



# DUSTWATCH CC

Company Registration Number : 2008/134744/23

| P.O. Box 1810 Sun Valley 7985, Republic of South Africa |

| Tel: 021 785 6999 | Fax: 0866 181 421 | Cell: 082 875 0209 |

| [info@dustwatch.com](mailto:info@dustwatch.com) | [www.dustwatch.com](http://www.dustwatch.com) |

## DustWatch Training Handout

### 1. Introduction:

Looking up at the sky, we would never guess that our atmosphere contains between one and three billion tons of dust and other particles at any given time. Wind assists in keeping this dust airborne, but gravity wins most of the time, forcing the dust particles earthward, proving the old adage: "what goes up, must come down."

Dust comes from many different sources. Some, like the byproducts of the combustion of fossil fuels, are man-made. Others come from natural sources – like sea-spray blowing off the ocean, or dust blowing in from the desert. Dust comprises inorganic matter, such as sand particles, as well as a large amount of organic matter, including pollen, spores, moulds and viruses. These minute particles, ranging in size from around 100 micro metres ( $\mu\text{m}$ ) to a few nano metres (nm), invade our airspace every day, a part of life that we aren't even aware of, except when we dust the furniture!

#### Definitions

- Aerodynamic diameter is the diameter of a spherical particle that has a density of  $1\text{g/cm}^3$  and which has the same terminal settling velocity as the particle of interest.
- Atmospheric dust – Dust that is in the atmosphere.
- Brownian Motion – The continual random movement, due to molecular agitation, of fine particles suspended in a gas or a liquid.
- $d_{50}$  – In a sample of dust the  $d_{50}$  diameter is the diameter above which fifty percent of the particles are larger, and below which fifty percent of the particles are smaller.
- Dry deposition – The collection of precipitant dust during periods with no rainfall.

- Export bucket – The export bucket can be the north, south, east or west bucket that is closest to the dust source. When the wind blows over the dust source towards the sampling location then the export bucket is open and dust from the dust source is collected in the bucket.
- Fugitive dust – Dust that is not emitted from a point source that can be easily defined, such as stacks. Sources are open fields, travel routes, stockpiles and process buildings.
- Meteorology – the earth science dealing with phenomena of the atmosphere (especially weather).
- Occult deposition – Increasing particle size due to moisture that results in deposition due to increased mass of particle.
- PM<sub>2.5</sub> – Sampling of atmospheric dust where the aerodynamic d<sub>50</sub> diameter is 2.5 µm.
- PM<sub>10</sub> – Sampling of atmospheric dust where the aerodynamic d<sub>50</sub> diameter is 10 µm.
- Precipitant dust – Any particulate matter that has an aerodynamic diameter below 100 µm.
- Total deposition – The sum of wet and dry deposition. Occult deposition is also included.
- Wet deposition – The collection of precipitant dust and any soluble substances in the rainwater during periods of rainfall.

### **Definition of monitoring:**

- Keep the focus on using the tool to create awareness and achieve the objective of monitoring which is to create awareness of environmental pollution.
- The design of a monitoring programme must therefore have regard for the final use of the data before monitoring starts.
- Environmental monitoring - The process of checking, observing, or keeping track of something for a specified period of time or at specified intervals.
- Environmental monitoring must have a goal in mind and be linked to a problem or potential problem.

- Keep it simple initially and then as the monitoring identifies problems, the results can be used to include more complicated results. Reports should be easy to read and understand.
- It is important to keep the big picture in focus when running a monitoring programme, while still maintaining high levels of quality control.

## 2. What is Precipitant Dust

Precipitant dust, as the word implies, is dust that precipitates or falls down.

Precipitant dust refers to any particle with an aerodynamic diameter less than 100  $\mu\text{m}$ .

Precipitant dust is broadly defined as particulate that ranges in size up to 100  $\mu\text{m}$  in diameter.

1. Inhalable particulate mass is for those materials that are hazardous when deposited anywhere in the respiratory tract. This is the particulate that will pass from the air into the nose or mouth and will travel up to the beginning of the throat.
2. Thoracic Particulate mass is for those materials that are hazardous when deposited anywhere within the lung airways and the gas-exchange region. This is the particulate that will pass through the throat and up to the small bronchiole.
3. Respirable particulate mass is for those materials that are hazardous when deposited in the gas-exchange region.

# Result Analysis Report

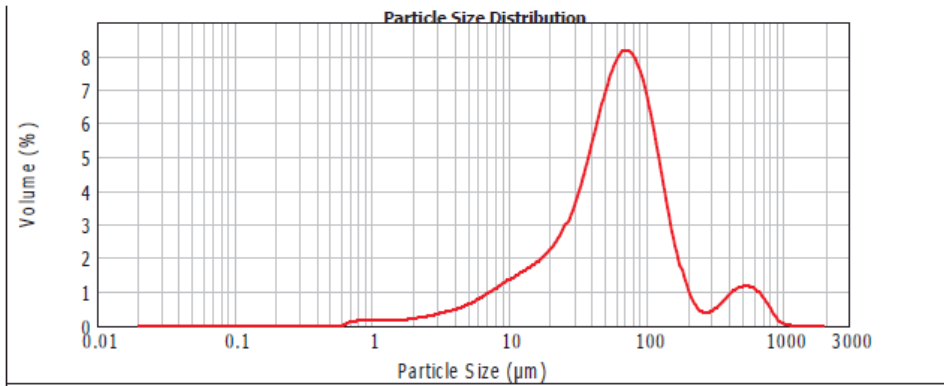
Sample Name: 12N ps + us - Average	SOP Name:	Measured: 31 October 2011 12:41:27 PM
Sample Source & type: Customer = Biograde	Measured by: Lab	Analysed: 31 October 2011 12:41:28 PM
Sample bulk lot ref: SDS 6715	Result Source: Averaged	

Particle Name: Default 1.52 0.01	Accessory Name: Hydro 2000G (A)	Analysis model: General purpose	Sensitivity: Normal
Particle RI: 1.520	Absorption: 0.01	Size range: 0.020 to 2000.000 um	Obscuration: 6.75 %
Dispersant Name: Water	Dispersant RI: 1.330	Weighted Residual: 0.692 %	Result Emulation: Off

Concentration: 0.0225 %Vol	Span : 2.432	Uniformity: 1.04	Result units: Volume
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Specific Surface Area: 0.251 m <sup>2</sup> /g	Surface Weighted Mean D[3,2]: 23.872 um	Vol. Weighted Mean D[4,3]: 94.996 um
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d(0.1): 12.723 um                      d(0.5): 61.210 um                      d(0.9): 161.559 um



—12N ps + us - Average, 31 October 2011 12:41:27 PM

Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.020	0.00	0.142	0.00	1.002	0.38	7.096	5.09	50.238	40.42	355.656	94.44
0.022	0.00	0.159	0.00	1.125	0.49	7.962	5.86	56.368	45.85	399.052	95.04
0.025	0.00	0.178	0.00	1.262	0.60	8.934	6.72	63.246	51.70	447.744	95.78
0.028	0.00	0.200	0.00	1.416	0.71	10.024	7.69	70.963	57.79	502.377	96.63
0.032	0.00	0.224	0.00	1.589	0.82	11.247	8.75	79.621	63.91	563.677	97.52
0.036	0.00	0.252	0.00	1.783	0.95	12.619	9.91	89.337	69.82	632.456	98.36
0.040	0.00	0.283	0.00	2.000	1.09	14.159	11.17	100.237	75.29	709.627	99.08
0.045	0.00	0.317	0.00	2.244	1.25	15.887	12.53	112.468	80.11	796.214	99.61
0.050	0.00	0.356	0.00	2.518	1.44	17.825	13.99	126.191	84.15	893.367	99.90
0.056	0.00	0.399	0.00	2.825	1.66	20.000	15.59	141.589	87.35	1002.374	99.98
0.063	0.00	0.448	0.00	3.170	1.91	22.440	17.36	158.866	89.72	1124.683	100.00
0.071	0.00	0.502	0.00	3.557	2.19	25.179	19.36	178.250	91.35	1261.915	100.00
0.080	0.00	0.564	0.00	3.991	2.52	28.251	21.67	200.000	92.40	1415.892	100.00
0.089	0.00	0.632	0.00	4.477	2.90	31.698	24.36	224.404	93.02	1588.656	100.00
0.100	0.00	0.710	0.05	5.024	3.33	35.566	27.52	251.785	93.39	1782.502	100.00
0.112	0.00	0.796	0.15	5.637	3.84	39.905	31.23	282.508	93.68	2000.000	100.00
0.126	0.00	0.893	0.26	6.325	4.42	44.774	35.53	316.979	94.00		

Operator notes:

<b>Inhalable</b>	
<b>Particle Aerodynamic Diameter (µm)</b>	<b>Mass % Inhalable Particulate</b>
0	100
1	97
2	94
5	87
10	77
20	65
30	58
40	54.5
50	52.5
100	50

The Mass % of Inhalable Dust that can be deposited.

<b>Thoracic</b>	
<b>Particle Aerodynamic Diameter (µm)</b>	<b>Mass % Thoracic Particulate</b>
0	100
2	94
4	89
6	80.5
8	67
<b>10</b>	<b>50</b>
<b>12</b>	<b>35</b>
<b>14</b>	<b>23</b>
<b>16</b>	<b>15</b>
<b>18</b>	<b>9.5</b>
<b>20</b>	<b>6</b>
<b>25</b>	<b>2</b>

Mass % that can be Deposited in the Lung Airways and the Gas-exchange Region

<b><u>High Sensitivity</u></b>	<b><u>Medium Sensitivity</u></b>	<b><u>Low Sensitivity</u></b>
Hospitals and clinics	Schools	Farms
Retirement homes	Residential areas	Light and heavy industry
Hi-tech industries	Food retailers	Outdoor storage
Areas where painting is being done	Greenhouses and nurseries	
Food processing	Horticultural land	
	Offices	

The fall-out dust standards from STANDARDS SOUTH AFRICA are shown in the table below. (SANS 1929:2011)

<b>Classification</b>	<b>Dustfall (mg/m<sup>2</sup>/day) – averaged over 30 days.</b>	<b>Permitted frequency of exceeding the levels.</b>
Target – long-term average	300	Long-term average (Annual)
Action – residential	600	Three within any year, no two sequential months.
Action – industrial	1200	Three within any year, no two sequential months.
Alert threshold	2400	None. First time exceeded, triggers remediation and reporting to authorities.

### 3. How to collect fallout dust.

The present method to establish precipitant dust levels is the ASTM (American Standard Test Method) D-1739 of 1998 “Standard Method for Collection and Analysis for Dust Fall (Settleable particulates)”

While single open buckets partly-filled with a capture medium will accumulate all precipitating dust, this does not establish precipitant dust emanating from a given direction unless the bucket is closed to any dust from other directions. Such open buckets are also subject to inaccuracies due to wind turbulence within the buckets, lower air densities over the bucket and other factors.

The single bucket precipitant dust collection method “is a crude and nonspecific test method, but it is useful in the study of long-term trends.”

#### **Sidebar: How big is a micrometer?**

A. One micrometer is 1/1 000 000 of a meter, or 1/1 000 of a mm. For comparison, the thickness of a human hair ranges from 50 to 200 micrometers. The smallest particle discernible by the human eye is about 10 micrometers.

Initially keep it simple and then, if required, go to more complex scenarios.

## DustWatch Training Handout

TABLE TWO - CARRIAGE OF AIRBORNE PARTICULATES

WIND VELOCITY m/s	DUST PARTICULATE SIZE µm	MODE OF TRAVEL / CREEP	NOTES-
0 - 15	< 20		VEGETATION DOES NOT IMPEDE TRAVEL OF DUST UNLESS CLOSE TO SOURCE OF DUST.
1,5 - 2,0	20 < 50		TREES WILL ARREST 50µm PARTICULATES
2,5 - 3,0	50 < 80		BUSHES WILL ARREST 80µm PARTICULATES
3,5 - 4,0+	80 >		BUSHES WILL ARREST + 80µm PARTICULATES

Vegetation does not impede travel of dust unless close to source of dust

Trees will arrest greater than 50 micrometre or 50 micron dust particulates up to a height of 10 metres

Bushes will arrest greater than 80 micrometres or 80 micron particulates up to a height above the ground of 3 metres.

Bushes will arrest greater than 80 micrometres or 80 micron particulates.

### Notes:

With factors like particulate density and shape playing a major part in the distance that the particle will travel, the above table is only an indication based on test work with tracer dust. The height to which particulate is lifted depends on air turbulence, temperatures, humidity, density and thermals which can be encountered. Vegetation and Bush can impede and capture larger particulates.

## 4. How to Calculate fallout dust Results and Interpretation.

### CALCULATIONS

- The cross-sectional area of the buckets is a standard constant in all of the calculations representing the area over which fall-out collection has been made:

$$= 0.02545\text{m}^2$$

- The actual mass collected is derived by subtraction of the mass of the filter ( $\text{mass}_1$ ) from the combined mass of the filter and filtrate ( $\text{mass}_2$ ):

$$\text{Mass}_2 - \text{mass}_1 = \text{collected mass of dust sample}$$

- All units should be expressed in milligrams and the value of milligram/square metre/day derived from the formula:

$$\text{Fall-out rate (mg/m}^2\text{/day)} = \frac{\text{collected mass} \times 1}{0.02545 \times \text{days}}$$

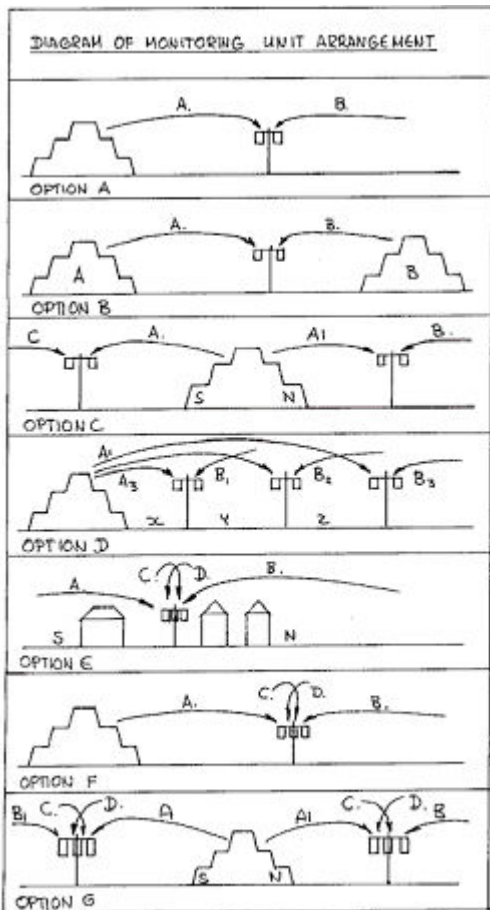
### LIMITATIONS OF SAMPLING AND FILTER MATERIALS

- Generally finer suspended dust ( $2.5\mu\text{m} > 5\mu\text{m}$ ) will remain airborne almost indefinitely due to the dynamic nature of the air currents and thermal activities on any given day, even if there is no wind at all. A rapid increase in humidity together with an absence of wind will result in precipitation of less than 5 micron particulate.
- Particulate larger than about  $5\mu\text{m}$  will settle on a very still day and this material is collected within the DustWatch buckets in varying amounts depending on the wind velocities.
- Particulate of a size about  $0.5\text{mm}$  carried by high wind velocities will not be collected within the buckets due to the aerodynamic shape and wind screen effect of the selector disk. This acts much like the wing of an aircraft, which produces a high-pressure area below the disk, keeping the gritty particulate from falling into the



buckets. The disk optimum efficiency occurs at wind velocities exceeding 2.0m/s. At velocities below 3.0 m/s no particulate of this size is lifted higher than a maximum of about 2.0m.

- Once the wind drops to lower levels the particulate starts precipitating and this gets captured in the buckets. We thus note that no dust gets captured during very windy conditions but actually when the wind drops. Once the wind changes, the maximum precipitation rate is reached when the air mass movement is totally arrested and then starts to move in the opposite direction.



### Results Achieved - Linear Function

#### Source Export Dust and Ambient Import

- A. Direct Export from Source
- B. Ambient Import

#### Cross Contamination - Two Stockpiles

- A. Direct A Export
- B. Direct B Export

#### Nett Export / Ambient Import

- Nett Export North =  $A1 - C$
- Nett Export South =  $A - B$
- Ambient Import =  $C$  and  $B$  (S and N)

#### Fall-out Quantification

- Fall-out at  $x$  metres =  $A3$
- Fall-out at  $(x+y)$  metres =  $A2$
- Fall-out at  $(x+y+z)$  metres =  $A1$

#### Village Nett Import

- Import from North =  $B$
- Import from South =  $A$
- + Import from East and West =  $C$  and  $D$  (4 bucket units)

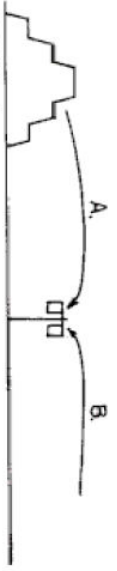
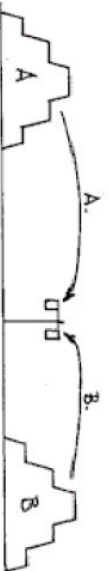


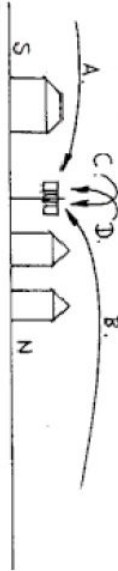
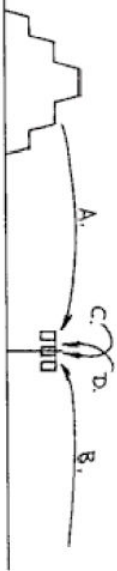
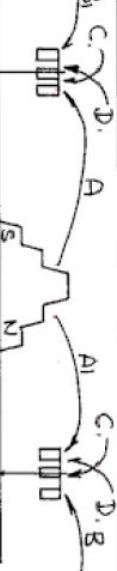
#### Source Export with Ambient Import From 3 Directions

- A. Direct Export From Source
- B. Opposing Ambient Import and Import From Other Directions  $C$  and  $D$  (4 bucket units)

#### 4 Directions - Nett Export / Ambient Import - 4 Directions

- Nett Export North -  $A1 - B1$
- Nett Export South -  $A - B$
- Ambient Import =  $B1$  and  $B$  (S & N)
- Ambient Import =  $C$  Checks  $C$  and  $D$  Checks  $D$  (East and West)

A slightly larger image has been shown on the next page.

DIAGRAM OF MONITORING UNIT ARRANGEMENT	RESULT ACHIEVED LINEAR FUNCTION
 <p>OPTION A</p>	<p><u>SOURCE EXPORT DUST &amp; AMBIENT IMPORT</u></p> <p>A. DIRECT EXPORT FROM SOURCE B. AMBIENT IMPORT</p>
 <p>OPTION B</p>	<p><u>CROSS CONTAMINATION-TWO STOCKPILES</u></p> <p>A. DIRECT A EXPORT B. DIRECT B EXPORT</p>
 <p>OPTION C</p>	<p><u>NETT EXPORT/AMBIENT IMPORT</u></p> <p>NETT EXPORT NORTH = A1-C NETT EXPORT SOUTH = A-B AMBIENT IMPORT = C AND B (S4N)</p>
 <p>OPTION D</p>	<p><u>FALL-OUT QUANTIFICATION</u></p> <p>FALL OUT AT <math>x_m = A_3</math> FALL OUT AT <math>(x+y)_m = A_2</math> FALL OUT AT <math>(x+y+z)_m = A_1</math></p>
 <p>OPTION E</p>	<p><u>VILLAGE NETT IMPORT</u></p> <p>IMPORT FROM NORTH = B IMPORT FROM SOUTH = A + IMPORT FROM EAST &amp; WEST = C AND D (4 BUCKET UNITS)</p>
 <p>OPTION F</p>	<p><u>SOURCE EXPORT WITH AMBIENT IMPORT FROM 3 DIRECTIONS</u></p> <p>A. DIRECT EXPORT FROM SOURCE B. OPPOSING AMBIENT IMPORT + IMPORT FROM OTHER DIRECTIONS C AND D (4 BUCKET UNITS)</p>
 <p>OPTION G</p>	<p><u>NETT EXPORT/AMBIENT IMPORT-4 DIRECTIONS</u></p> <p>NETT EXPORT NORTH = A1-B1 NETT EXPORT SOUTH = A-B AMBIENT IMPORT = B1 AND B (S4N) AMBIENT IMPORT = C CHECKS C B D CHECKS D (S4W) (4 BUCKET UNITS)</p>

## 5. TRACE ELEMENT ANALYSIS AND FINGERPRINTING

Very often there is a necessity to know more than the mere proportions of various chemical elements within a sample, especially when detailed fingerprinting has to be undertaken. Under these circumstances or where a high natural radiation level exists it is important to view trace elements like the following:

- Super short-lived radio nuclides (F & Se)
- Short-lived radio nuclides (Ti, V, Cl & Br)
- Intermediate – lived radio nuclides (As, Mn, Mo, Ni & Br)
- Long-lived radio nuclides (Ba, Cd, Cr, Co, Hg, Mo, Se, Th & U)

The analysis lends itself ideally to fingerprinting for a suite of some 40 – 60 elements depending on the composition of the dust.

## 6. MicroScanning

The carrying out of a routine microscopic examination offers a valuable continuous check for any sign of fibres of a mineral nature as well as giving an indication of the amount of organics within the sample. While very detailed examinations require specialised knowledge and techniques, the type of examination carried out here can be extremely valuable in offering an insight into the collected dust.