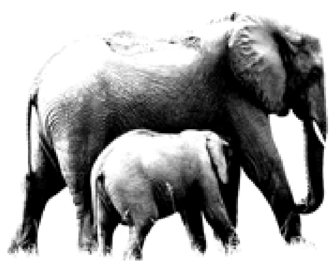
A Well Cemented Technique – XRF

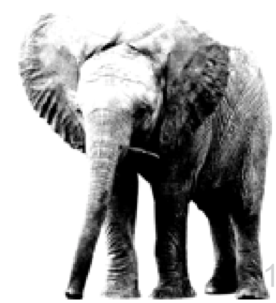
Maggi Loubser

UWO XRF 2010

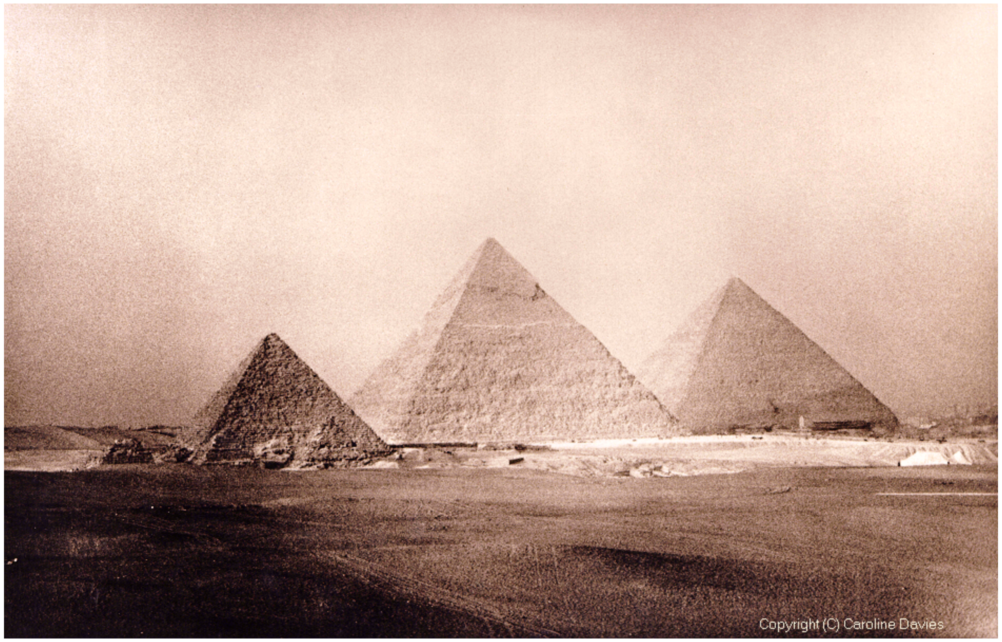
20th Anniversary Celebration Symposium:

Practical XRF Application in Industry





A bit of history



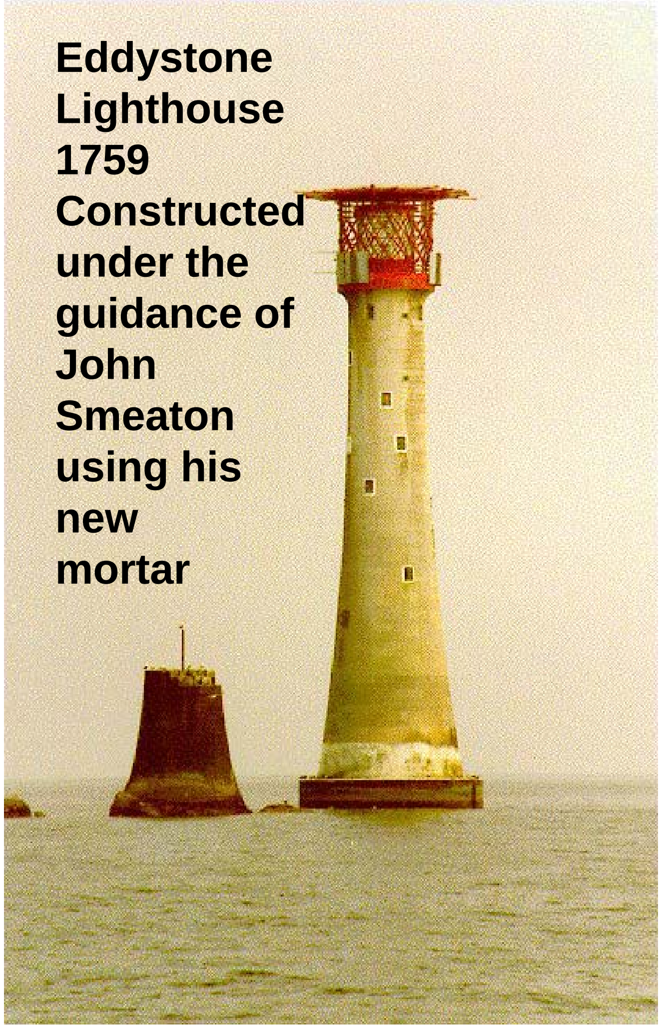
- 3000 BC
  - – Egyptians used mud mixed with straw to bind bricks. Also furthered the discovery of lime and gypsum mortar as a binding agent for the Pyramids

A bit of history

- 300 BC
  - **Romans used slaked lime and volcanic ash called pozzuolana, found near Pozzouli at the bay of Naples. They used lime as a cementitious material. Pliny reported a mortar mixture of 1 part lime to 4 parts sand. Vitruvius reported a 2 parts pozzolana to 1 part lime. Animal fat, milk, and blood were used as admixtures**

A bit of history

- After 400 AD
  - **The art of Concrete was lost after the fall of the Roman Empire**
- 1756
  - **John Smeaton, British Engineer, rediscovered hydraulic cement through repeated testing of mortar in both fresh and salt water on samples of volcanic origin**



Eddystone Lighthouse 1759 Constructed under the guidance of John Smeaton using his new mortar

A bit of history

- **Portland cement** is an extremely fine grey powder manufactured from some of the earth's most common minerals. It's the glue that binds sand and gravel together into the rock-like mass we know as concrete.
- **The term "portland cement" was coined by its inventor, English stonemason Joseph Aspdin. Aspdin heated a mixture of finely powdered limestone and clay in a small furnace to produce hydraulic cement- one that would harden when water is added. He called his new cement "portland" because concrete made from it resembled a highly prized natural building stone quarried on the Isle of Portland, off the English coast.**

5

A bit of history

- Pretoria Portland Cement Company Limited (PPC) established the first cement plant in South Africa in 1892
- Listed on the Johannesburg Stock Exchange in 1910.

A bit of history

Dwaalboom 2008

- PPC is the leading supplier of cement in Southern Africa, with eight manufacturing facilities and three milling depots in South Africa, Botswana and Zimbabwe.
- These facilities are capable of producing more than seven million tons of cement products each year.
- Also a LIME section and aggregate quarries.
- PPC is the market leader in South Africa with a product range that encompasses all applications and a technical services team that is on hand to provide industry solutions.

Van Stadens River Bridge – South Africa

Built:	**1967 - 1971**
Structural type	**Arch Bridge**
Function	**Road Bridge**
arch span:	**198.10 m**
height above valley floor or water	**140 m**

BOMBELA GAUTRAIN project

- One factory dedicated to this client
- Very strict specifications placed on the cement by the contractor (2day strength 25MPa because of high alkalis in their quarry)
- Very stringent Quality assurance measures in place to ensure compliance

Soccer Stadiums

- Green Point Stadium, Cape Town

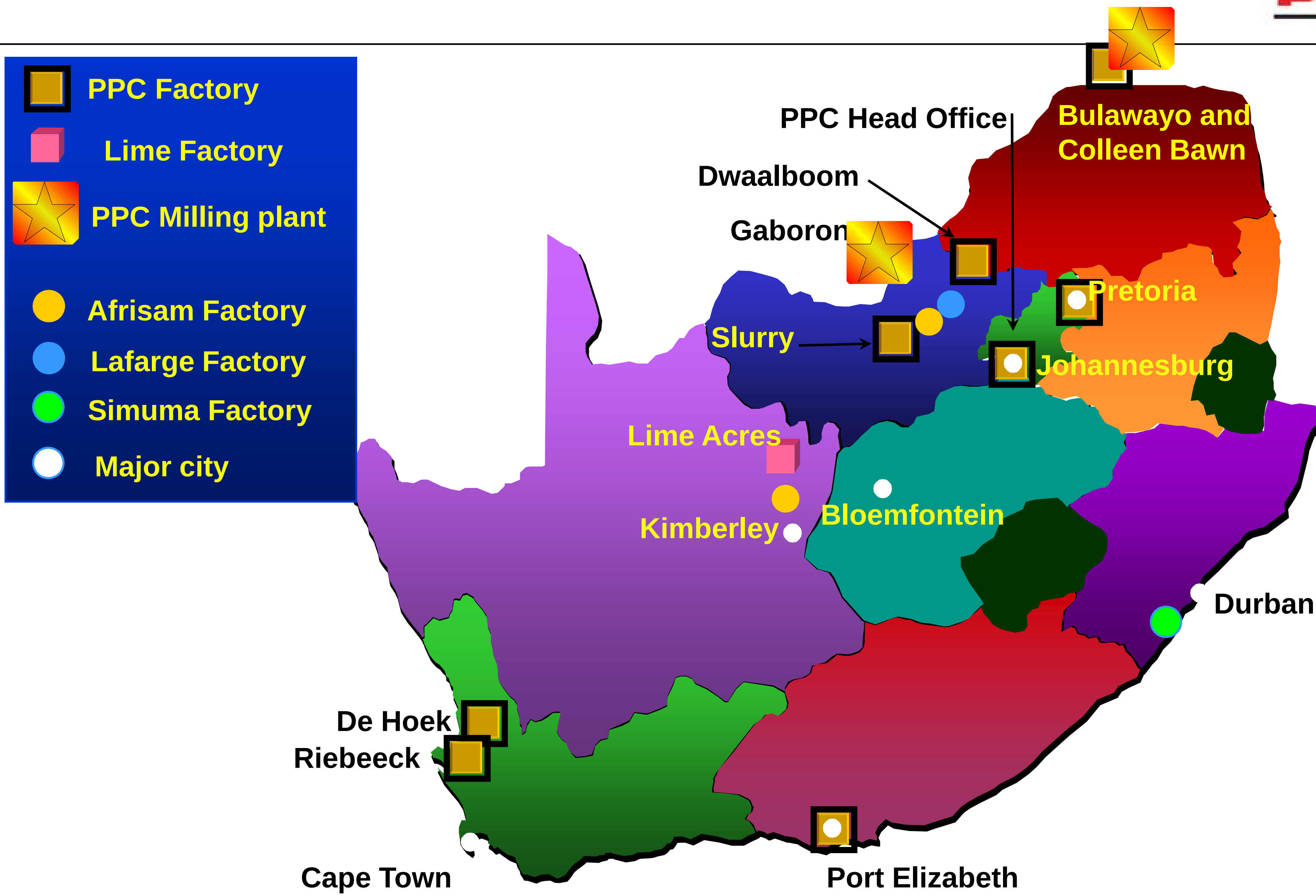
- Nelson Mandela Bay Stadium,

Port Elizabeth


KENYA
TANZANIA
SEYCHELLES
MALAWI
ZAMBIA
ZIMBABWE
NAMIBIA
MAURITIUS
BOTSWANA
MOZAMBIQUE
SWAZILAND
LESOTHO
SOUTH AFRICA

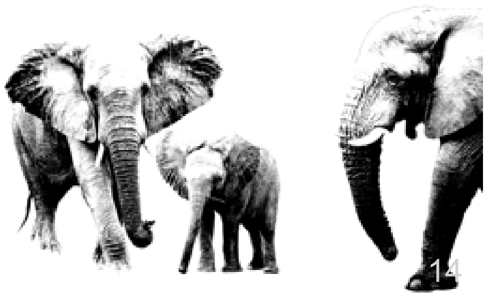
South Africa
SOUTH AFRICA 2010
FIFA
Controversy at the World Cup
wgntv.com
WGN9 8:05
49°
PL$ LOAN STORE
Tonight Partly Cloudy Low: 49°

South African Regional Producers Factories



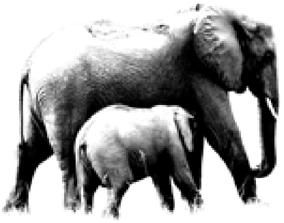
Quality Control

- **Quality assurance (QA)**
  - is the activity of providing evidence needed to establish confidence, that quality-related activities are being performed effectively.
  - All those planned or systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality
- **In plain English – Quality assurance is the steps we take to assure the quality of the output of our laboratory.**

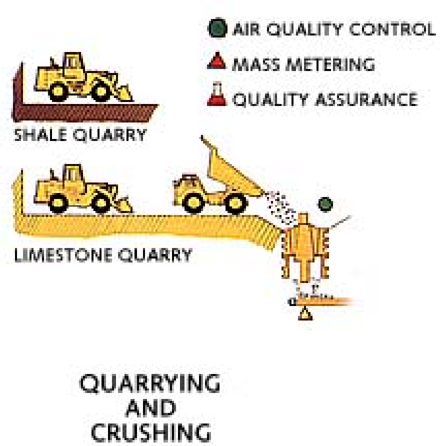


Quality Control – the role of XRF

- XRF is the main Quality Control tool used in PPC
  - Exploration samples
  - Raw materials and fuel
  - Raw mix and kiln feed
  - Clinker
  - Cement
  - Environmental
- Mostly pressed powder briquettes for process control
  - Group Laboratory Services use fused beads



PPC



Stockpile quality

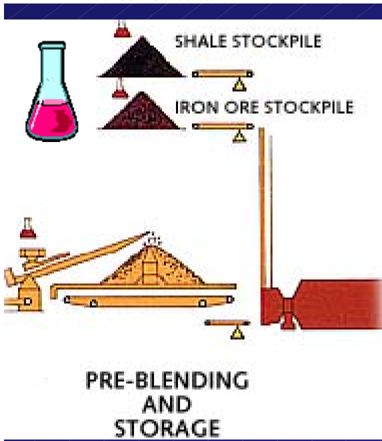
Limestone – mine 70% self

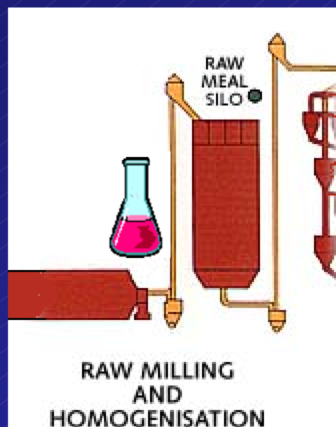
Quality assurance:

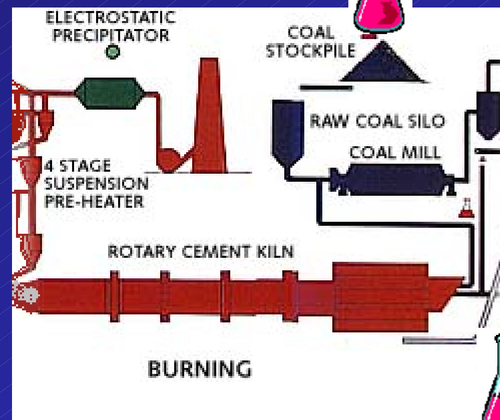
Raw meal -In line XRF

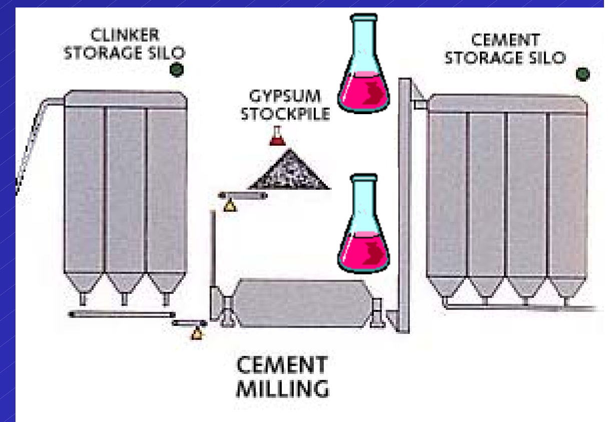
Coal

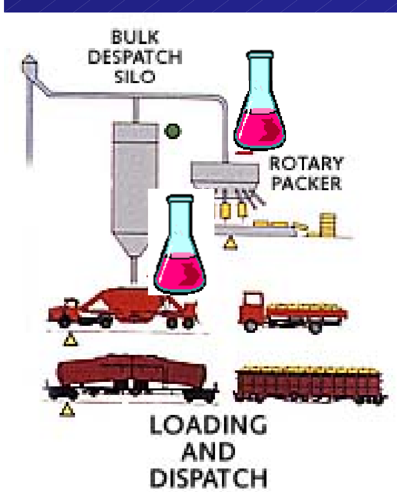
Clinker – cold sampling











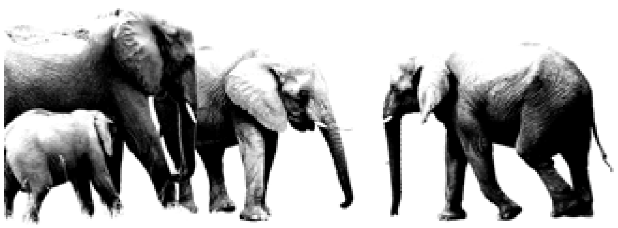
Air quality management

Finished Product

Cement factories monthly samples

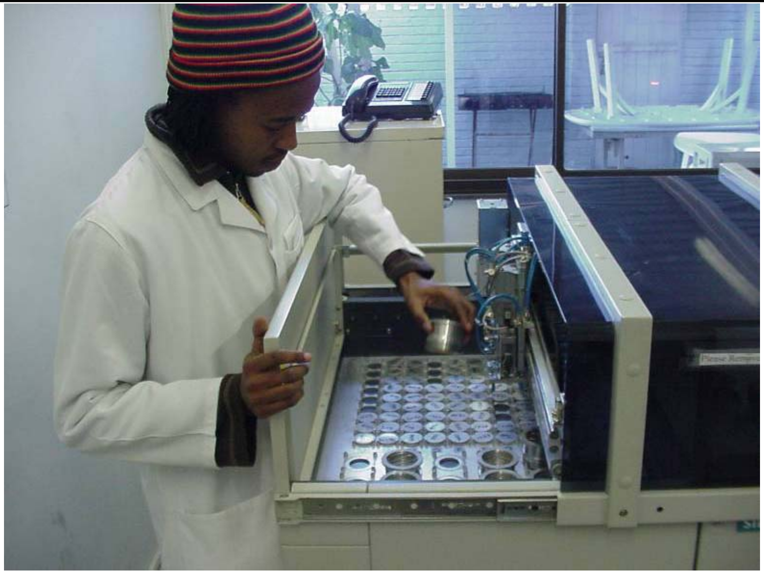
- Between 1000 and 5000 samples per month per factory
- This excludes air quality samples and ad hoc samples done by GLS

Materials	Frequency
Exploration	daily
Limestone	Daily
Sand	Daily
Shale	weekly
Boiler ash	Daily
Coal incoming	daily
Iron ore	weekly
NDM	weekly
FDG	weekly
SPL	Daily
Gypsum into mills	Daily
Clinker into mills	Daily
Raw Mill	1.5 hourly
Kiln feed	3.0 hourly
Clinker	4.0 hourly
Cement	2.0 hourly
Fine Coal	per shift
Incoming Limestone	Adhoc
Incoming coal	Adhoc
Incoming gypsum	Adhoc
Check samples	daily
Total	**16202**



Group Laboratory Services monthly samples

- Air Quality Samples:
  - XRF 1180
  - ICP 2832
- Laboratory interchange
- Certification of Reference materials
- Exploration samples



Lime Acres – monthly XRF samples

- **Lime stone**
  - Stacker – 174 samples - Stock pile control
  - Kiln feed – 136 samples - Process verification
  - Sinter – 67 samples - Final Product verification
  - XRF check samples – 21 samples – XRF quality control
- **Dolomite stone**
  - Drill samples – 10 samples - Quarry check
  - Stacker – 48 samples - Stock pile control
  - Internal Pile samples - 45 samples - Stock pile control
  - Kiln feed –36 samples - Process verification

Lime Acres – monthly XRF samples

- **Burnt lime**
  - Final Product composites - 234 samples - Final Product verification
- **Burnt dolomite**
  - Despatch samples - 291 samples - Final Product verification
  - Kiln product – 288 samples - Final product storage selection tests
- **Hydrated lime**
  - Final Product composites – 38 samples - Final Product verification

Total - excluding environmental samples - 1388

XRF Instrumentation

- Two Thermo Electron instruments
- Three Bruker instruments
- Seven PANalytical instruments
- One Oxford instrument

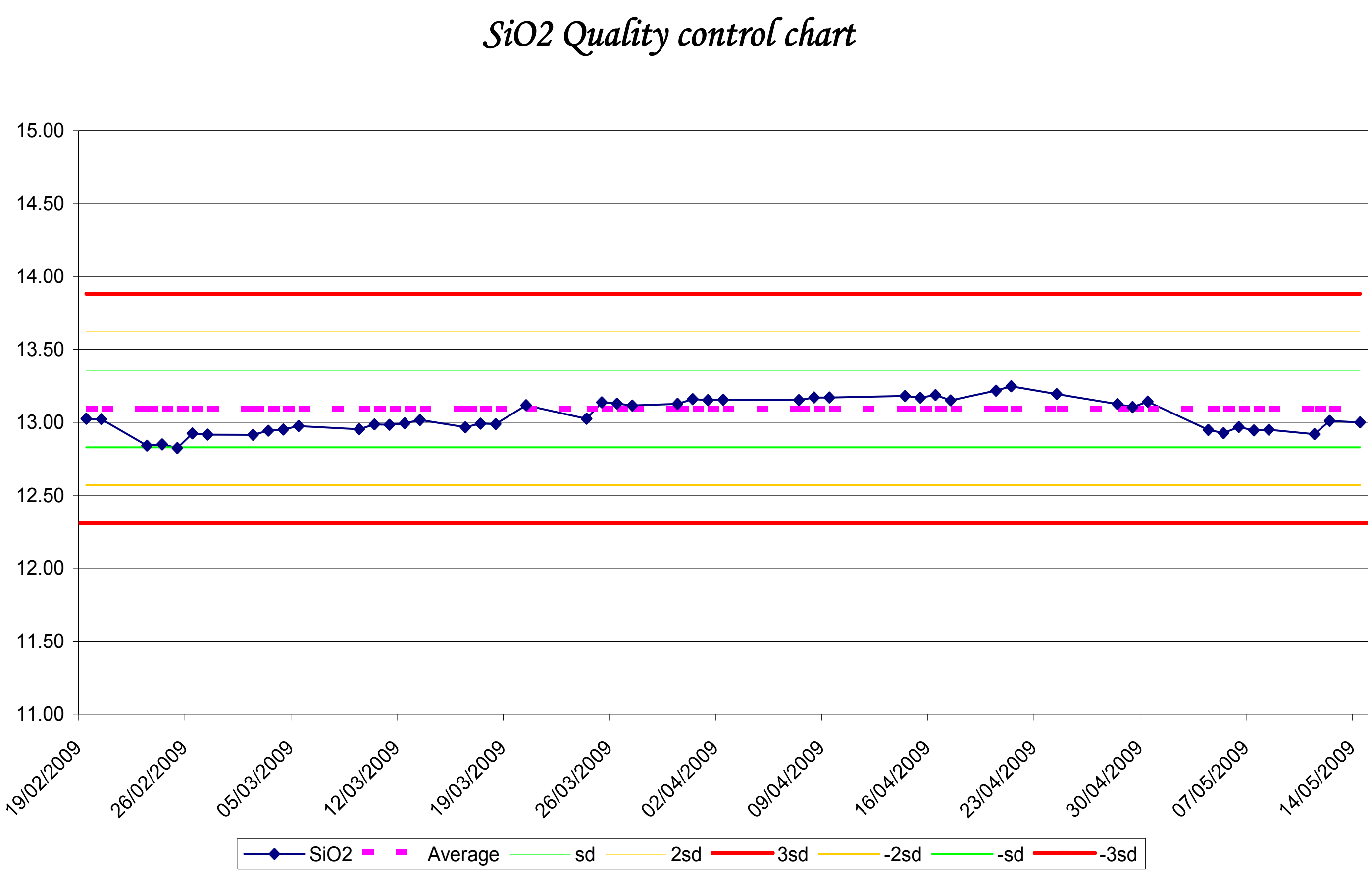
Backup by GLS

PPC

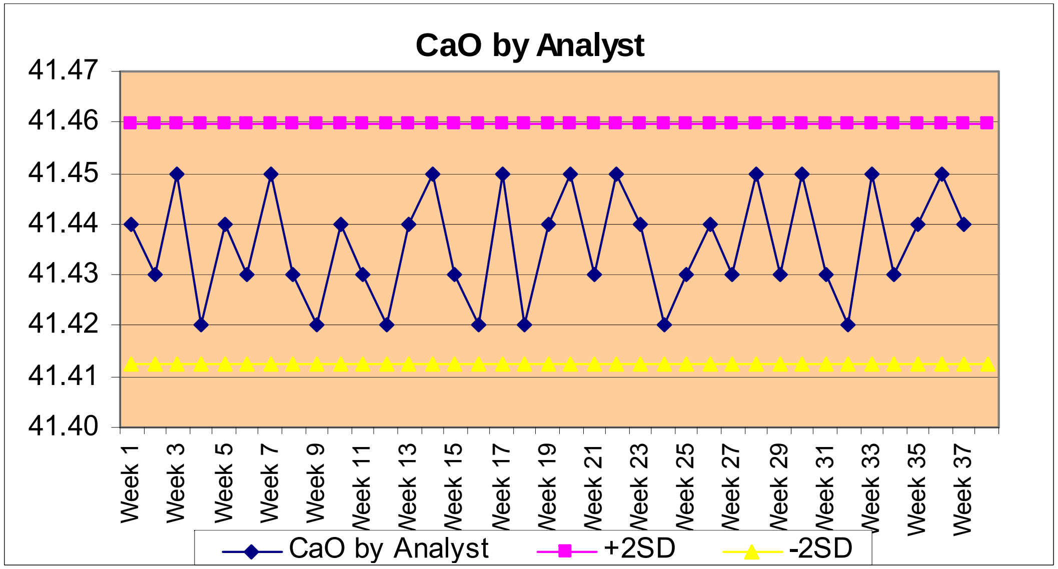
- Classical Wet methods
- Instrumental Methods
  - Colorimetric
  - Atomic Absorption/Emission
  - X-Ray Fluorescence
  - X-Ray Diffraction
  - Microscopy
  - Inductively Coupled Plasma
  - Ion Chromatography
  - UV-VIS Spectrophotometry

Quality control in the XRF labs

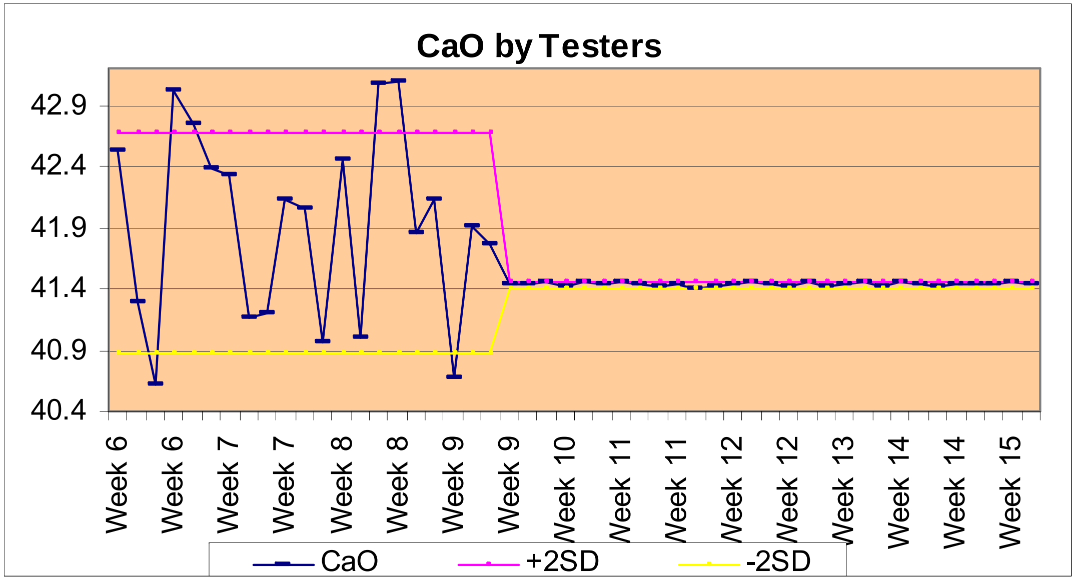
- Best practises used throughout the group
- Daily (once a shift) check samples and drift monitor samples
- “Sample 99” prepared on each shift to check sample preparation



“Sample 99”



CaO by Analyst
41.47
41.46
41.45
41.44
41.43
41.42
41.41
41.40
Week 1
Week 3
Week 5
Week 7
Week 9
Week 11
Week 13
Week 15
Week 17
Week 19
Week 21
Week 23
Week 25
Week 27
Week 29
Week 31
Week 33
Week 35
Week 37
CaO by Analyst
+2SD
-2SD



CaO by Testers
42.9
42.4
41.9
41.4
40.9
40.4
Week 6
Week 6
Week 7
Week 7
Week 8
Week 8
Week 9
Week 9
Week 10
Week 11
Week 11
Week 12
Week 12
Week 13
Week 14
Week 14
Week 15
CaO
+2SD
-2SD

Round Robins

FINAL DATE FOR SUBMITTING RESULT		SiO_2	Al_2O_3	Fe_2O_3	Mn_2O_3	TiO_2	CaO	MgO	P_2O_5	SO_3	K_2O	Na_2O	LOI	Total
22-Feb-10	DEH	19.73	5.63	3.61	0.42	0.41	62.53	2.89	0.00	2.25	0.46	0.19	1.58	99.7
	DWB	21.17	4.58	2.39	0.41	0.55	62.84	2.30	0.81	2.16	0.23	0.12	1.51	99.07
	GLS	20.72	5.26	4.01	0.41	0.46	62.21	3.00	0.08	2.46	0.35	0.11	1.51	100.6
	HERC	20.49	5.18	3.90	0.41	0.46	61.52	2.87	0.06	2.59	0.24	0.10	1.76	99.6
	PE	21.8	6.2	3.8	0.4	0.5	61.7	2.9	0.08	2.58	0.31	0.25	1.67	100.5
	RBK	20.62	5.37	3.74	0.62	0.57	60.46	3.42	0.07	2.46	0.32	0.00	1.75	99.40
	JUP	21.4	5	3.8	0.4	0.5	62.0	2.7	0.1	2.7	0.4	-0.1	1.92	100.82
	JUPfb	20.6	5.5	3.8	0.4	0.5	62.0	2.8	0.1	2.4	0.3	0.1	1.92	98.5
	SLR	20.11	5.00	3.30	0.43	0.47	60.19	2.50	0.06	2.51	0.33	0.11	1.51	96.51
08-Mar-10	DEH	19.73	5.63	3.61	0.42	0.41	62.53	2.89	0.00	2.25	0.46	0.19	1.68	99.8
	DWB	19.78	5.87	3.69	0.43	0.42	61.35	2.96	0.00	2.23	0.46	0.18	1.55	99.11
	GLS	21.65	5.29	3.88	0.38	0.46	62.47	2.80	0.08	2.53	0.35	0.11	1.54	101.5
	HERC	20.31	5.20	3.84	0.41	0.46	61.35	2.86	0.06	2.79	0.25	0.10	1.71	99.4
	PE	22.0	6.4	3.8	0.4	0.5	61.9	3.0	0.08	2.66	0.30	0.26	1.85	101.2
	RBK	20.60	5.36	3.76	0.62	0.58	60.50	3.52	0.07	2.43	0.32	0.02	1.60	99.38
	JUP	22	5.2	3.8	0.4	0.5	62.4	2.9	0.1	2.5	0.4	0.1	1.52	101.8
	JUPfb	21.1	5.6	3.9	0.4	0.4	62.8	2.9	0.1	2.4	0.1	0.0	1.52	99.6
	SLR	20.15	5.07	3.36	0.43	0.47	59.90	2.53	0.06	2.43	0.33	0.10	2.00	96.82
22-Mar-10	DEH	19.32	5.68	3.66	0.42	0.41	62.51	2.89	0.00	2.23	0.46	0.18	1.66	99.4
	DWB	21.18	4.59	2.40	0.41	0.55	62.83	2.30	0.80	2.12	0.23	0.12	1.91	99.46
	GLS	21.57	5.28	3.8	0.38	0.46	62.24	2.79	0.07	2.46	0.35	0.11	1.59	101.1
	HERC	20.56	5.20	3.86	0.40	0.44	61.24	2.88	0.06	2.56	0.24	0.10	1.75	97.9
	PE	22.0	6.3	3.8	0.4	0.5	61.4	2.9	0.08	2.68	0.30	0.28	1.65	100.5
	RBK	20.52	5.32	4.06	0.63	0.58	60.18	3.62	0.07	2.40	0.32	0.02	1.63	99.35
	JUP	22.00	5.10	3.90	0.40	0.50	62.50	2.90	0.10	2.30	0.30	0.10	1.63	101.73
	SLR	20.62	5.06	3.44	0.442	0.474	60.21	2.58	0.06	2.34	0.33	0.11	1.96	97.61

Reference materials

The Problem:

- A Best practise exists within the PPC group where data over a period of time is evaluated to ensure that the calibrations cover the range experienced in the specific factory.
- Limited Concentration Ranges
  - of materials covering the concentration range for all analytes
  - commercially available CRM's

Reference materials

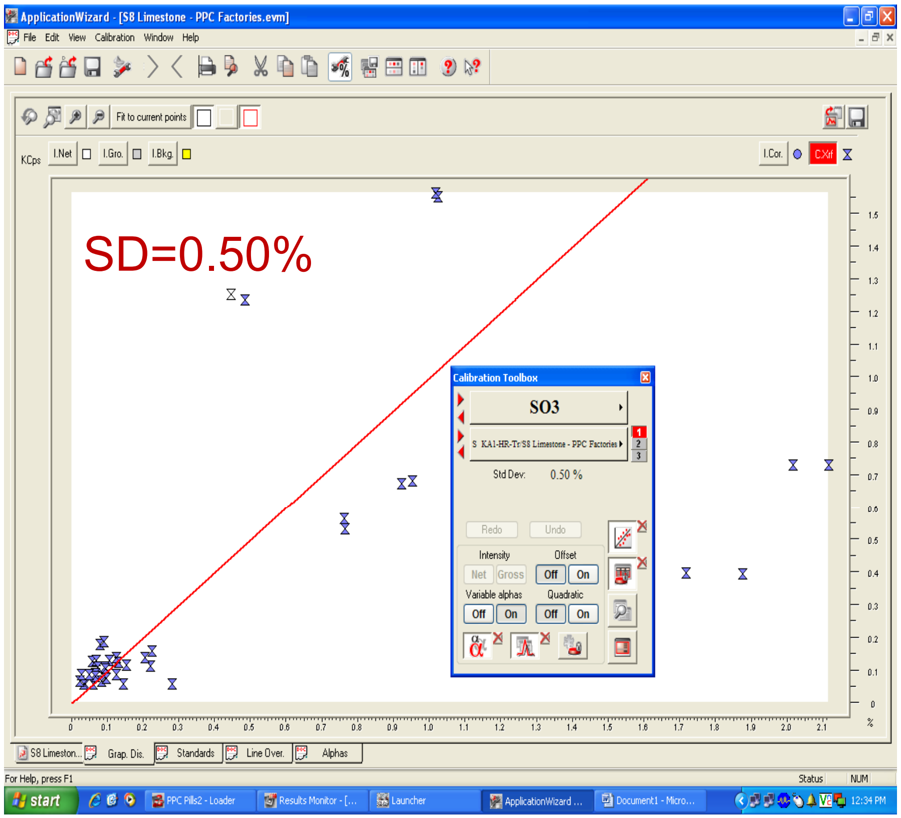
- A project was initiated to address this issue:
  - Materials from the different factories were collected
  - Homogenized and splitting
  - Certified against a fused bead XRF curve, prepared using Certified Reference Materials.
  - Homogeneity testing
  - Validation by setting up pressed powder curves using the fused bead results
  - Distributing to the different factories as a global reference material set.

Preparation

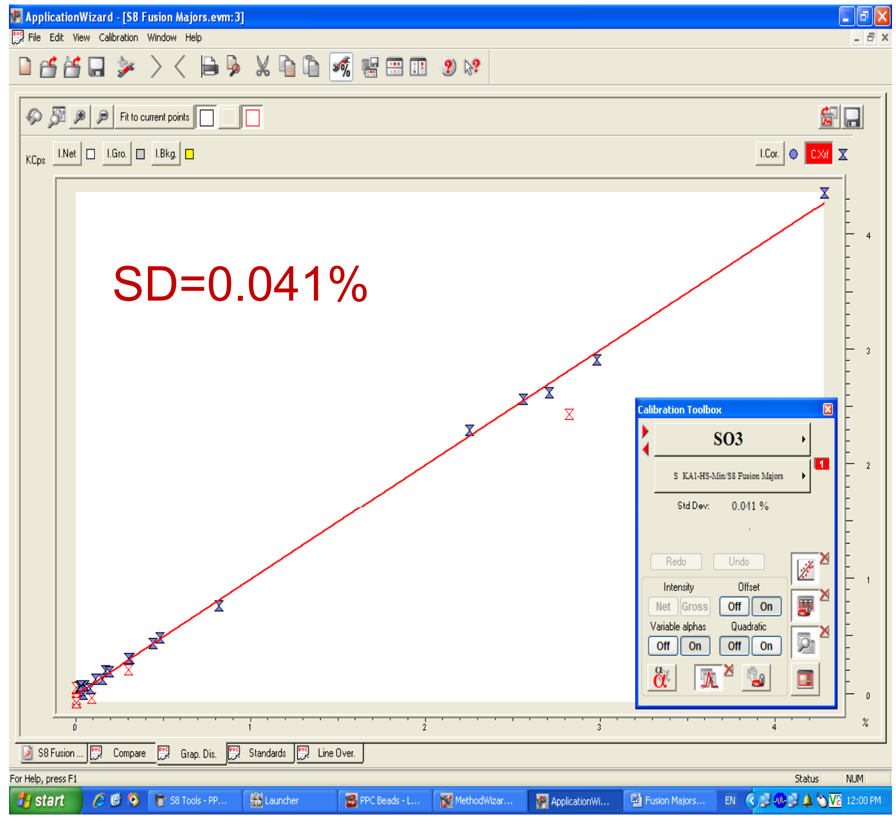
PPC CEMENT

Limestone Analysis

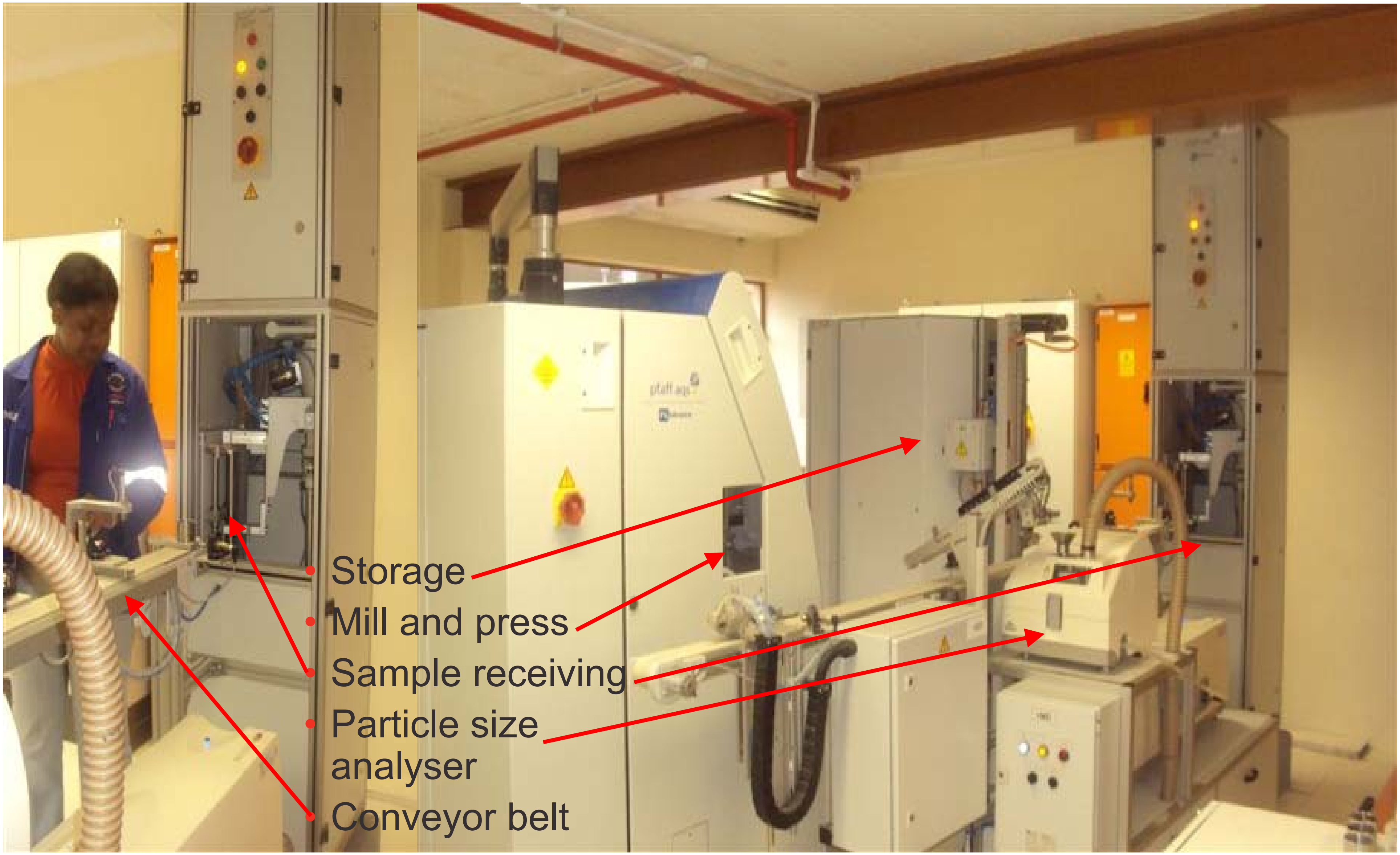
Original Line for SO3



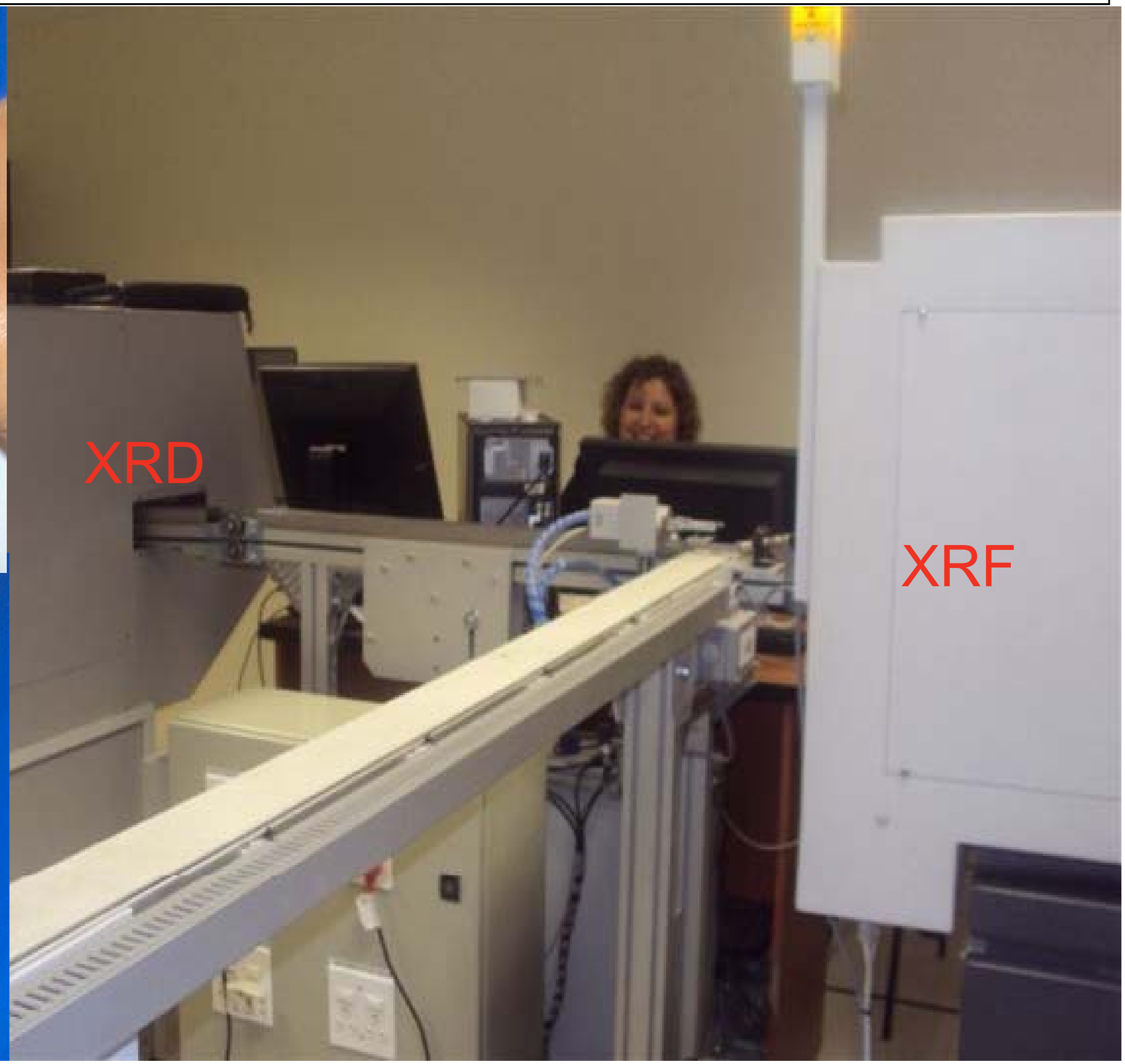
New Line for SO3



Automation – Hercules factory



Automation – Hercules factory



PGNAA- Prompt Gamma Neutron Activation Analysis

- Analyses the entire material stream on a nuclear level and eliminates errors and the costs associated with material sampling
- Accuracy independent of the mineralogical composition of raw materials
- Independent of material particle size
- With on-line, real-time information rapid process control can be achieved for individual elements as well as calculated parameters such as LSF.
- Stable accuracy and precision
- Technology is robust, reliable and consistent in a industrial environment

PGNA Principle

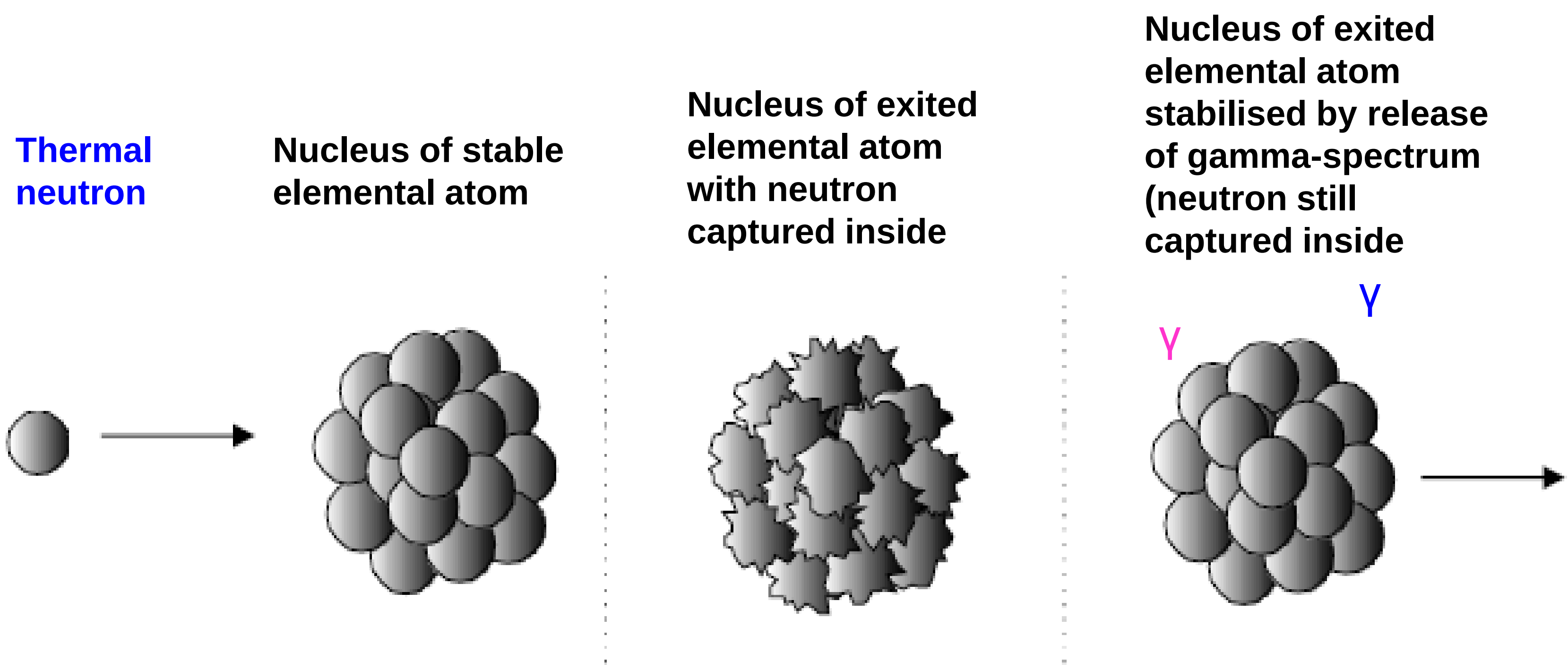


Figure 1: Principle of PGNA


Dwaalboom

Slurry – Neutron Source being installed

Certain Things have to be Correct from the Design Phase

By making sure of the product leaving the gates:

And the community we serve

Rally to Read

And the community we serve

PPC

ASPASA

Thanks

- J Gaylard (PPC ACADEMY Technology Course - March 2009)
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- Bheki Mthembu
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