability**

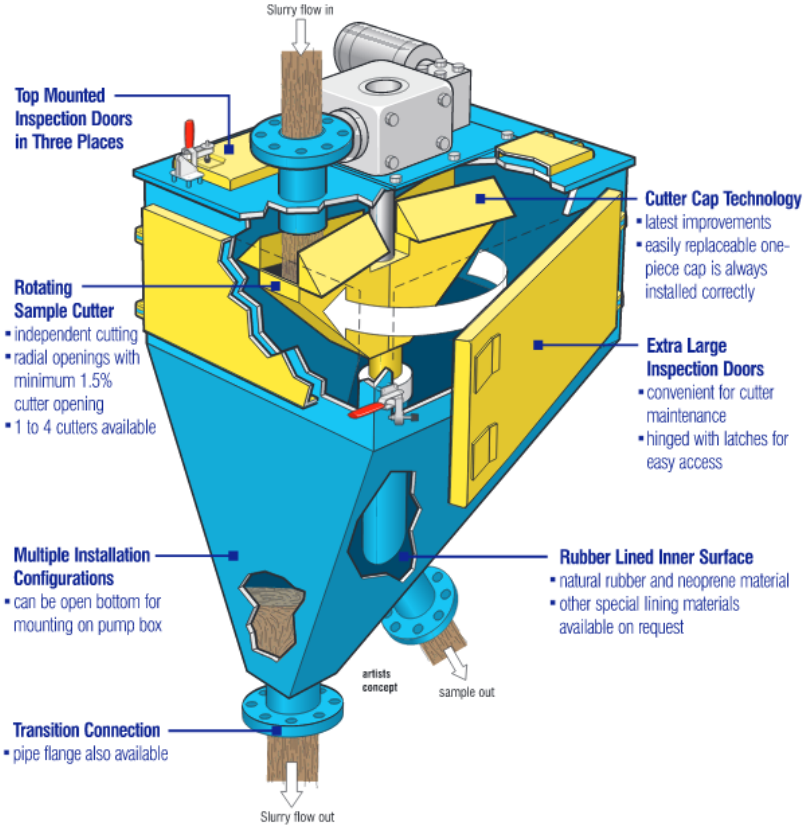
Metallurgical Samplers

They cut completely across the stream

Linear Sampler



Rotary Vezin

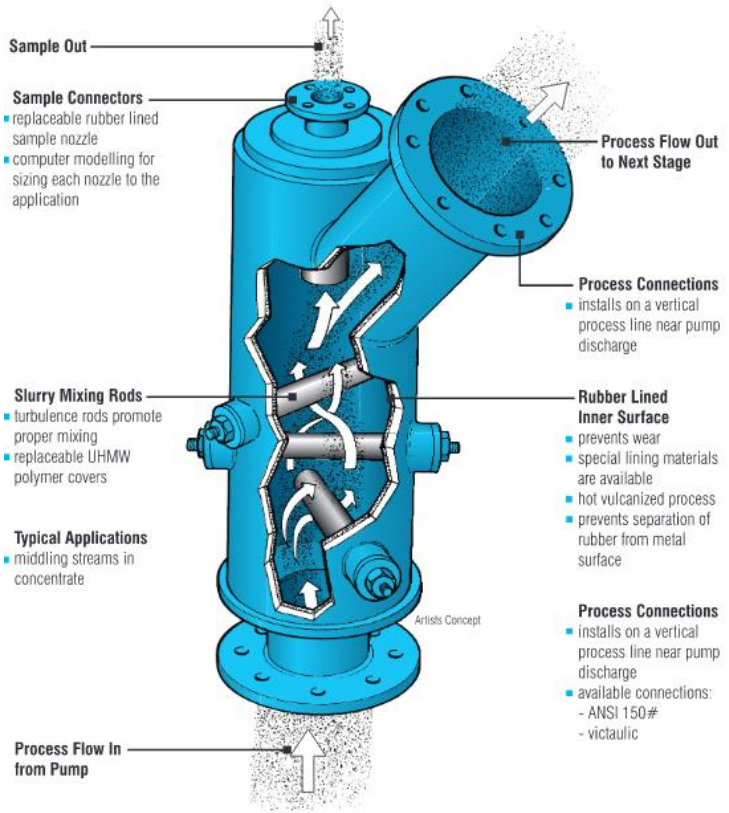


Heath & Sherwood
The legend continues

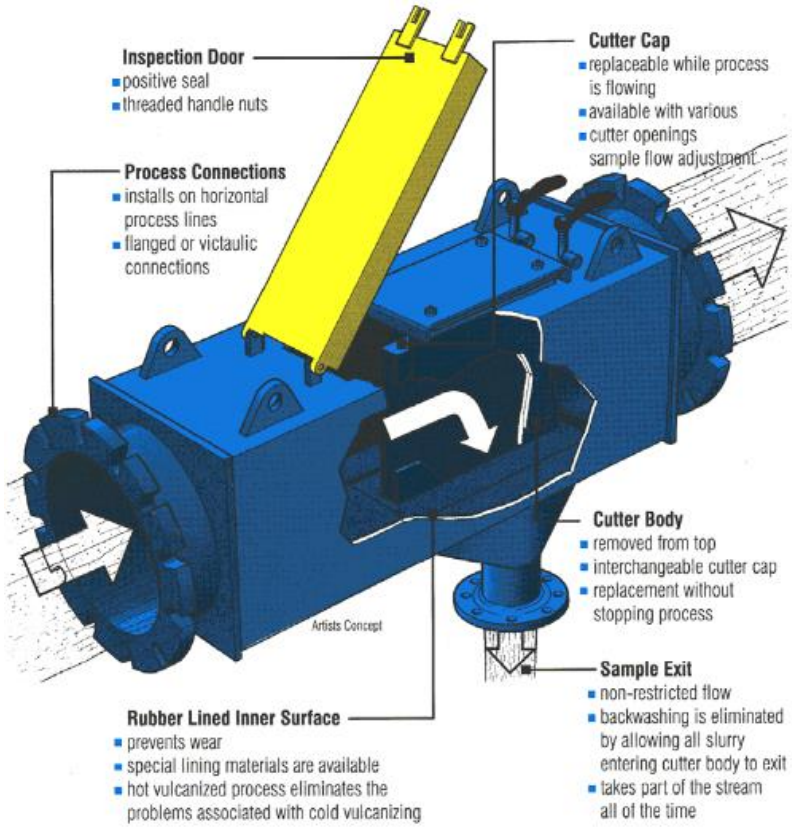
Process Control Samplers

Thief cutters

Pressure Pipe Sampler



Gravity Flow Sampler

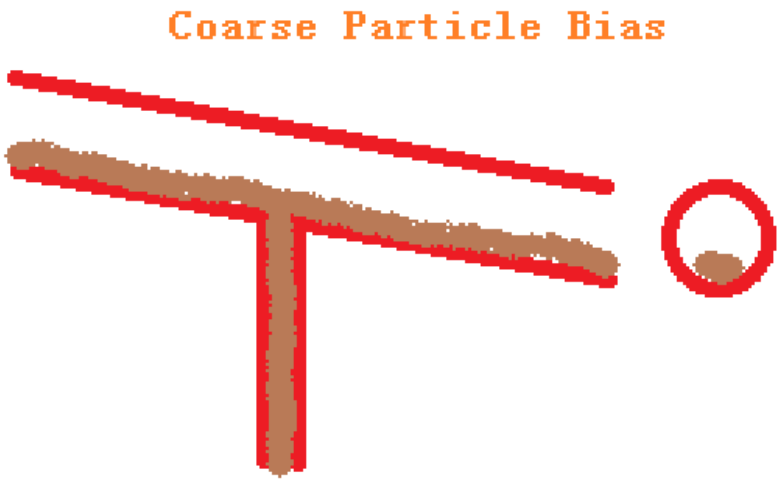


Heath & Sherwood
The legend continues

Poor Samplers

Home Made

- OSA analyzes what it is presented
- Biased samples produce biased assay results
- “Garbage In - Garbage Out”



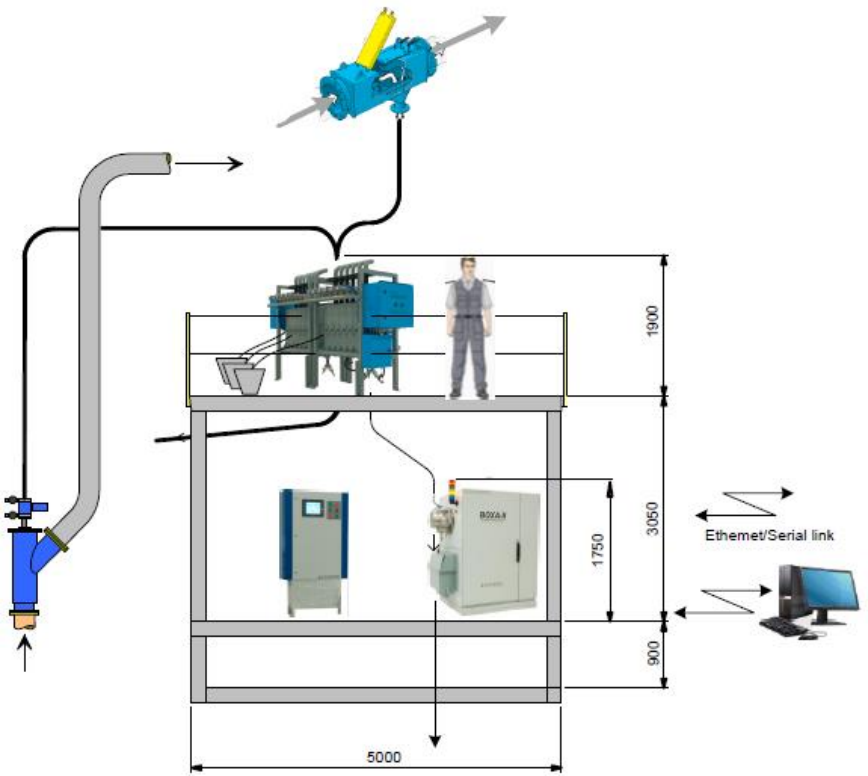
Heath & Sherwood
The legend continues


HEATH & SHERWOOD
ANALYZING MINERALS FOR METAL CONTENT
The BOXA System
Heath & Sherwood
The legend continues

OSA System Overview

Layout

- Samplers provide sample to the MXA's
- Return lines go back to the process
- MXA's direct a single sample to the probe to be measured
- CSA Sampler for calibration
- Assay results generated and sent to plant's DCS and displayed locally

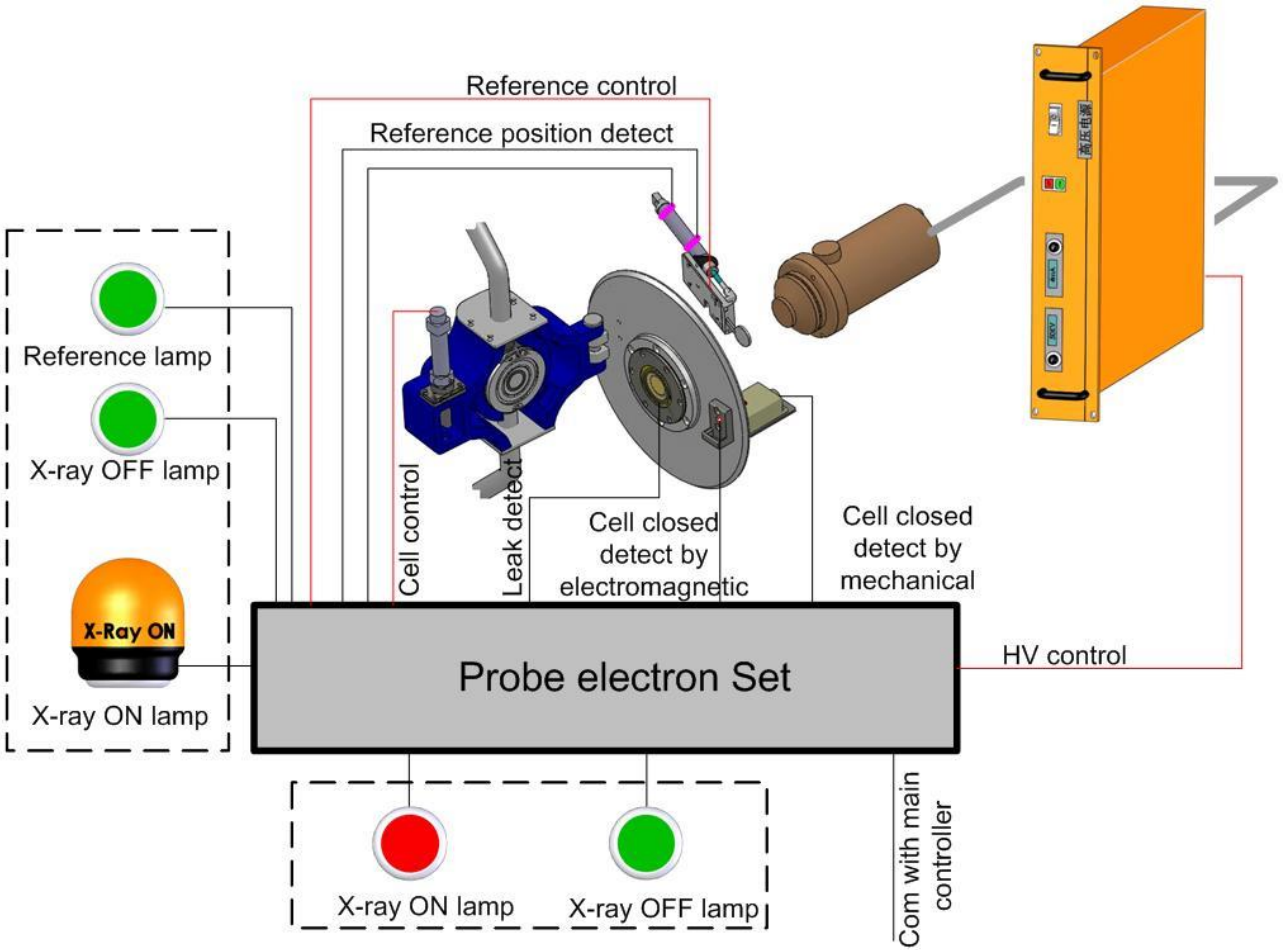


Heath & Sherwood
The legend continues

Interlocking safety

Electromagnetic/Mechanical

Visual Indication

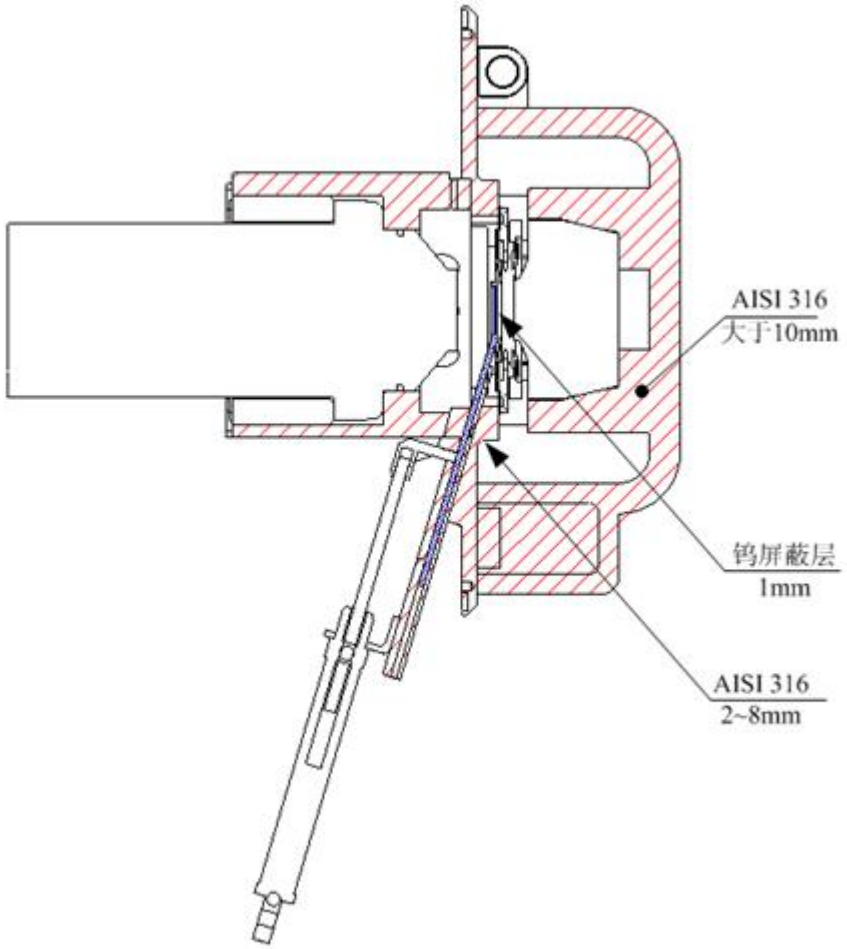


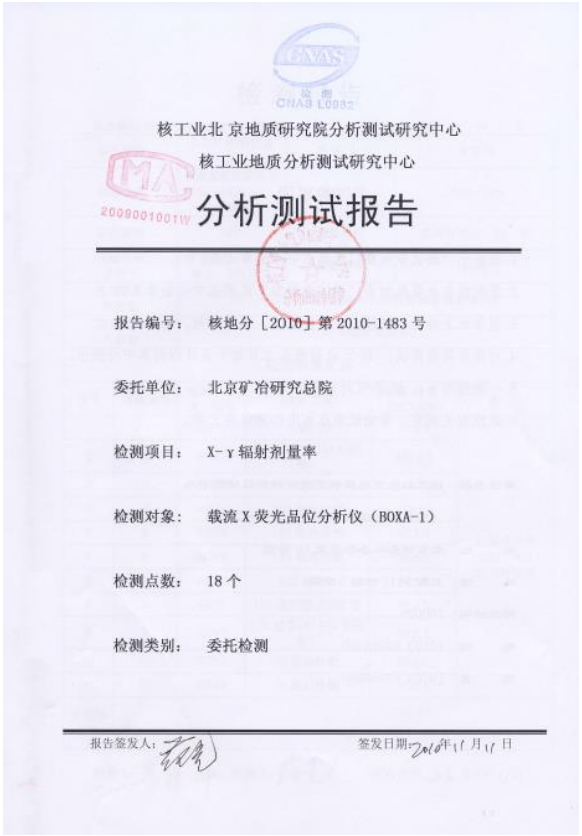
Heath & Sherwood
The legend continues

Radiation safety

Certified By

Radiation Safety Institute of Canada
Institut de radioprotection du Canada





核工业北京地质研究院分析测试研究中心

核工业地质分析测试研究中心

分析测试报告

报告编号： 核地分［2010］第 2010-1483 号

委托单位： 北京矿冶研究总院

检测项目： X-γ辐射剂量率

检测对象： 载流 X 荧光品位分析仪（BOXA-1）

检测点数： 18 个

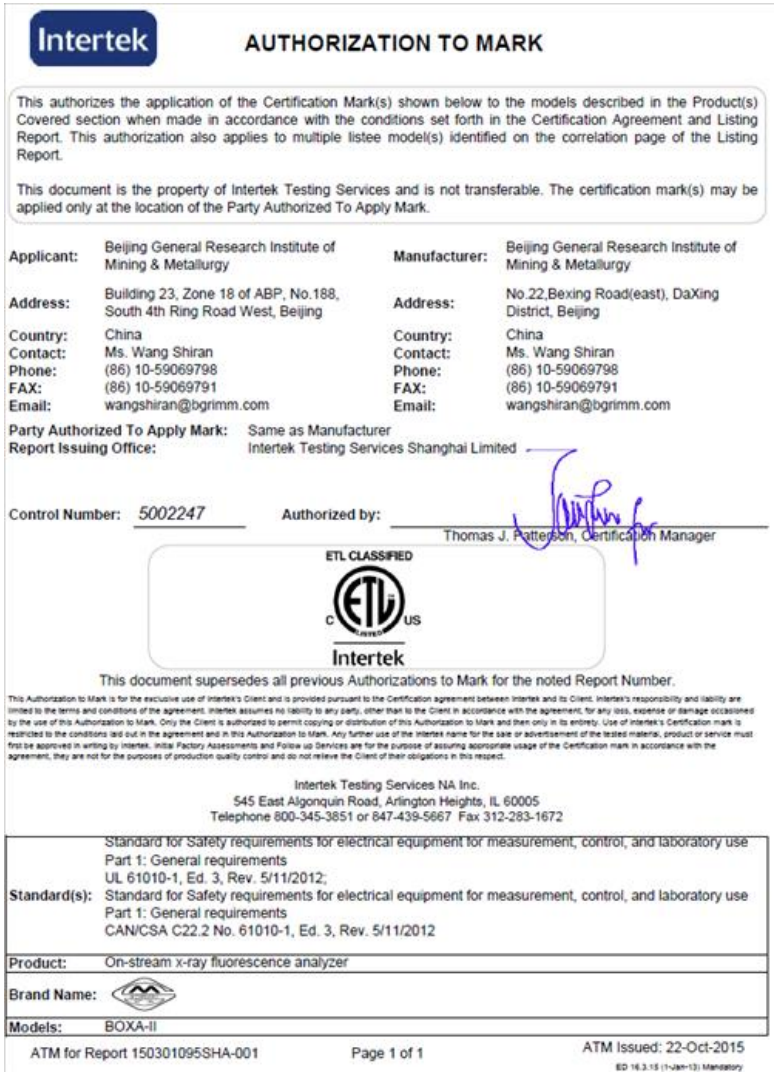
检测类别： 委托检测

报告签发人：

签发日期：2010年11月11日

Heath & Sherwood
The legend continues

Electrical safety



Intertek

AUTHORIZATION TO MARK

This authorizes the application of the Certification Mark(s) shown below to the models described in the Product(s) Covered section when made in accordance with the conditions set forth in the Certification Agreement and Listing Report. This authorization also applies to multiple listee model(s) identified on the correlation page of the Listing Report.

This document is the property of Intertek Testing Services and is not transferable. The certification mark(s) may be applied only at the location of the Party Authorized To Apply Mark.

Applicant:	Beijing General Research Institute of Mining & Metallurgy	**Manufacturer:**	Beijing General Research Institute of Mining & Metallurgy
Address:	Building 23, Zone 18 of ABP, No.188, South 4th Ring Road West, Beijing	**Address:**	No.22,Bexing Road(east), DaXing District, Beijing
Country:	China	**Country:**	China
Contact:	Ms. Wang Shiran	**Contact:**	Ms. Wang Shiran
Phone:	(86) 10-59069798	**Phone:**	(86) 10-59069798
FAX:	(86) 10-59069791	**FAX:**	(86) 10-59069791
Email:	wangshiran@bgrimm.com	**Email:**	wangshiran@bgrimm.com

Party Authorized To Apply Mark: Same as Manufacturer
Report Issuing Office: Intertek Testing Services Shanghai Limited

Control Number: 5002247 **Authorized by:**

Thomas J. Patterson, Certification Manager

ETL CLASSIFIED

Intertek

This document supersedes all previous Authorizations to Mark for the noted Report Number.

This Authorization to Mark is for the exclusive use of Intertek's Client and is provided pursuant to the Certification agreement between Intertek and its Client. Intertek's responsibility and liability are limited to the terms and conditions of the agreement. Intertek assumes no liability to any party, other than to the Client in accordance with the agreement, for any loss, expense or damage occasioned by the use of this Authorization to Mark. Only the Client is authorized to permit copying or distribution of this Authorization to Mark and then only in its entirety. Use of Intertek's Certification mark is restricted to the conditions laid out in the agreement and in this Authorization to Mark. Any further use of the Intertek name for the sale or advertisement of the tested material, product or service must first be approved in writing by Intertek. Initial Factory Assessments and Follow up Services are for the purpose of assuring appropriate usage of the Certification mark in accordance with the agreement, they are not for the purposes of production quality control and do not relieve the Client of their obligations in this respect.

Intertek Testing Services NA Inc.
545 East Algonquin Road, Arlington Heights, IL 60005
Telephone 800-345-3851 or 847-439-5667 Fax 312-283-1672

Standard(s):	Standard for Safety requirements for electrical equipment for measurement, control, and laboratory use Part 1: General requirements UL 61010-1, Ed. 3, Rev. 5/11/2012; Standard for Safety requirements for electrical equipment for measurement, control, and laboratory use Part 1: General requirements CAN/CSA C22.2 No. 61010-1, Ed. 3, Rev. 5/11/2012
Product:	On-stream x-ray fluorescence analyzer
Brand Name:	
Models:	BOXA-II

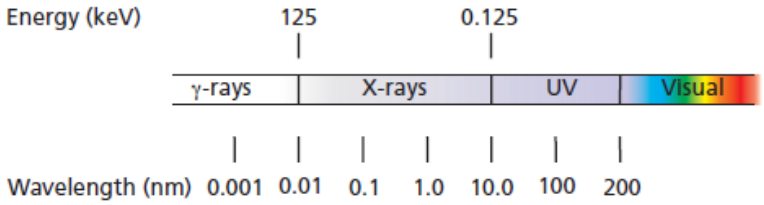
ATM for Report 150301095SHA-001 Page 1 of 1 ATM Issued: 22-Oct-2015

ED 16.3.15 (1-Jan-13) Mandatory

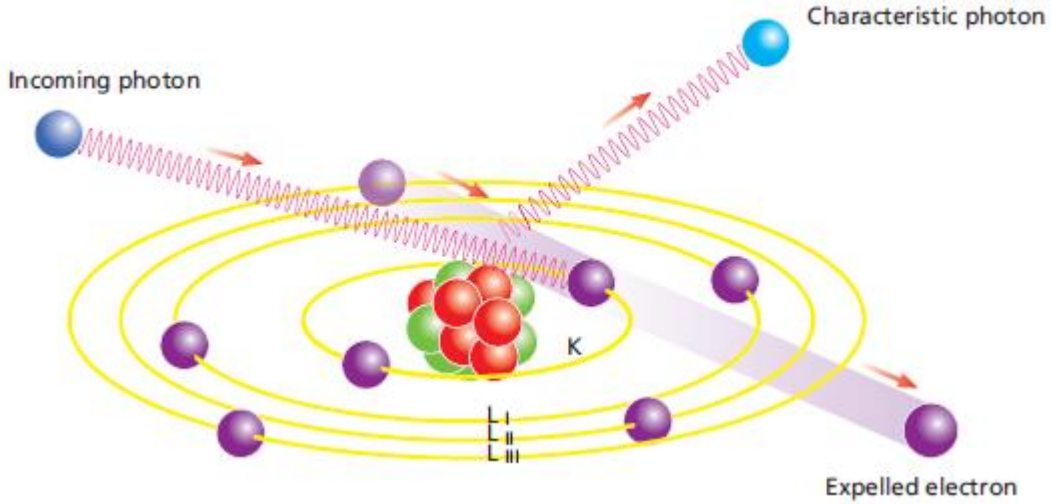
Heath & Sherwood
The legend continues

What is XRF

- X-Rays are part of the electromagnetic spectrum



- They interact with matter – ionizing.



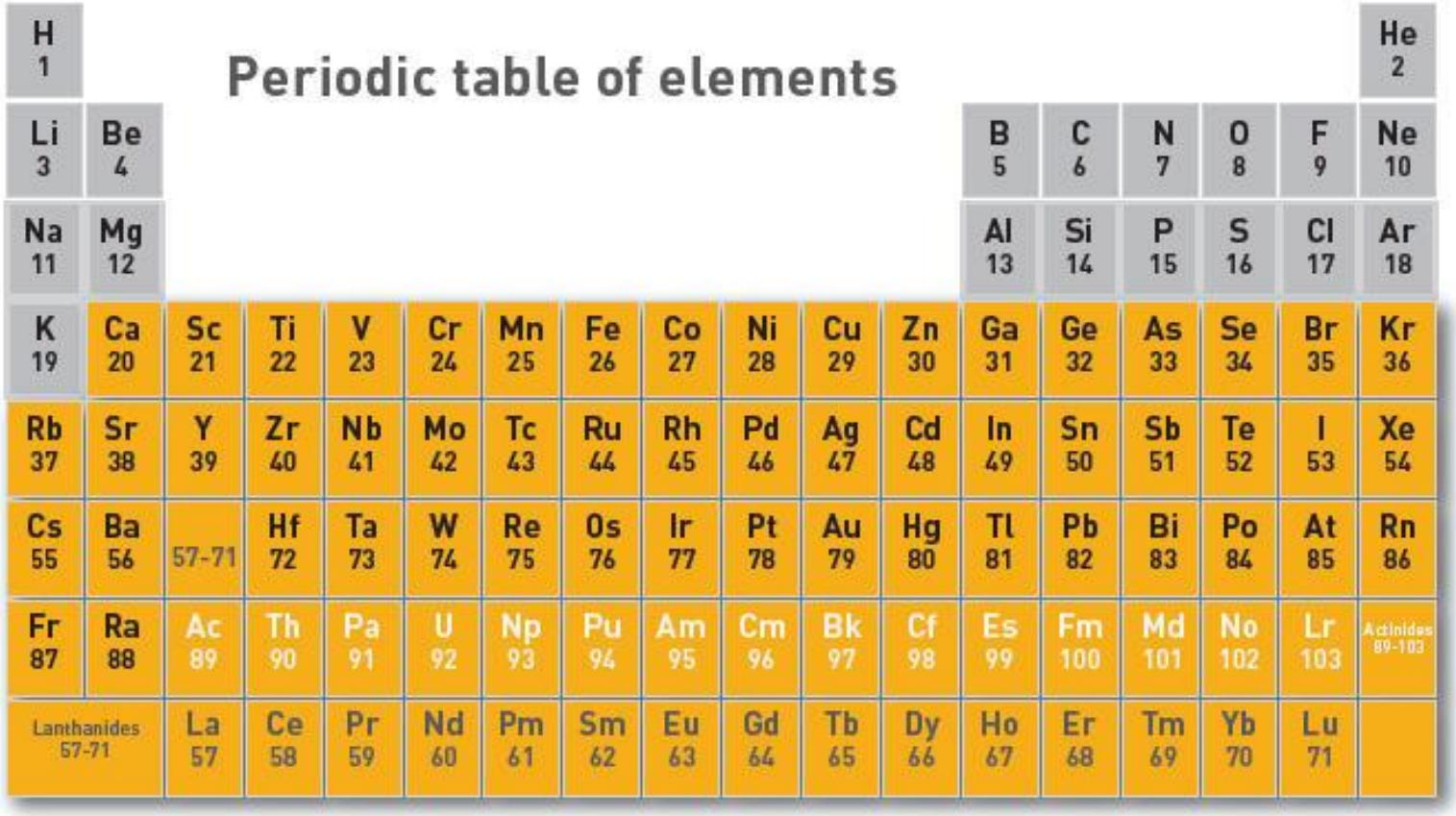
Heath & Sherwood
The legend continues

What is XRF

- The basic principles
  - Excite the characteristic x-rays of the elements
  - Measure their intensities
  - Calculate concentrations from intensities
- The energy (or wavelength) -> the element
  - Each element's (Cu, Zn,…) energy is unique
- The element intensity -> the assay of element
  - The higher the intensity, the greater the % of element
- Equations are derived to calculate assays from intensities. This is called calibration.

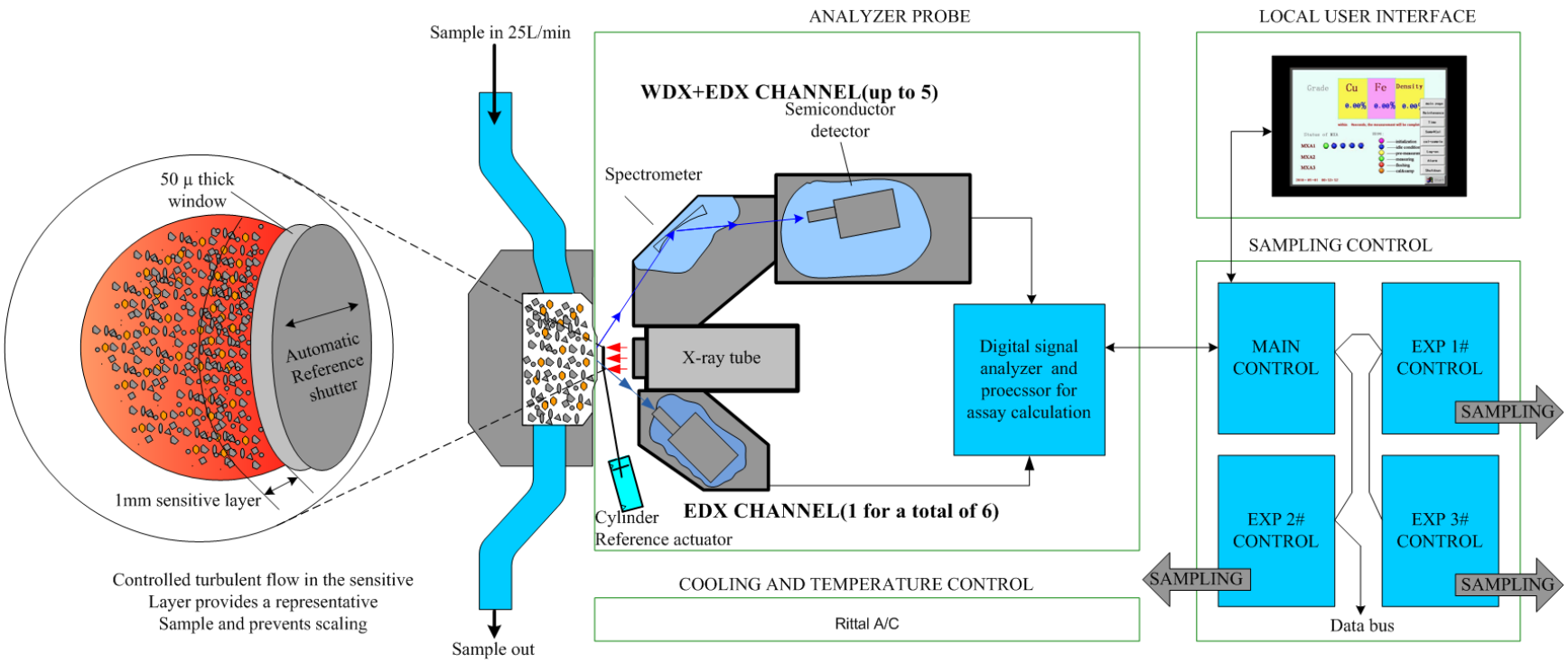
HEATH & SHERWOOD

Measuring Range



Heath & Sherwood
The legend continues

ED & WD Measuring Principle



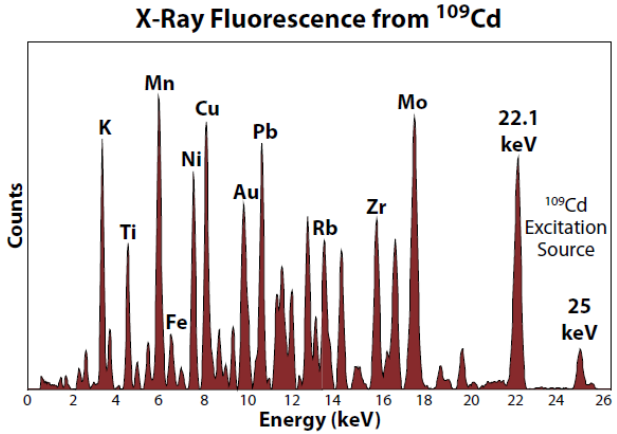
Heath & Sherwood
The legend continues

Amptek Detector

- Compact integrated system
- Used for XRF Instrumentation
- Si-PIN and SDD types used
- 2-stage thermoelectrically cooled
- Energy range 1keV to 40 keV

- Si-PIN resolution 145-260eV FWHM @ 5.9keV
- Si-PIN Maximum count range 200,000 cps

- SDD resolution 125eV FWHM @ 5.9keV
- SDD Maximum count range 100,000 cps

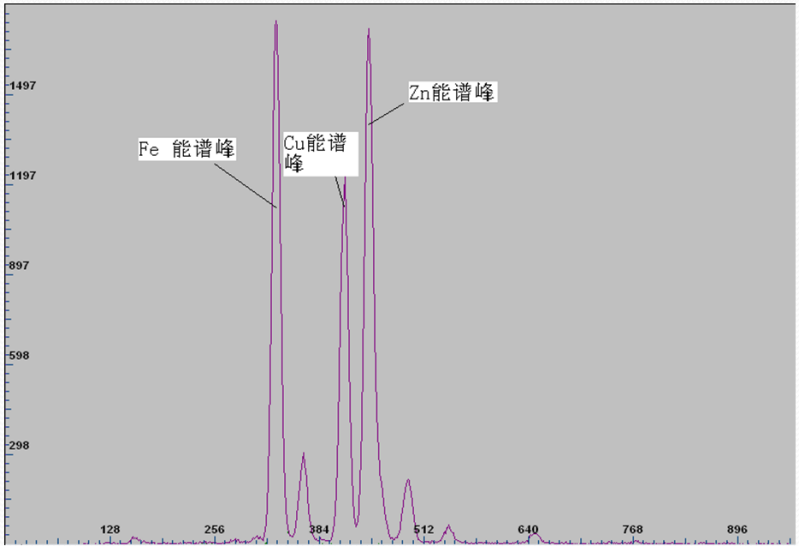


Heath & Sherwood
The legend continues

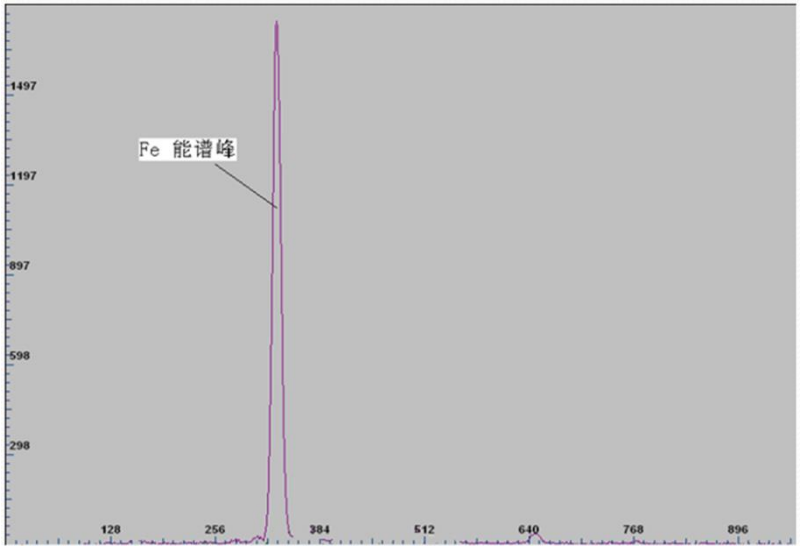
Spectrum Displays (ED & WD)

- Photons go into a detector and are converted to an electrical pulse, where the amplitude of the pulse is proportional to the photon's energy
- Thousands of pulses produce a spectrum
- Energy dispersive channels have a continuous spectrum of all energies
- Wavelength dispersive channels have a filter to reject unwanted energies

ED Channel



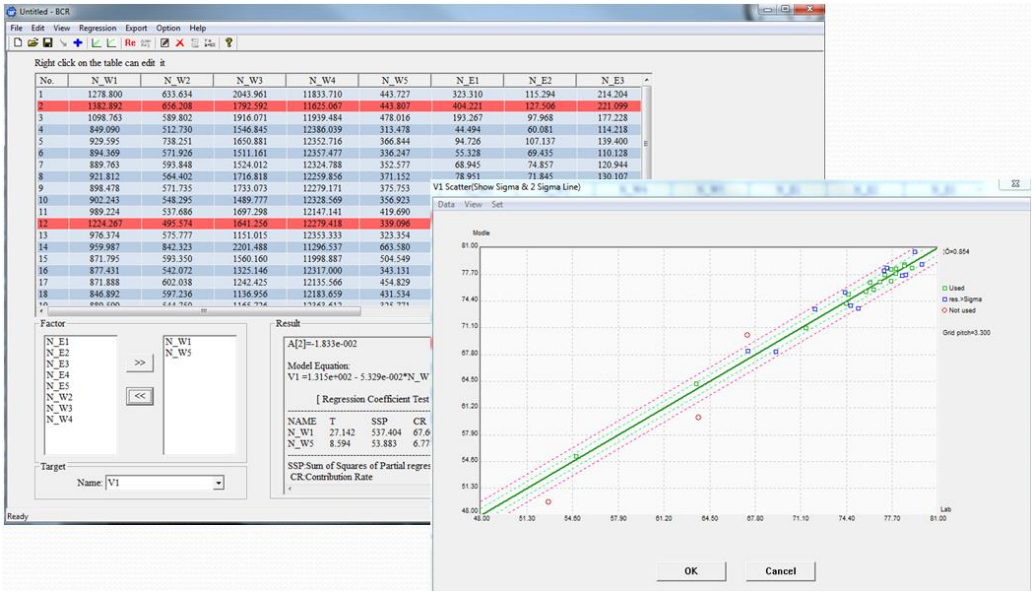
WD Channel



Heath & Sherwood
The legend continues

XRF - Calibration

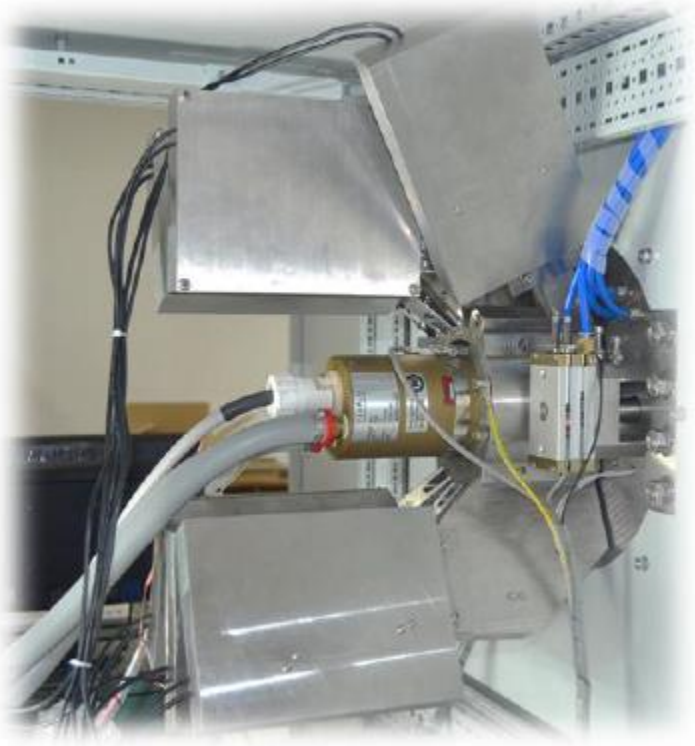
- From the spectrum results, the count rates (intensities) of each element are calculated. At the same time a sample is taken from the analyzer and assayed by the lab.
- These count rates and lab assays are then used to calculate the element content in the slurry based on a derived formula
  - %Cu= A + B* Cu Counts
  - %Zn= A + B* Zn Counts + …….
- Formulas are derived using a regression analysis program



Heath & Sherwood
The legend continues

Channel Sets and X-Ray Tube

WD and ED Channels



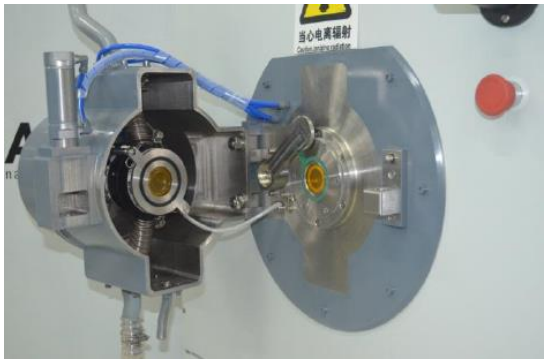
Heath & Sherwood
The legend continues

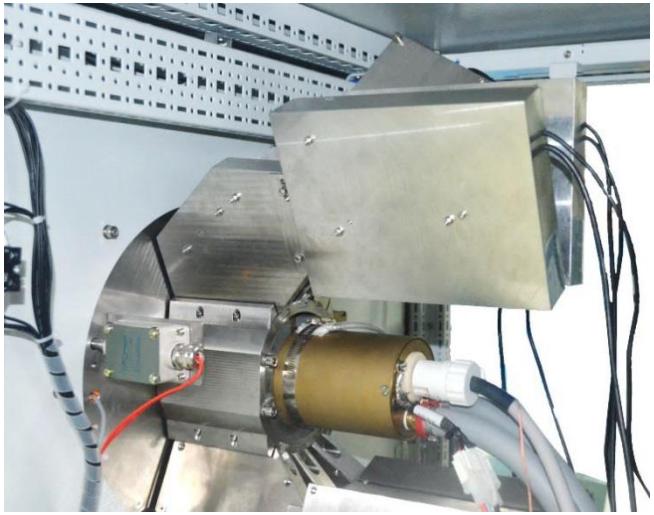
Dedicated Channel Processor

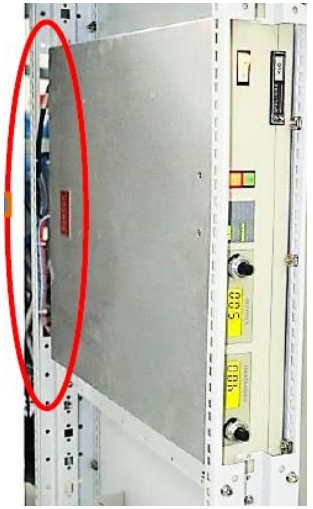
Heath & Sherwood
The legend continues

Probe Electronics

- Houses XRF excitation and detection electronics, control electronics, calibration sampler and slurry flow cell







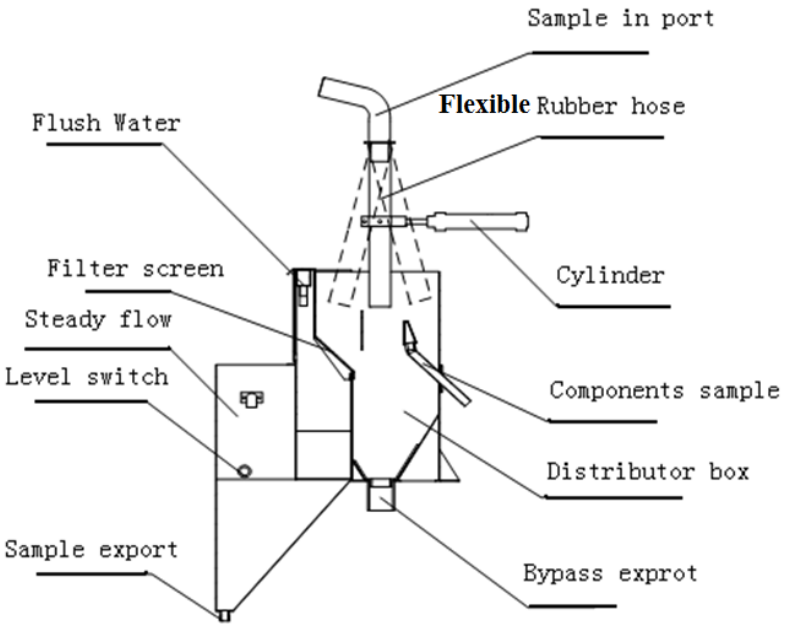
Heath & Sherwood
The legend continues

Probe Control Set

- Houses controllers for MXA's, main controller and a display for operators

Multiplexers

- Used for sample preparation, de-aeration of sample, and feeding sample to the probe
- MXA and probe flow cell are flushed with water after each sample is measured
- Used for composite / shift samples



DCS Modbus – Assay Data

Address	Data	Type Floating Decimal (F)
30001	MV 1 of SM 1	F
30002		
30003	MV 2 of SM 1	F
30004		
30005	MV 3 of SM 1	F
30006		
30007	MV 4 of SM 1	F
30008		
30009	MV 5 of SM 1	F
30010		
30011	MV 6 of SM 1	F

DCS Modbus – Assay Data

Address	Alarm ID	Alarm information	type Integer(I)	Value	
				0	1
31101	1	[1]Caution light for X-ray failure	I	normal	abnormal
31102	2	[2]Meas cell open failure	I	normal	abnormal
31103	3	[3]Meas cell close failure	I	normal	abnormal
31104	4	[4]X-ray tube not on the right position	I	normal	abnormal
31105	5	[5]X-ray tube inner temperature over upper limit	I	normal	abnormal
31106	6	[6]Meas cell film broken	I	normal	abnormal
31107	7	[7]Insufficient air pressure	I	normal	abnormal
31108	8	[8]X-ray tube surface temperature too high	I	normal	abnormal
31109	9	[9]Analyser temperature too high	I	normal	abnormal
31110	10	[10]X-ray tube current lower than the set value	I	normal	abnormal
31111	11	[11]X-ray tube voltage lower than the set value	I	normal	abnormal
31112	12	[12]X-ray tube current upper than the set value	I	normal	abnormal
31113	13	[13]X-ray tube voltage upper than the set value	I	normal	abnormal

Installation Example

Doe Run - Fletcher Mill

Heath & Sherwood
The legend continues

BOXA Benefits & Advantages

- New construction
  - Majority of critical electronics' parts are from proven US suppliers
  - Cabinet is large enough to allow easy access for maintenance, not cramped - Rittal
  - Si-PIN / SDD detectors output spectrum to ARK PC, no requirement for separate HV, Pre-amp, and pulse processing – Amptek (they have a detector on the mars probe)
  - Reference is outside and mechanism is air driven, easier maintenance, no springs (fatigue), more reliable, no extra openings in x-ray tube housing (radiation and tight tolerances)
  - System is air cooled
  - X-ray tube is oil cooled, oil is air cooled, one unit - Varian
  - Database is SQL, open to customer, not proprietary

BOXA Benefits & Advantages

- 50+ yrs of XRF experience within H&S (Minexan 151, Beltcon 200,Courier 10/20/30/300/30XP/6/6i)
- Economical Investment with comparable quality
- Easy to install, calibrate and maintain
- Reliable system operation
  - stability of measurement cabinet & internal reference
  - improved calibration software BCR_{BGRIMM}
  - power regulation - UPS
  - solid construction
  - current hardware & software
- Service & Engineering network to assist with measurement and sampling problems

Heath & Sherwood
The legend continues

Next Generation BOXA-III

- Designed in collaboration between BGRIMM and H&S
- PCS Control panel is removed
- Replaced with adjustable display
- MXA Controls moved into Probe set.
- Digital I/O wiring to MXA's replace by communication line
- Reduces installation foot print
- Redesigned MXA/CSA by H&S

Heath & Sherwood
The legend continues

Benefits of OSA Systems

- Daily reconciliations and balances are accurately calculated (shift composite samples)
- Mass balancing can be done online (requires 3rd party software)
- Reagents can be adjusted online to control grade and recovery efficiently. Reagent consumption and their cost is reduced
- Process upsets can be quickly noticed and corrected
- Areas in the plant where losses are occurring can be identified and the required changes made

Benefits of OSA Systems

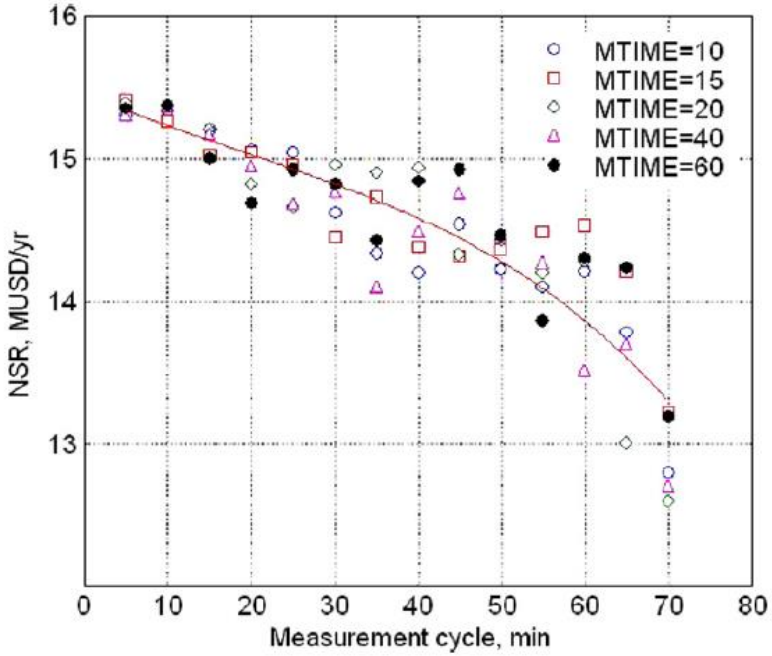
- Improved process production/recovery and quality/grade.
- Reduce process variability
- Economic optimization
- A small 1% process improvement in a $100M/yr. (small plant) production plant is $1M/yr. OSA system and installation is paid for in one year
- Think about $500M/yr. or more.

- **“Can you really afford not to have an OSA System”**

Some $ Numbers

- $250K reagent savings – Kidd Creek [Thwaites,1983]
- $1.5M improved grade and recoveries – Buick [Deister,1985]
- Non-Optimal control effect of analysis cycle speed, Pyhasalmi Mine [Elsevier article, 2007]

NSR – Net Smelter Return



With no OSA, measurement delays are in hours or days!!!

Heath & Sherwood
The legend continues

Thank-you from HEATH & SHERWOOD & BGRIMM

Heath & Sherwood
The legend continues