

## PERFORMANCE FOR CEMENT APPLICATION

ARL 9900 Series XRF spectrometers  
Clinker samples prepared in the form of pressed powders

		<b>ARL 9900 3600 4GN X-ray tube</b>	<b>ARL 9900 1200 4GN X-ray tube</b>	<b>ARL 9900 1200 5GN X-ray tube</b>
	Power	3600W	1200W	1200W
Analyte	Range (%)	Typical Repeatability (%) 1 sigma at Mid range in 60 s	Typical Repeatability (%) 1 sigma at Mid range in 60 s	Typical Repeatability (%) 1 sigma at Mid range in 60 s
CaO	59 - 66	0.012	0.021	0.021
SiO <sub>2</sub>	18 - 24	0.0045	0.0078	0.0071
Al <sub>2</sub> O <sub>3</sub>	3 - 6	0.003	0.0052	0.0047
Fe <sub>2</sub> O <sub>3</sub>	1 - 4	0.0013	0.0023	0.0023
S tot	0.2 - 2	0.001	0.0017	0.0015
MgO	0.6 - 3	0.0027	0.0047	0.0041
K <sub>2</sub> O	0.1 - 2.0	0.001	0.0017	0.0017
Na <sub>2</sub> O	0.1 - 0.8	0.0018	0.0031	0.0027
P <sub>2</sub> O <sub>5</sub>	0.05 - 0.3	0.0004	0.0007	0.0006
TiO <sub>2</sub>	0.1 - 0.4	0.001	0.0017	0.0017
Mn <sub>2</sub> O <sub>3</sub>	0.05 - 0.3	0.0004	0.0007	0.0007
Free CaO	0.2 - 3.0	0.007	0.012	0.011
For guaranteed values the above precision values should be multiplied by factor 2				

- X-ray tube type 4GN is fitted with 75 micron Be window
- X-ray tube type 5GN is fitted with 50 micron Be window: it benefits from increased sensitivity on the light elements notably Na, Mg, Al, Si which produces better repeatability on these elements.

Above specifications are valid for XRF monochromator channels

Free lime specifications are valid for integrated XRD system

Repeatability is defined as 10 consecutive runs on a stable sample

As can be seen from the above table, the repeatability results for all instruments are very good, therefore the counting time can generally be decreased to 10 seconds for ARL 9900 XP and to 30 seconds for ARL 9900 Oasis. In this case the typical repeatability results will be the following:

		<b>ARL 9900 XP 4GN X-ray tube</b>	<b>ARL 9900 Oasis 4GN X-ray tube</b>	<b>ARL 9900 Oasis 5GN X-ray tube</b>
	Power	3600W	1200W	1200W
Analyte	Range (%)	Typical Repeatability (%) 1 sigma at Mid range in 10 s	Typical Repeatability (%) 1 sigma at Mid range in 30 s	Typical Repeatability (%) 1 sigma at Mid range in 30 s
CaO	59 - 66	0.029	0.03	0.03
SiO <sub>2</sub>	18 - 24	0.011	0.011	0.01
Al <sub>2</sub> O <sub>3</sub>	3 - 6	0.0074	0.0074	0.0066
Fe <sub>2</sub> O <sub>3</sub>	1 - 4	0.0032	0.0033	0.0033
S tot	0.2 - 2	0.0025	0.0024	0.0021
MgO	0.6 - 3	0.0066	0.0066	0.0058
K <sub>2</sub> O	0.1 - 2.0	0.0025	0.0024	0.0024
Na <sub>2</sub> O	0.1 - 0.8	0.0044	0.0044	0.0038
P <sub>2</sub> O <sub>5</sub>	0.05 - 0.3	0.001	0.001	0.0008
TiO <sub>2</sub>	0.1 - 0.4	0.0025	0.0024	0.0024
Mn <sub>2</sub> O <sub>3</sub>	0.05 - 0.3	0.001	0.001	0.001
Free CaO	0.2 - 3.0	0.017	0.017	0.016
For guaranteed values the above precision values should be multiplied by factor 2				

Above specifications are valid for XRF monochromator channels

Free lime specifications are valid for integrated XRD system

Repeatability is defined as 10 consecutive runs on a stable sample

- X-ray tube type 4GN is fitted with 75 micron Be window
- X-ray tube type 5GN is fitted with 50 micron Be window: it benefits from increased sensitivity on the light elements notably Na, Mg, Al, Si which produces better repeatability on these elements.

Alternatively to the fixed channels, the universal goniometer can be used for analysis of most elements. The universal goniometer has the capability to analyse all elements of the periodic table from Fluorine to Uranium. The analysis on the goniometer is performed in parallel to the analysis on the fixed channels. The performance of the universal goniometer is similar to those of fixed channels.

Thanks to its lower power the ARL 9900 Oasis has the advantage of not requiring any external water cooling, i.e. a water chiller is not necessary. But to reach the same level of performance, the counting time needs to be longer on ARL 9900 Oasis compared to ARL 9900 XP.

For example for analysis of 8 elements with the universal goniometer only, the typical total time with ARL 9900 Oasis will be 200s (=4 elements with 30s and 4 elements with 20s counting time). For analysis of 8 elements with only goniometer, the typical total time with ARL 9900 XP will be 80s (=8 elements with an average of 10s per element).

For faster analysis speed and for backup, 4 fixed channels can be added for analysis of Ca, Al, Si, Fe. In that case the above total counting times decrease to 100s for ARL 9900 Oasis and to 40s for ARL 9900 XP.

In that case a typical instrument configuration for the cement industry is the following:

- Four fixed channels for analysis of Ca, Al, Si and Fe
- Universal Goniometer for the analysis of the remaining elements/oxides
- Integrated XRD system for the analysis of free lime and other phases.