

OPERATING EXPERIENCE WITH HIGH VOLUME AIR SAMPLERS

A. le Roux
Occupational Hygiene Officer

M.R. Grant
Senior Chemical Engineer
PPC Technical Service, P O Box 40073 Cleveland

PPC Technical Services has operated several types of high volume air samplers - hivols - since 1983. The only real advantage of hivols seems to be that a large sample mass is collected. The disadvantages which we have experienced are the subject of this article.

One hivol was purchased as an experiment in 1983. This is the General Metal Works Sierra model shown in Figure 1. It is easy to transport and the open construction is ideal for eliminating heat build-up inside the cabinet. However, the inside of the cabinet tends to become just as dusty as the surrounding environment. It also has an alarming tendency to topple over in even a moderately high wind.

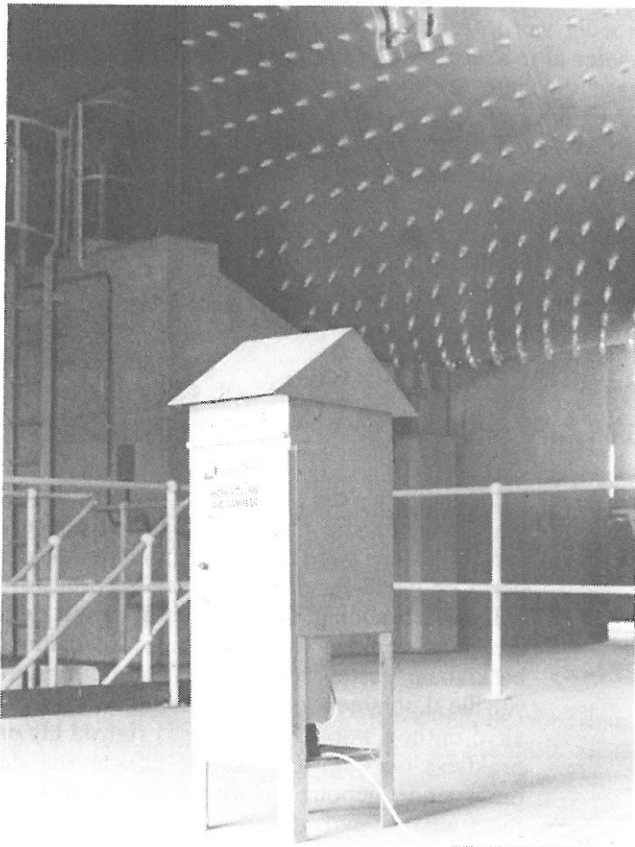


FIGURE 1: The Sierra hivol cabinet

When the sampling program began to expand in 1985 it was decided to purchase some locally designed cabinets - the 'rocket' hivol supplied by D. Giles Scientific, Figure

2. Five rockets were purchased and fitted with elapsed time indicators in order to measure total airborne dust. One additional rocket was fitted with a flow controller, a seven day programmable timer and a differential pressure type chart recorder. A size selective inlet (10 μm cutoff) and a set of Sierra impactor plates were also purchased for this unit as shown in Figure 3.



FIGURE 2: The Giles hivol cabinet

At the time there was a significant cost advantage in purchasing the rocket cabinets as compared to importing the Sierra. The temperature inside the rocket cabinet often goes over 45°C when operating in summer sunshine, however. This reduces the lifetime of the electrical components in the flow controller and timer/programmer. The rocket is cleaner on the inside than the Sierra but the outlets must be properly screened to keep out snakes and insects. Like the Sierra, a moderately high wind tends to knock it over.

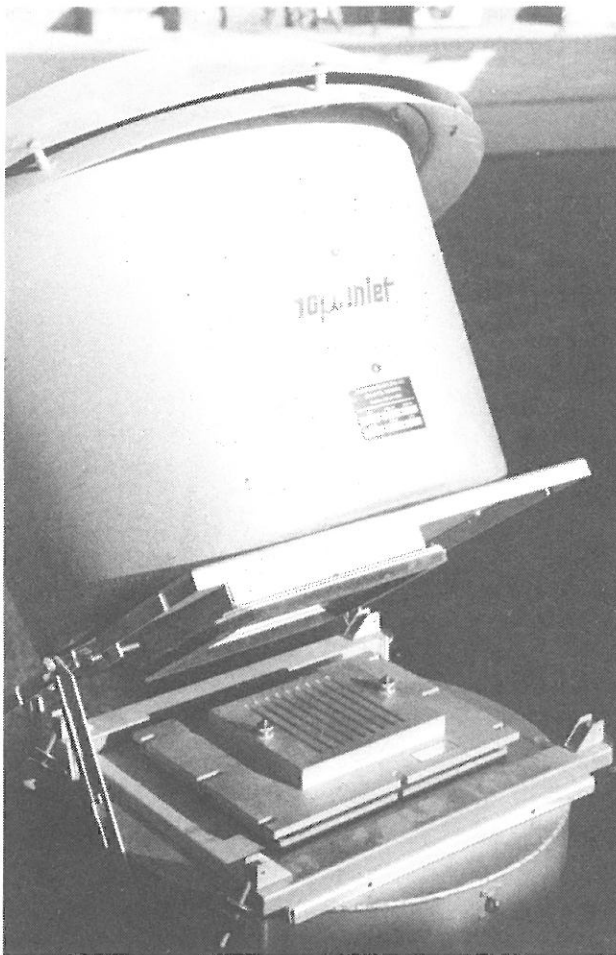


FIGURE 3: Size Selective Inlet and impactor plates fitted on top of Giles Cabinet

If a flow controller is not available allowance has to be made for ambient temperature and pressure when calibrating the motors. The Kurz calibrator and flow controller are designed for operation at sea level and 25°C. The calibration then requires correction to highveldt conditions.

Hivols are used mainly for investigative work where free (alpha-) quartz is the most potentially harmful component of the dust. Where possible the size selective hivol is used in conjunction with a standard hivol in order to measure both the total and respirable ambient dust concentrations simultaneously. Figure 4 shows the size selective and Sierra hivols in use beside a quarry haul road. A portable 220V power supply is usually necessary in remote locations. Normally this is a welding machine, as shown in Figure 4, or one of the quarry's diesel lighting plants. The power problem tends to limit the sampling period to day shift only as experience has shown that the power source should be checked every four hours. This type of sampling is not recommended unless no alternative method is possible.

Good results can be obtained with perseverance, however. Table 1 shows the results of one quarry survey. Unfortunately even with hivol samplers the mass collected is sometimes not enough for chemical analysis of the dust.



FIGURE 4: Size Selective and Sierra next to quarry haul road

TABLE 1
Hivol Sampler Results in Quarry

Location in quarry	Ambient dust level, mg/cubic metre		Free quartz, %	
	Total	Respirable	Total	Respirable
T junction haul road	0,58	0,16	**	**
Haul road to stockpile	0,29	--	**	--
Outside main workshops	0,38	--	**	--
Primary crusher/screening plant	2,04	--	14,9	--

**Insufficient sample mass for free quartz analysis
--Not determined

We have found no statistically significant difference between the Sierra and the rocket when both are collecting total dust at one location. Thus the samplers are interchangeable in a network of hivol samplers. We have run such networks at several factories, usually when there is a question as to differences in total dust levels at different locations. Figure 5 presents the results of one survey at a coastal cement factory where one rocket and the Sierra were run concurrently at two different locations. Since the samplers were known to be equivalent the observed difference in average ambient dust concentration was taken to be real.

This was confirmed by a statistical analysis which compared the results using the 'F' ratio and the paired chi-square test (Hald 1952).

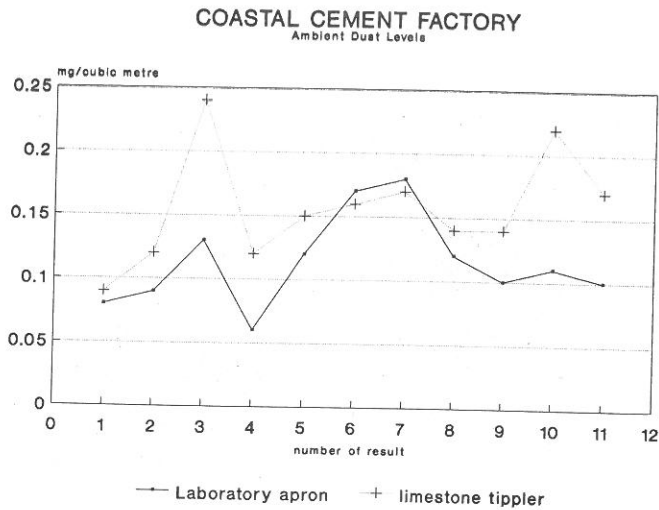


FIGURE 5

For operation in locations where space is at a premium PPC Technical Services has designed a tripod sampler. For example, we were required to conduct a total dust survey during a kiln rebricking operation, Figure 6; the work was done to establish the necessity of enforcing the use of dust masks during the rebricking operation. The

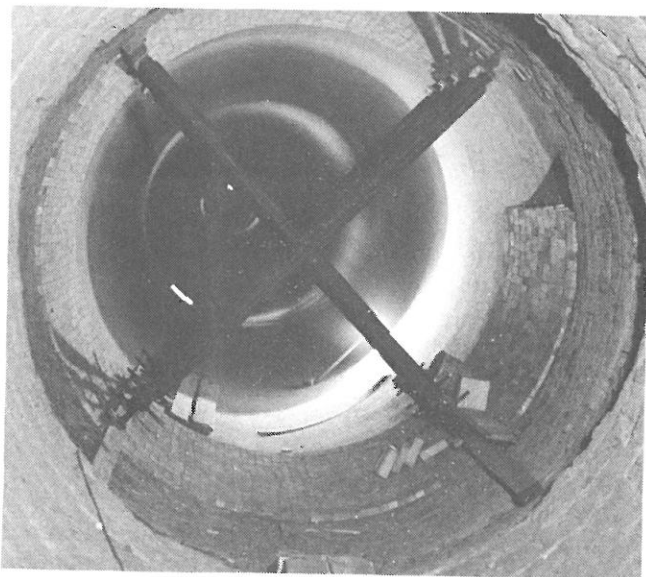


FIGURE 6: Inside a rotary cement kiln during rebricking

tripod, constructed of electrical conduit with telescoping legs, is very useful in a kiln where the 'floor' is concave. It can be placed out of the path of the bricking crew. Two tripods were fitted with flow controllers, Figure 7, and

placed (A) inside the kiln behind the bricking gang and (B) at the kiln entrance. Results are presented in Table 2.



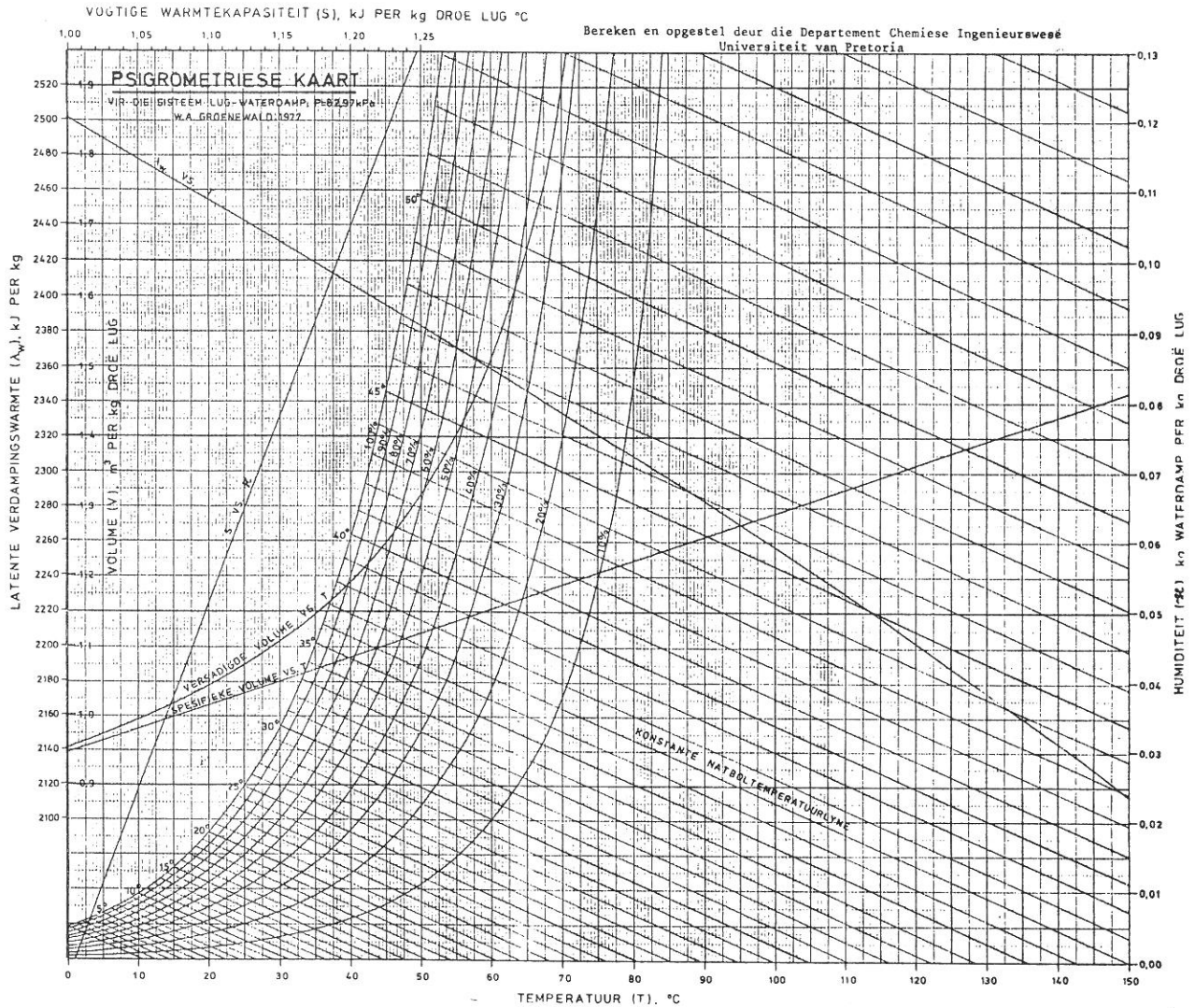
FIGURE 7: Tripod sampler with flow controller

TABLE 2
Dust Levels During Kiln Re-bricking Operation

Location:	A		B	
test number:	1	2	1	2
Atm. Pressure	kPa 100,2	99,9	100,2	99,9
temperature °C	dry 32,0	27,0	32,0	27,0
	wet 19,5	19,0	19,5	19,0
Density of air	1,126	1,143	1,126	1,143
kg/cubic metre actual	Flow in CFM 38,14	28,59	38,14	28,09
	cubic metres/minute actual 1,08	0,81	1,08	0,80
Dust collected, grammes	1,2219	0,3446	0,9373	0,4191
Elapsed sampling time	380	452	480	452
Ambient dust level, mg/cubic metre actual	2,4	0,9	1,8	1,2

TEGNIESE NOTAS:

NR 1: Psigometriese kaart by 83 kPa atmosferiese druk (dws vir die Witwatersrand-omgewing)



MET KOMPLIMENTE / WITH COMPLIMENTS

ENPRO (Edms) Bpk
(Pty) Ltd
Omgewingsprojekte
Environmental Projects

79/02517/07

Deltagebou / Building
Monicaweg / Road
LYNNWOOD 0081
Pretoria RSA

DIREKTEURE / DIRECTORS
N Boegman C J Els

Posbus / P O Box 11229
BROOKLYN 0011
Tel: (012) 47-1153
Fax: (012) 47 7835

Om "n A3-grootte afdruk van hierdie kaart te verkry, skryf aan bogenoemde adres of skakel ons.

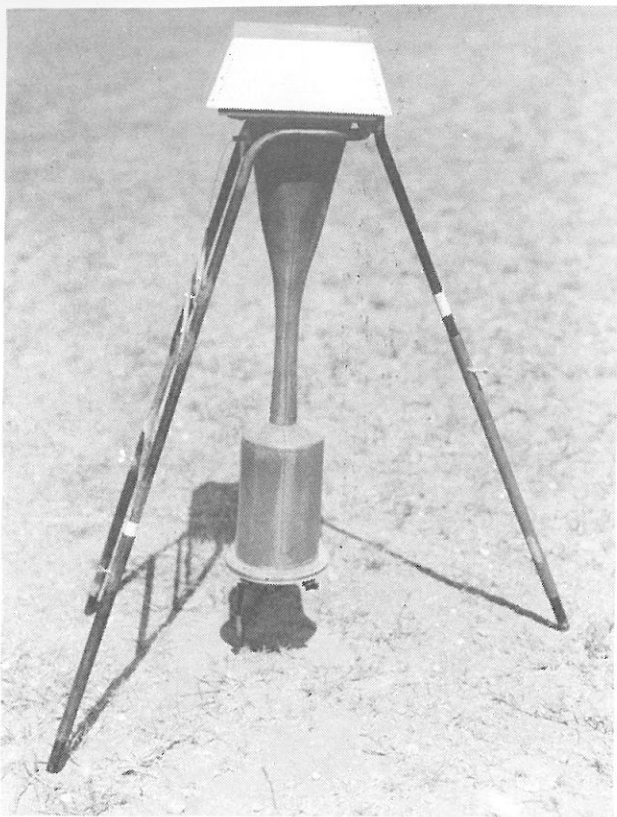


FIGURE 8: Tripod sampler fitted with critical flow device

The latest improvement to the flow controller is the critical flow device which is claimed to eliminate the effect of ambient atmospheric conditions. The inlet throat is designed to operate at the speed of sound while the orifice on the outlet maintains a constant flow of 1,13 cubic metres/minute. Figure 8 shows a critical flow device fitted to a tripod sampler.

The selection of filter papers is complicated by the fact that both the cellulose nitrate and plain cellulose types are not very porous and produce high pressure drops. We have used the plain cellulose filters almost exclusively as they seem to be the best suited for chemical analysis of the dust. Over a four year period we burned out more than 30 motors because of the pressure drop problem. Glass fibre filters are well suited to gravimetric analysis and they give the lowest pressure drop. They may cause interference to some types of chemical or X-ray analyses, however.

REFERENCE

HALD, A., *Statistical Theory with Engineering Applications*, John Wiley, New York 1952.