Dok. 16

AIR QUALITY MONITORING
CEMENT SILOS

OUR REF: ENV33208/B/13

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Quality Assurance

Air Quality Monitoring Cement Silos

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1. Introduction

AIS Environmental was commissioned by UC Limited to conduct an air quality assessment prior to the construction of the cement handling and storage facility at Laboratory Wharf, Kordin. A 21-day campaign was undertaken between the 8 and 13 October 2013.

The parameters measured during this assessment included: PM_{10} and $PM_{2.5,}$ calcium and magnesium. These metals were considered relevant to monitor due to the activities to be performed at cement handling and storage facilities. After the plant starts to be operative, the results of this survey will serve as a basis for future air quality evaluations in the area.

2. The Cement Handling and Storage Facility

The bulk cement storage facilities cover an area of approximately 650 m^2 excluding offices and un/loading facilities. The area is within the confines of the wharves managed by Valletta Gateway Terminals Ltd.

The system installed consists of rectangular storage silos having a combined storage capacity of 6,000m^3 (equivalent to approximately 8,000 metric tonnes of cement). This system consists of the following main sections:

- Ship unloading equipment;
- Cement bulk storage silos;
- Loading stations for cement road bulk carriers; and
- Dust bag filtration systems.

Cement will be delivered to the site by sea in bulk cement carriers, which are completely sealed. These will berth alongside the quay and unload cement into the bulk cement storage silos. This shall be unloaded and stored in rectangular silos and will be subsequently delivered to cement road bulk carriers by means of enclosed screw conveyors. Unloading into road bulk carriers shall be via telescopic loading bellows.

In close proximity to the bulk cement storage silos is the Kordin Grain Terminal which makes use of open conveyor systems to unload grains from the carriers into its silos. The location of both facilities is mapped in Figure 1.

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Figure 1: Location of cement handling and storage facilities and Kordin Grain Terminal

3. Legislative context

3.1. Ambient Air Quality Legislation

3.1.1. European Directives

The two European Directives of greatest relevance to this air quality assessment are: 2008/50/EC and 2004/107/EC.

Directive 2008/50/EC incorporates, in a single directive, the previous existing legislation acts issued between 1996 and 2002:

Air quality Framework directive (Directive 96/62/EC).

- First Daughter Directive (1999/30/EC);
- Second Daughter Directive (200/69/EC);
- Third Daughter Directive (2002/3/EC) except for the Directive 2004/107/EC relating the Arsenic, Cadmium. Mercury, Nickel and Benzo(a)pyrene that remains in force; and
- The main aim of this Directive is to maintain, and whenever possible, improve the air quality to protect the health of humans, vegetation and ecosystems.

Directive 2004/107/EC of the European Parliament and of the Council of 15 December 2004 relating to Arsenic, Cadmium, Mercury, Nickel and Polycyclic Aromatic Hydrocarbons in ambient air (the Fourth Daughter Directive) is the final stage in the process launched by framework Directive 96/62/EC of recasting the European legislation on the presence of pollutants posing a risk to human health. Given that the substances involved are human carcinogens, and that there is no identifiable threshold below which they do not pose a risk to human health, the Directive applies the principle of lowest possible exposure to them.

The directive does not set limit values for emissions of Polycyclic Aromatic Hydrocarbons (PAH), but uses Benzo(a)pyrene as a marker for the carcinogenic risk of these pollutants and sets a target value to be reached.

The Directive also determines methods and criteria for assessing the concentrations and deposition values of the substances in question in order to ensure that adequate information is obtained and made available to the public.

3.1.2. Maltese legislation

The Maltese national legislation transposes the European Directives related to air quality assessment and monitoring as specified in Table 1:

Table 1: The Maltese Legal Notices

EU DIRECTIVE	MALTESE LEGAL NOTICE
Directive 2004/107/EC	*L.N. 478/2010*
Directive 2008/50/EC	*L.N. 478/2010*

L.N. 478/2010 determines the European Norm (EN) that must be applied in Malta for sampling and measuring ambient air pollutants. Norms are developed by the European Committee for Standardization which is a European Institute that develops and uniforms procedures in any technical field. The EN specifications which have been applied in this project are:

Reference method for the sampling and measurement of PM_{10}: EN 12341:1999 *"Determination of the PM_{10} fraction of suspended particulate matter";*

Reference method for the sampling and measurement of $PM_{2.5}$: EN 14907:2005 *"Standard gravimetric measurement method for the determination of the $PM_{2.5}$ mass fraction of suspended particulate matter";*

3.1.2.1. Limit values

Table 2 and Table 3 specify the pollutants' limit value applied in this air quality monitoring.

- **PM_{10} (Schedule 7 of L.N. 478/2010)**

Table 2: PM10 (Schedule 7 of L.N. 478/2010)

PM_{10}			
One day	50 µg/m³, not to be exceeded more than 35 times a calendar year	50 %	— (1)
Calendar year	40 µg/m³	20 %	— (1)

- **$PM_{2.5}$ (Annex XIV of L.N. 478/2010)**

Table 3: $PM_{2.5}$ (Annex XIV of L.N. 478/2010)

Averaging period	Limit value	Margin of tolerance	Date by which limit value is to be met
STAGE 1			
Calendar year	25 µg/m³	20 % on 11 June 2008, decreasing on the next 1 January and every 12 months thereafter by equal annual percentages to reach 0 % by 1 January 2015	1 January 2015
STAGE 2 (1)			
Calendar year	20 µg/m³		1 January 2020

(1) Stage 2 — indicative limit value to be reviewed by the Commission in 2013 in the light of further information on health and environmental effects, technical feasibility and experience of the target value in Member States.

- **Calcium and Magnesium**

Directive 2004/107/EC relating to Arsenic, Cadmium, Mercury, Nickel and Polycyclic Aromatic Hydrocarbons in ambient air does not specify any identifiable threshold below which these human carcinogens do not pose a risk to human health. The Directive applies the principle of lowest possible exposure to them. Based on this, the European or Maltese legislation still need to specify the limit values for Calcium and Magnesium.

4. Technical Specification

4.1. Sampling activities

Sampling and measurement of PM_{10} and $PM_{2.5}$ was conducted following the European Norms, EN 12341:2001 and EN 14907:2005, as stated in the L.N. 478/2010 (*Ambient Air Quality Regulations*).

The sampling was performed by using the SKYPOST PM HV model, a gravimetric instrument which draws in the ambient air at a constant flow rate and forces it to pass through a membrane filter that captures all the particulate matter with a diameter smaller than 10µm. The filter was changed every 24 hours and provided the daily average PM_{10} and $PM_{2.5}$ concentration.

The location of the two SKYPOSTs, one for PM_{10} and one for $PM_{2.5,}$ are shown in Figure 2 and Figure 3. The instruments were placed close to the quay where unloading practices of various cargo takes place on regular basis. This quay is called Lab Wharf / Magazine Wharf and is used by the Grimaldi RORO vessels, grain cargo vessels and oil/fuel vessels while another cement discharge/storage operation is carried out at Fuel Wharf. The cement carriers for UC Limited will also be docking at this quay in the future for unloading purposes.

The figures below show a vessel moored at the quay in the same location where both cement carriers and grain cargo vessels would eventually dock to unload cargo according to stipulated schedules. The yellow metal structure visible in Figure 3 is the open conveyor belt upon which grain unloaded from the cargo vessel is transported to the terminal.

Figure 2: Positioning of two instruments: one SKYPOST for PM10 and the other for $PM_{2.5}$

Figure 3: Positioning of two instruments: one SKYPOST for PM_{10} and the other for $PM_{2.5}$

4.1.1. Sampling device requirements

The EN 12341 specifies the gravimetric sampling method for the determination of the PM_{10} in the atmosphere. According to the norm the sampling instrument to be used must have an inlet orifice connected directly with the sampling filters and a flow regulator. From this basic structure, either of the below specifications must be availed of to ensure standard measurement:

- Low volume sampling device (LVS-PM_{10}) with a total air flow of 2.3 m^3/h;
- High volume sampling device (HVS-PM_{10}) with a total air flow of 68 m^3/h; and
- Extra high volume sampling device (WRAC-PM_{10}) with a total air flow of 1966 m^3/h.

In this project, a Low Volume Sampling device was used. This device forces a constant volume of air (2.3 m^3/h – flow rate determined by EN12341 for Low Volume Sampler) to pass through a filter, and then the concentration of PM_{10} is calculated comparing the filter's weight before and after the sampling.

The inlet orifice design specifications are shown in Figure 4. They include a cover for the orifice so it is protected against atmospheric events such as rain or snow. The impaction area should be able to incorporate filters of diameter between 47 and 50mm and it should be cleaned and lubricated frequently.

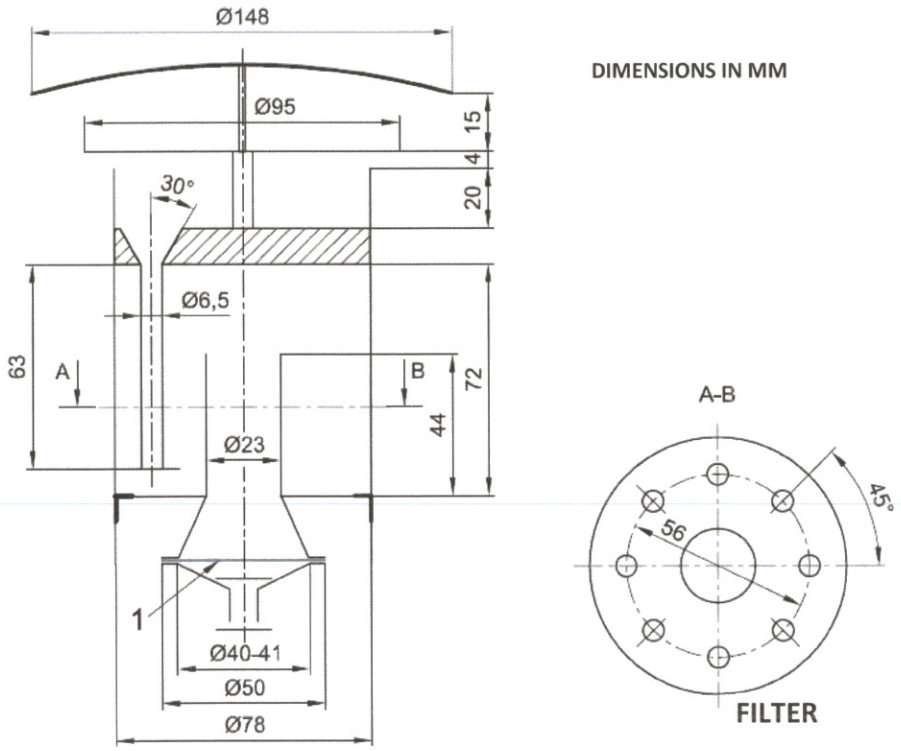


Figure 4: Constructive features of the standard sampling head in compliance with EN 12341 (Source: EN12341)

The European Norm EN 14907:2005 establishes the sampling specifications for the $PM_{2.5}$. The basic components of the sampling device to be used are illustrated in Figure 5.

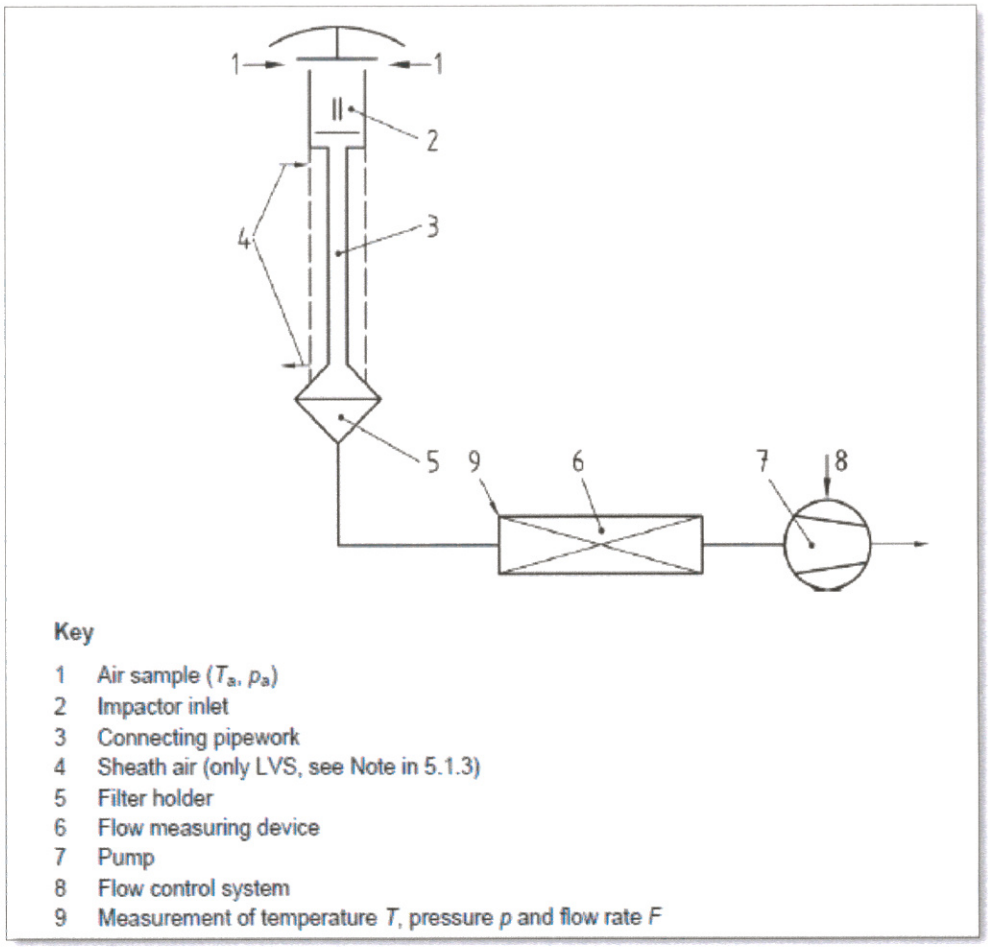


Figure 5: Technical specifications of the PM2.5 standard sampler

In the UN EN 12345, two modalities of sampling device are accepted:

- LVS standard inlet design (as applied in this project); and
- HVS standard inlet design.

Further technical specifications consider that the connecting pipework should have a close temperature to the surrounding environment, no less than ± 5°C. Also during spring and summer, the filters should not experience a temperature increase higher from 5°C in comparison with the air surrounding the sampler.

Based on these specifications, the instrument used for this campaign was the SKYPOST PM HV model (manufactured by TECORA Company), a particulate matter dedicated station for continuous sequential sampling. It is weather proof and designed for outdoor uses.

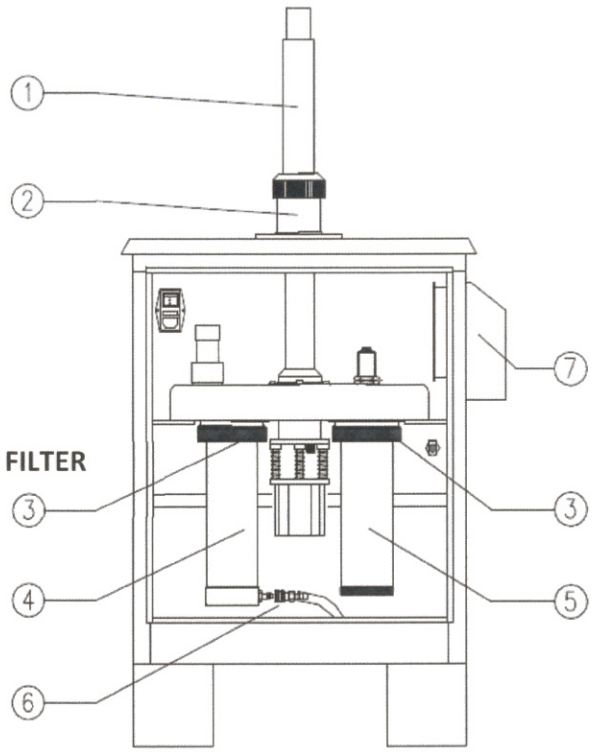
5. SKYPOST characteristics

The characteristics of this sampler meet and exceed the requirements of the European Norm EN 12341 that establishes the methodology for correct sampling and it is certified by TUV and UNI EN ISO 9001. The construction features of the sampling head are fundamental because they allow only the particulate matter with a diameter less than 10 μm to enter the suction tube (Figure 6) and consequently be captured by the filter. Particulate matters with a diameter bigger than 10 μm remain on the impaction plate placed below the nozzles.

Figure 6: SKYPOST PM HV sampler

Because of its configuration, the impaction plate has to be cleaned and greased every 15 consecutive monitoring days. The incoming air enters the suction tube of 23mm diameters and then passes through the filter membrane with a diameter of 47mm which it is automatically substituted every 24 hours with a clean one.

The SKYPOST PM is equipped with the following features (Figure 7) :



1. Suction tube
2. Slide device for suction tube complete of a waterproof o-ring gasket
3. Filter reservoir tightening screwed rings
4. Clean filter reservoir
5. Exposed filter reservoir
6. Pneumatic quick connection for filter load
7. Internal ventilation air exit

Figure 7: SKYPOST PM HV - Front Side Detail

The straight suction tube with its round shape and the separation of the storage filter zone from internal and radiant source of heat allows collecting and keeping the integrity of the pollutants. The pneumatic tube serves to push up the clean filter in the mobile horizontal panel which every time there is a change of the filter it moves to the right to discharge the exposed filter in the exposed filter reservoir and at the same time to place the unexposed filter in the sampling position. Thus the upper filter contained in the exposed reservoir represents the last day of sampling.

Internal ventilation system guarantees a differential temperature between the filter and the sample inlet of maximum 5°C complying therefore with the EN 14907 specifications. The instrument also measures the instantaneous filter temperature (Θf) and the maximum difference from the instantaneous ambient temperature (Θa) and Θf.

The instrument reports an error "Alarm filter temperature out of specification" in the case that for more than 30 minutes the differential temperature between filter and ambient is over 5°C.

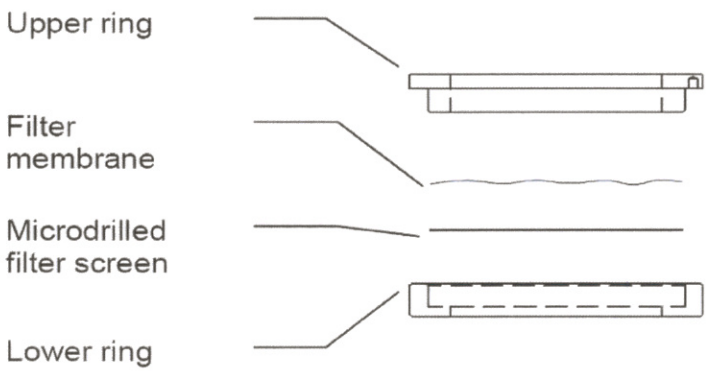


Figure 8: Filter cassette - assembling parts

Figure 9: Filter cassette without the filter

Since the sampler has to work with a constant flow rate of 2.3 $m^3/h \pm 2\%$ (EN 12341), the SKYPOST has installed a dry gas meter within 2% precision and it can electronically control the flow. SKYPOST is also equipped with a sensor to measure the atmospheric pressure and temperature and the pressure drop on filter. This sensor is installed on the suction tube and is protected against bad meteorological conditions (Figure 10). The data from the sensors and the volumetric measurements is automatically printed by the instruments but these can also be downloaded in the field by using the dedicated software and a RS 232 interface connection.

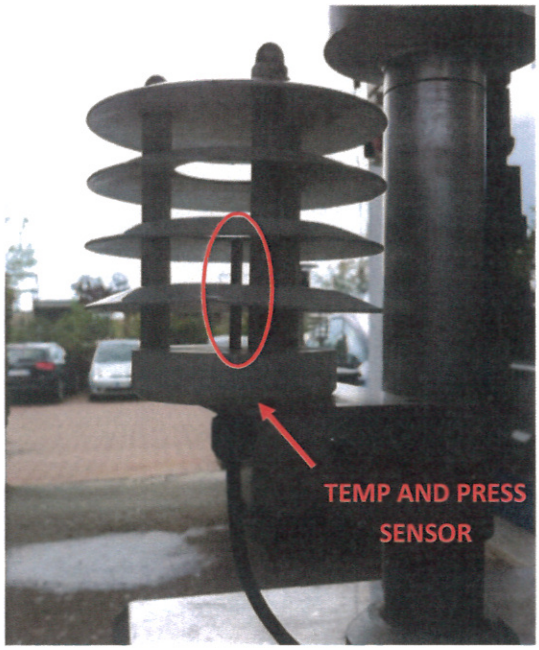


Figure 10: Particular of the atmospheric pressure and temperature sensor

A ventilation and differential thermo-regulated heating system allows the instruments to operate even in the extreme ambient conditions.

The pump is placed on the rear side below the front panel keyboard and printer (Figure 11). An hour-counter keeps the information of the total working hours of the pumps. It is highly recommended from the manufacturer to perform pump maintenance every 6000 hours.

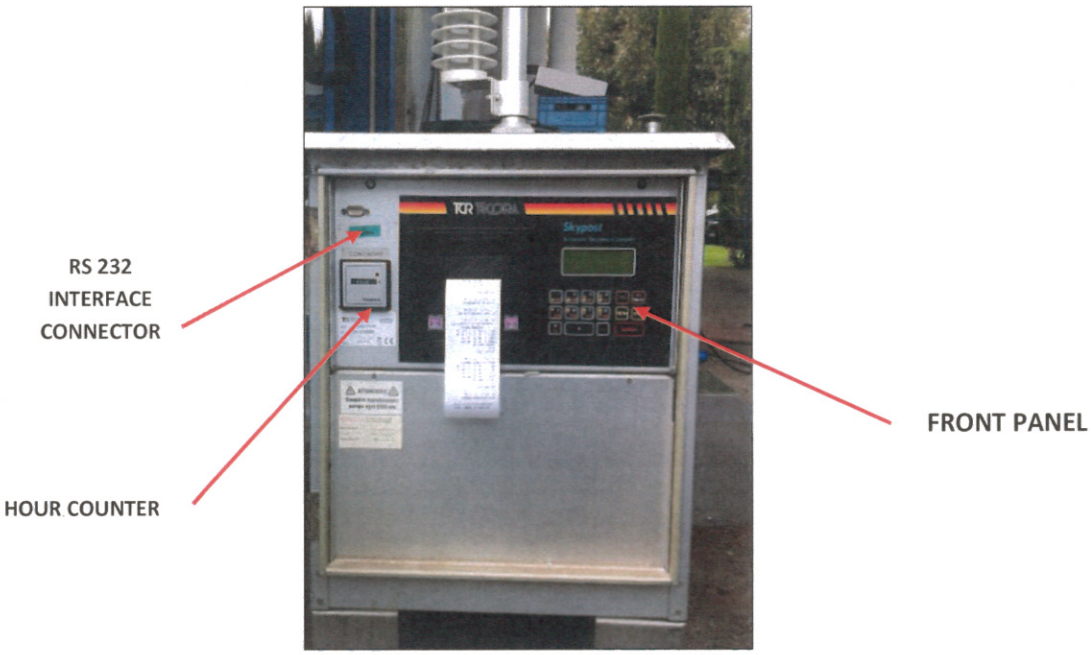


Figure 11: SKYPOST PM HV – backside detail

Table 4 summarizes the technical characteristics of the SKYPOST:

Table 4: SKYPOST technical characteristics

TECHNICAL CHARACTERISTICS	
Autonomy	16 filters
Filter diameter	47mm
Power supply	220 V 50Hz
Dimensions (b*b*h)	400*250*600 mm
Box	In fire painted steel
Weight Kg	42 Kg
Pump type	Rotary vane 6 m^3/h
Flow rate range	0.6-3 m^3/h

The SKYPOST PM can be set up for any sampling time interval and the exposed filters can easily be replaced without interrupting the sampling. In fact, the sampler is set up to automatically change the sample filter every 24 hours. The sampler can be paused for any reason (e.g. cleaning the sampling head, fix out a technical problem) and re-started again without losing data or compromise the sampling.

5.1. Laboratory activity

The laboratory activity can be subdivided in two main phases:

1. Preparation of the clean filters; and
2. Analysis of the exposed filters.

5.1.1. Preparation of the clean filters

In order to be in compliance with the EN 12341, the filters must be first conditioned for 48 hours in special perforated trays, protected from possible dust in the environment. The weighing room they are placed in, must have a temperature of 20° C ± 1° C and a relative humidity of 50 ± 5 %.

These specifications are followed by placing the filters into dedicated cassettes open at the bottom and covered at the top (so each filter is protected from dust) and especially designed against electrostatic charges. These cassettes are illustrated in Figure 12. Also the filters are handled using blunt tweezers to avoid contamination and damage, as indicated in the EN 14902.

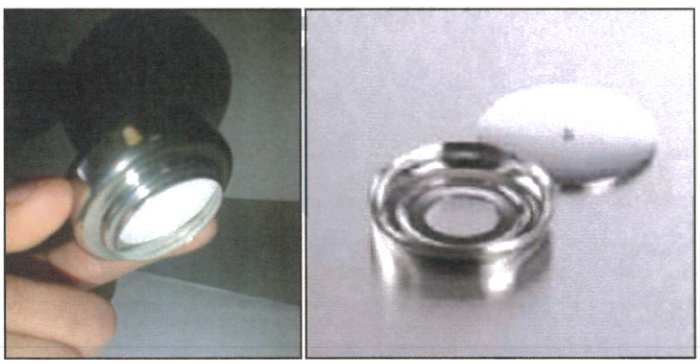


Figure 12: Filter cassette

All the cassettes are located within a rack of six levels painted with a special product that guarantees a lower contribution of electrostatic charges. This, together with the deionisation system, illustrated at the right side of Figure 13, ensures the absence of possible interfering electrostatic.

Figure 13: Micro-meteo station and Rack of six levels

This rack is located within a dedicated chamber, with controlled micro-climatic conditions.

A dedicated micro-meteo station monitors both the relative humidity and temperature values.

This chamber is also protected from dust and particular matter, as required by the Reference Method. The chamber is located in a dedicated room with air conditioning system, controlled micro-climatic conditions and monitored by a meteo station.

Figure 14 and Figure 15 show the conditioning chamber, the conditioning room and the automatic weighing system used by ambiente's laboratory.

Figure 14: ambiente's conditioning chamber

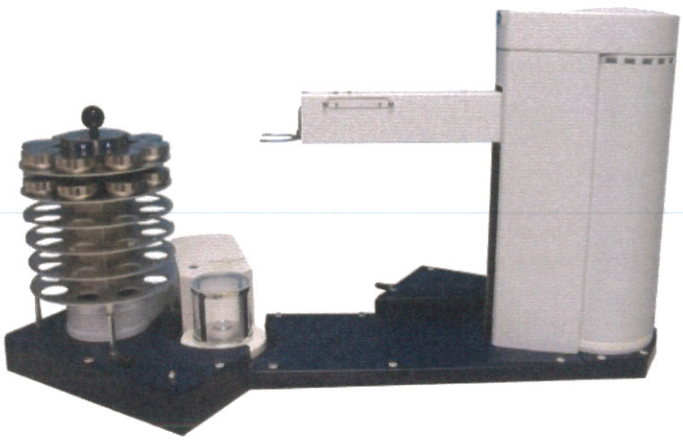


Figure 15: Analytical balance Mettler Toledo XP6

The next step specified by the norm is to weigh the filters before the sampling, which should be done using a balance located already in the weighing room and with a resolution of at least 10 µg. *ambiente's* laboratory, is provided with the analytical balance Mettler Toledo XP6 (Table 5) that has the following characteristics:

Table 5: Characteristics of the analytical balance Mettler Toledo XP6

Nominal and guaranteed values	**XP6**
Maximum capacity	6.1 g
Readability	0.001 mg
Repeatability - at nominal load	0.0008 mg
- at low load (measured at)	0.0006 mg (0.2 g)
Linearity	0.004 mg
Eccentric load deviation (test load)[1)]	0.005 mg (2 g)
Sensitivity offset	7×10^{-6}
Sensitivity temperature drift[2)]	0.0001 %/°C
Sensitivity stability[3)]	0.0001 %/a
Techical data - typical values[4)]	
Repeatability (sd)	0.0004 mg+3 x (10–8)•R_gr
Differential linearity deviation (sd)	$\sqrt{1.5x(10^{-13})g \cdot R\_nt}$
Differential eccentric load deviation (sd)	$5 \times (10^{-7}) \bullet R\_nt$
Sensitivity offset (sd)[2)]	$1.5x(10^{-6}) \cdot R\_nt$
Minimum weight (according to USP)	$1.2\ mg+9 \times (10^{-5}) \bullet R\_gr$
Minimum weight (@ U=1 %. 2 sd)	$0.08\ mg+6 \times (10^{-6}) \bullet R\_gr$
Settling time	< 8 s

[1)] According to OIML R76

[2)] In the temperature range 10 - 30°C

[3)]Stability of sensitivity as from first installation with FACT

[4)]Can be used for the estimation of uncertainty sd: standard deviation Rgr: gross weight Rnt: net weight (sample weight) a: year (annum)

The filters are then placed in a labeled sealed cassette. A laboratory report with the use of each filter, their position in the cylinder and the correspondence between cassette and filter weight (to avoid contamination. no marking is made on the filter surface) is written. After the 16 filters are put in the clean reservoir, these are ready to be directly inserted in the SKYPOST sampler.

5.1.2. Analysis of the exposed filters

According to the EN 12345 and the EN 14907, after the sampling phase, the filters should be left in a conditioning room at a temperature of 20°C and relative humidity of 50% for at least 48 hours in order to reach the equilibrium. Afterwards, these are weighed using the analytical balance. The PM_{10} and $PM_{2.5}$ concentrations are determined by the following formula:

$$C_{PM} = (W_{EF} - W_{UF}) / V$$

Where:

C_{PM}= PM concentration in ($\mu g/m^3$)

W_{EF}= Weight of the exposed filter (μg)

W_{UF}= Weight of the unexposed filter (μg)

V= Actual sampling volume (m^3)

The filters are also analysed for metals by being taken in solution by closed vessel microwave digestion using nitric acid and hydrogen peroxide. The resultant solution is analyzed by Inductively Coupled Plasma – Mass Spectrometry (ICP-MS). The laboratory is equipped with ICP-MS Agilent Technologies S.p.A. – 7500cx (Figure 16).

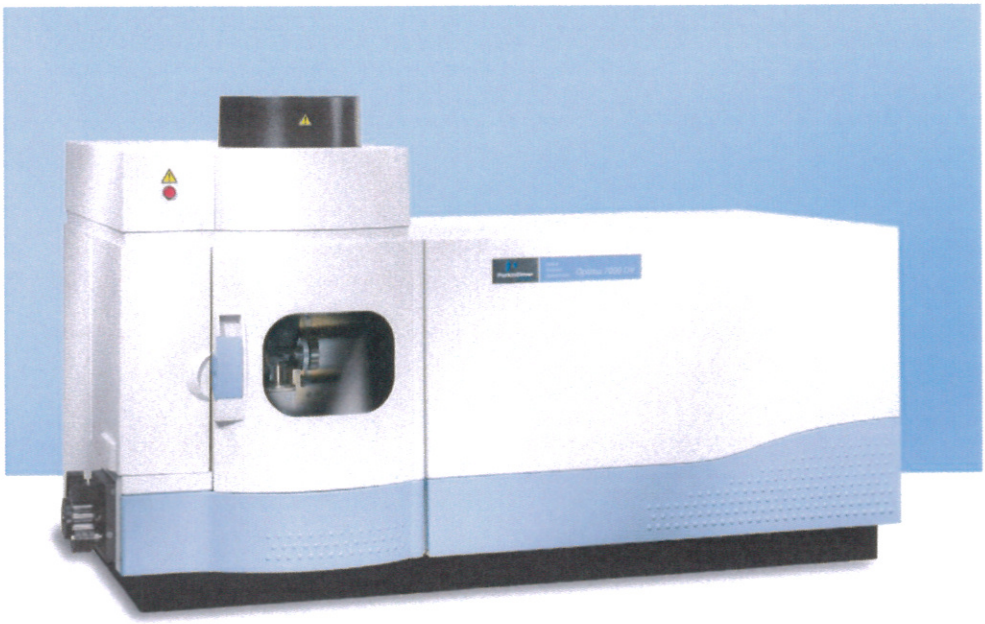


Figure 16: ICP -MS Agilent technologies S.p.A. - 7500cx.

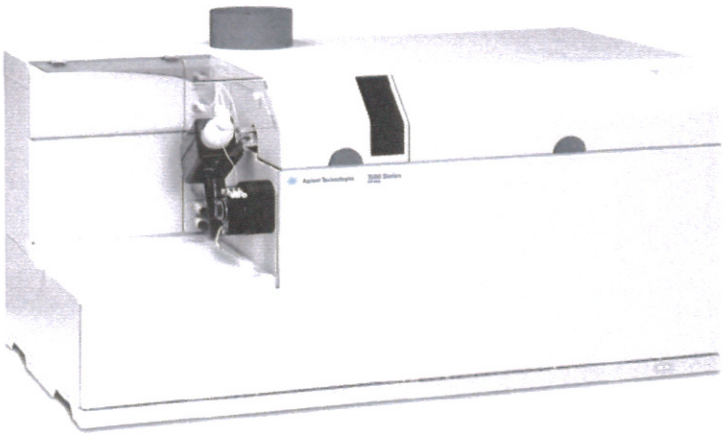


Figure 17: ICP -AES Perkin Elmer – Optima 7000DV.

The digestion occurs in the following microwave: Microwave Reaction System – Perkin Elmer Anton Paar – Multiwave 3000 (Figure 18).

Figure 18: Multiwave 3000 - Perkin Elmer Anton Paar

The limits of quantification for the parameters analysed were determined prior to the initiation of the monitoring campaign. The limits of quantification (LoQ) for each parameter are listed in Table 6:

Table 6: The limits of quantification (LoQ) for each parameter

Parameter	Unit	Limit of Quantification
PM_{10}	mg	< 0.1
Calcium in PM_{10}	mg	< 0.005
Magnesium in PM_{10}	mg	< 0.005

6. Results

The campaign started on the 8th October2013 at 00:05 and was completed on the 31st October 2013 at 23:55. The two sampling instruments were stopped between the 22nd and the 24th October 2013, in order to place clean filters. As already stated, the SKYPOST design requires that the tubes be re-loaded every 16 days.

6.1. Particulate Matter

6.1.1. PM_{10}

Table 7: Data for PM_{10}

Date	*PM10 (µg/m³)*
08/10/2013	43.6
09/10/2013	46.9
10/10/2013	62.3
11/10/2013	104.6
12/10/2013	57.7
13/10/2013	39.0
14/10/2013	65.5
15/10/2013	62.8
16/10/2013	*N.V.*[1]
17/10/2013	46.9
18/10/2013	51.6
19/10/2013	43.8
20/10/2013	22.5
21/10/2013	*N.V.*
22/10/2013	Technical stop
23/10/2013	Technical stop
24/10/2013	Technical stop
25/10/2013	*N.V.*
26/10/2013	27.47
27/10/2013	28.39
28/10/2013	*N.V.*
29/10/2013	8.44
30/10/2013	26.37
31/10/2013	28.35

[1] Not Valid because of power interruption. Same reason applicable to the rest of the N.V. data in the table

The daily limit value for PM_{10} is 50 $\mu g/m^3$ according to the L.N. 478/2010, and as noted from Figure 19: Concentration of PM_{10}, during six days there were exceedances of the daily limit value.

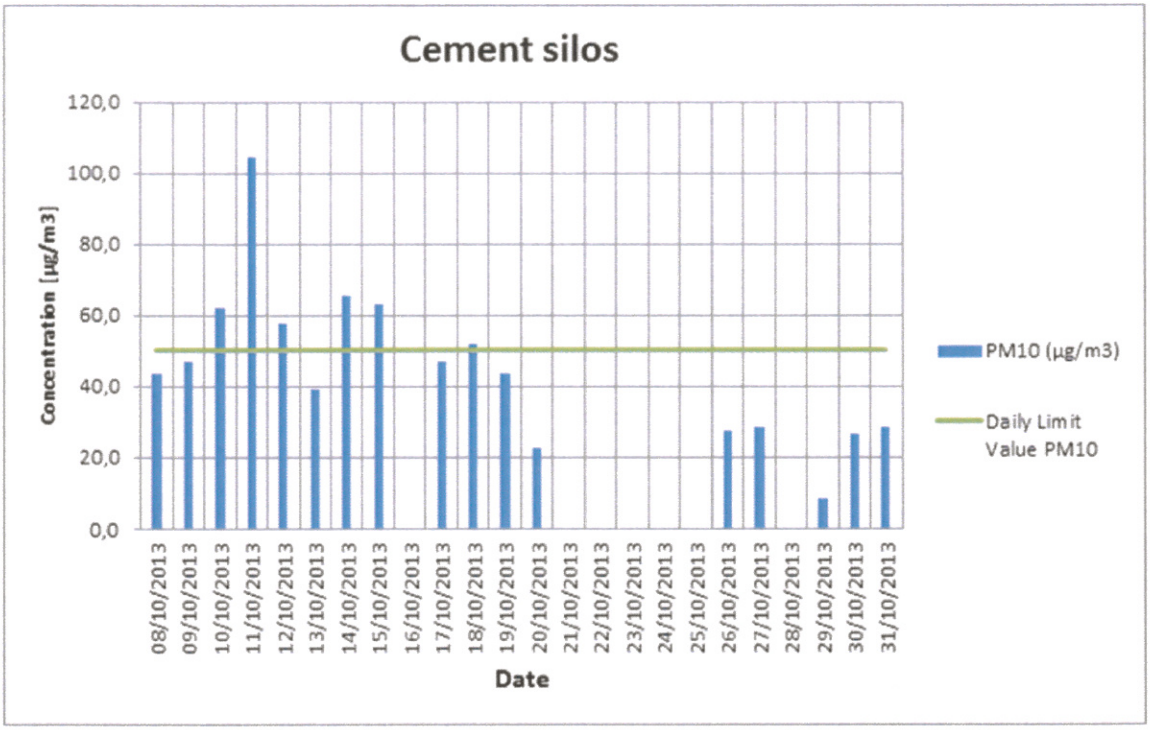


Figure 19: Concentration of PM_{10}

6.1.2. $PM_{2.5}$

Table 8: Data for $PM_{2.5}$

Date	PM2.5 (µg/m³)
08/10/2013	17.38
09/10/2013	19.94
10/10/2013	18.11
11/10/2013	3.53
12/10/2013	14.82
13/10/2013	13.90
14/10/2013	23.42
15/10/2013	23.23
16/10/2013	22.51
17/10/2013	12.81
18/10/2013	17.20
19/10/2013	14.45
20/10/2013	7.87
21/10/2013	Technical stop
22/10/2013	Technical stop
23/10/2013	Technical stop
24/10/2013	12.08
25/10/2013	7.87
26/10/2013	14.45
27/10/2013	22.87
28/10/2013	22.69
29/10/2013	5.79
30/10/2013	19.58
31/10/2013	21.52

The annual limit value for $PM_{2.5}$ is 25µg/m^{3,} and as we have only performed the monitoring for 21 days, it cannot be established if any exceedances took place. It can be however noted that the daily readings are all below the threshold (Figure 20: Concentration of $PM_{2.5}$).

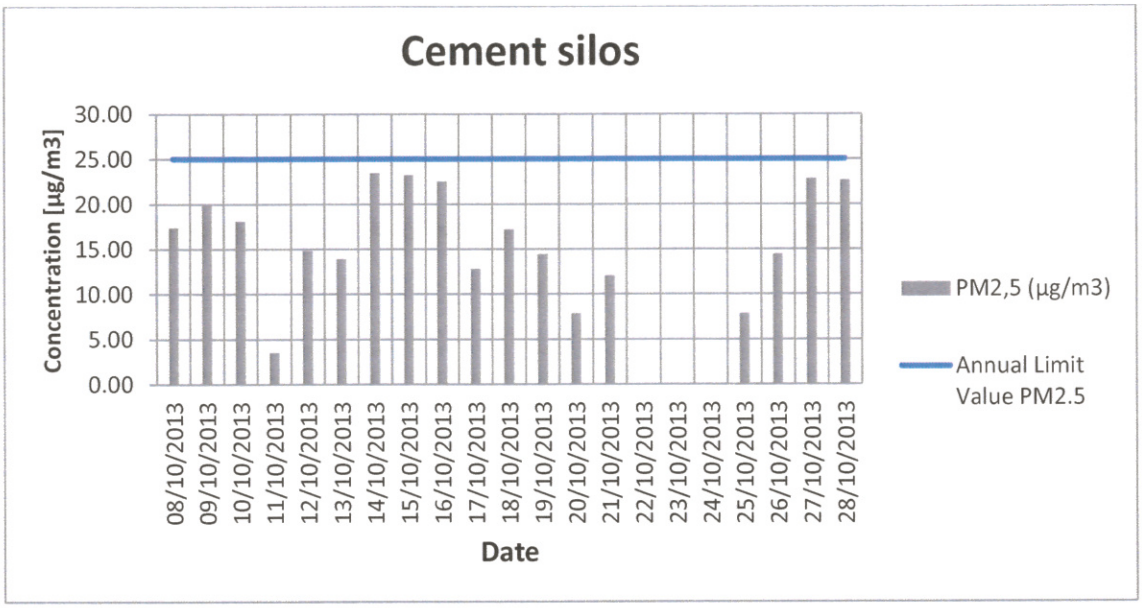


Figure 20: Concentration of $PM_{2.5}$

Figure 21 is a graph comparing the PM_{10} and $PM_{2.5}$ concentrations:

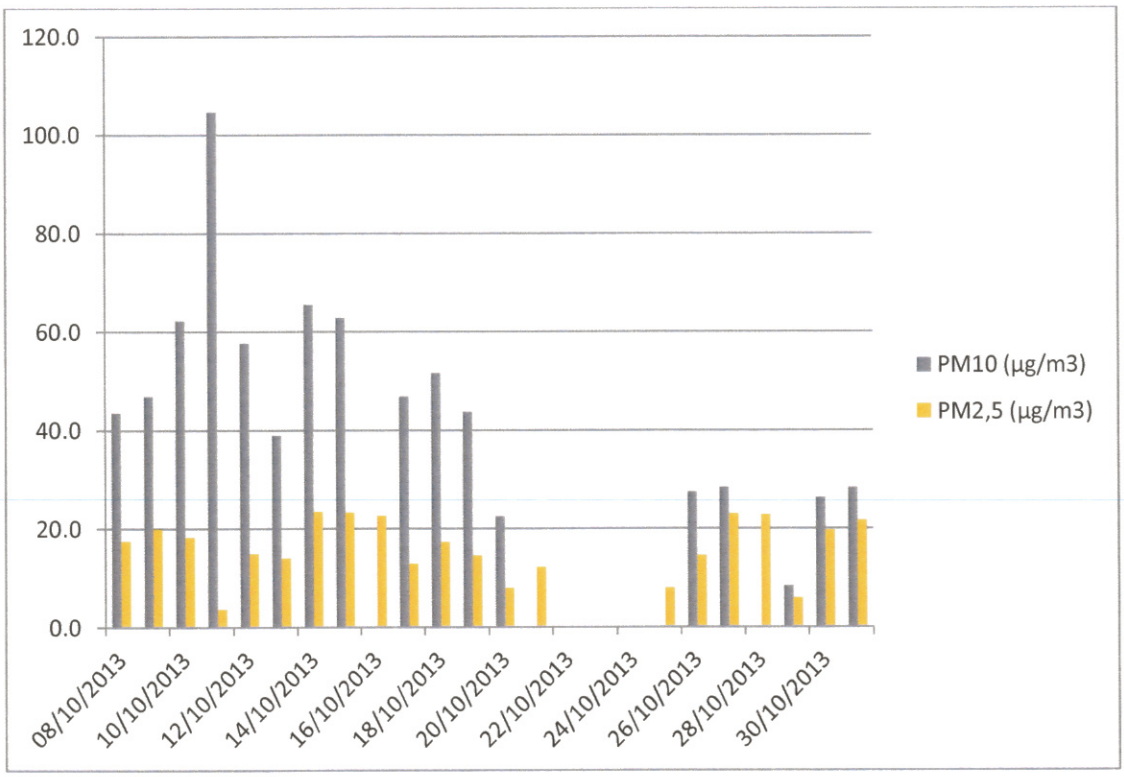


Figure 21: Concentration of PM10 and $PM_{2.5}$

In order to increase the validity of the data, the reported values were cross-checked with the air quality data provided by the monitoring network installed by MEPA. Table 9 shows the comparison between the SKYPOST data and the MEPA station data closest to our monitoring locations (Kordin). The information extracted from the MEPA website does not include the data between the 8th and the 18th October.

Table 9: The comparison between the SKYPOST data and the MEPA station data

	Air quality monitoring MEPA	*Air quality monitoring survey Ambiente sc*
Date	PM_{10} (µg/m³)- MEPA	PM_{10} (µg/m³)-ambiente sc
19/10/2013	22.34	43.8
20/10/2013	11.3	22.5
21/10/2013	17.6	N.V.
22/10/2013	19.03	Technical stop
23/10/2013	18.75	Technical stop
24/10/2013	24.58	Technical stop
25/10/2013	23.9	N.V.
26/10/2013	24.51	27.47
27/10/2013	19.26	28.39
28/10/2013	30.06	N.V.
29/10/2013	21.02	8.44
30/10/2013	21	26.37
31/10/2013	21.13	28.35

Figure 22: Comparison MEPA data and the ambiente sc data

In both cases, high values of PM_{10} were recorded from the SKYPOST and from the MEPA station.

A feasible explanation could be the activities taking place at the specific monitoring locations. As it can be seen from the figures above, the stations are located in highly urbanized areas and next to the port, hence a high density of traffic could be assumed to influence significantly the PM_{10} values recorded.

6.2. Metals

From the filters of PM_{10} the values of ***Calcium*** and ***Magnesium*** were calculated (Table 10).

Table 10: The values of Calcium and Magnesium from the filters of PM_{10}

Date	Calcium ($\mu g/m^3$)	Magnesium ($\mu g/m^3$)
08/10/2013	2.380	<0.09
09/10/2013	2.380	<0.09
10/10/2013	2.930	<0.09
11/10/2013	6.602	<0.09
12/10/2013	2.381	<0.09
13/10/2013	1.264	<0.09
14/10/2013	3.845	<0.09
15/10/2013	2.747	<0.09
16/10/2013	NV2	NV
17/10/2013	1.135	<0.09
18/10/2013	2.564	<0.09
19/10/2013	3.662	<0.09
20/10/2013	0.494	<0.09
21/10/2013	NV	NV
22/10/2013	Technical stop	Technical stop
23/10/2013	Technical stop	Technical stop
24/10/2013	Technical stop	Technical stop
25/10/2013	NV	NV
26/10/2013	3.480	<0.09
27/10/2013	3.296	<0.09
28/10/2013	NV	NV
29/10/2013	5.870	<0.09
30/10/2013	5.859	<0.09
31/10/2013	0.792	<0.09

[2] Not Valid because of power interruption. Same reason applicable to the rest of the N.V. data in the table

The total % contained in the PM_{10} value was calculated only for Calcium, as the Magnesium concentrations were always below the quantification limit (Table 11).

Table 11: The total % calcium in the PM_{10}

	% Calcium in PM10
08/10/2013	5%
09/10/2013	5%
10/10/2013	5%
11/10/2013	6%
12/10/2013	4%
13/10/2013	3%
14/10/2013	6%
15/10/2013	4%
16/10/2013	*NV*[3]
17/10/2013	2%
18/10/2013	5%
19/10/2013	8%
20/10/2013	2%
21/10/2013	*NV*
22/10/2013	Technical stop
23/10/2013	Technical stop
24/10/2013	Technical stop
25/10/2013	*NV*
26/10/2013	13%
27/10/2013	12%
28/10/2013	*NV*
29/10/2013	70%
30/10/2013	22%
31/10/2013	3%

In order to asses if this resulting % can be attributed to natural or anthropogenic activities, the sources and % contributing to PM_{10} values in other two projects were analyzed: "Regional project Patos: PM_{10} in Tuscany" and "Development of environmental monitoring strategy and environmental monitoring baseline surveys" in Malta.

In the Patos project the percentage of the different sources contributing to the final value of PM_{10} after one year of monitoring is shown in Figure 23.

[3] Not Valid because of power interruption. Same reason applicable to the rest of the N.V. data in the table

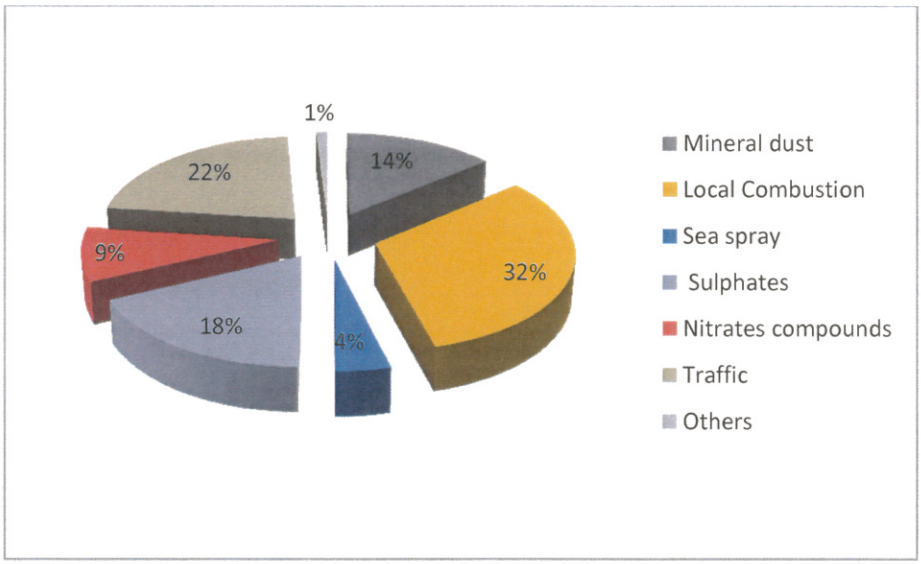


Figure 23: Example of different contributions to PM_{10} final value. Source Project Patos – Regione Toscana

The natural sources represented 4% in the case of Sea spray (constituted by sodium chloride, magnesium, sulfate, calcium and potassium) and 14 % in the case of Mineral dust (constituted of the oxides, SiO_2, Al_2O_3, FeO, Fe_2O_3, CaO, and carbonates, $CaCO_3$, $MgCO_3$)

In the project "Development of environmental monitoring strategy and environmental monitoring baseline surveys" ambiente s.c. performed an air quality monitoring in Malta for one year in 4 different stations at different locations: Għarb, Żejtun, Msida and Kordin.

PM_{10} and $PM_{2.5}$ were monitored in this project as well as for metals, which were analyzed by performing a chemical analysis on the same filter used to determine PM10. The purpose of monitoring these parameters was to elaborate an accurate assessment of the air quality and to evaluate any possible relationship between the pollutant concentrations, pollutant sources, its location and time of the year. From the stations previously mentioned, the data provided by Kordin was selected to provide a reference, as it is the one closest to this project's study area. The % Calcium values recorded in the month of October that could be attributed to natural source were analyzed and the mean value calculated; the results are shown in Table 12.

Table 12: The mean value of % Calcium

	Kordin
Calcium	10%

The mean value from our results is 10.2% or 6.52% if we take out the value of 29th which is considered an abnormality. Nevertheless both percentages are in coherence with the other ones found in the reference project of Tuscany and Malta. Therefore the % Calcium resulted in this project could be attributed to natural sources.

6.3. Vessel Calls

A correlation of the particulate matter concentration against the vessels which called at the lab/ magazine wharf was carried out to assess whether there are any significant associations.

A list of the vessels that called at the Valletta Ports in October during the period when the air quality assessment was carried out is available at Appendix 1.

The following figure shows the different types of vessels (these are categorised into 8 classes) which called at the lab/ magazine wharf only on a daily basis between the 8 and the 31 October 2013. The daily PM_{10} concentration is plotted as a scatter graph on the chart using a secondary vertical axis.

It can be noted that the PM_{10} exceedances of the 50 $\mu g/m^3$ limit value do not correlate with the number of vessels calling at the wharf. The days when the exceedances took place and the number of vessels docking at the wharf are listed in Table 13 and Figure 24:

Table 13: The exceedances and the number of vessels docking at the wharf

PM_{10} exceedance of the 50 $\mu g/m^3$ limit value	Number of vessels calling at the wharf	Types of vessels
10 October 2013	2	1 Roro vessel 1 Supply vessel
11 October 2013	2	1 Fishing trawler 1 Research vessel
12 October 2013	1	1 Roro vessel
14 October 2013	2	2 Roro vessels
15 October 2013	0	
18 October 2013	2	1 Research vessel 1 General cargo

ais environmental

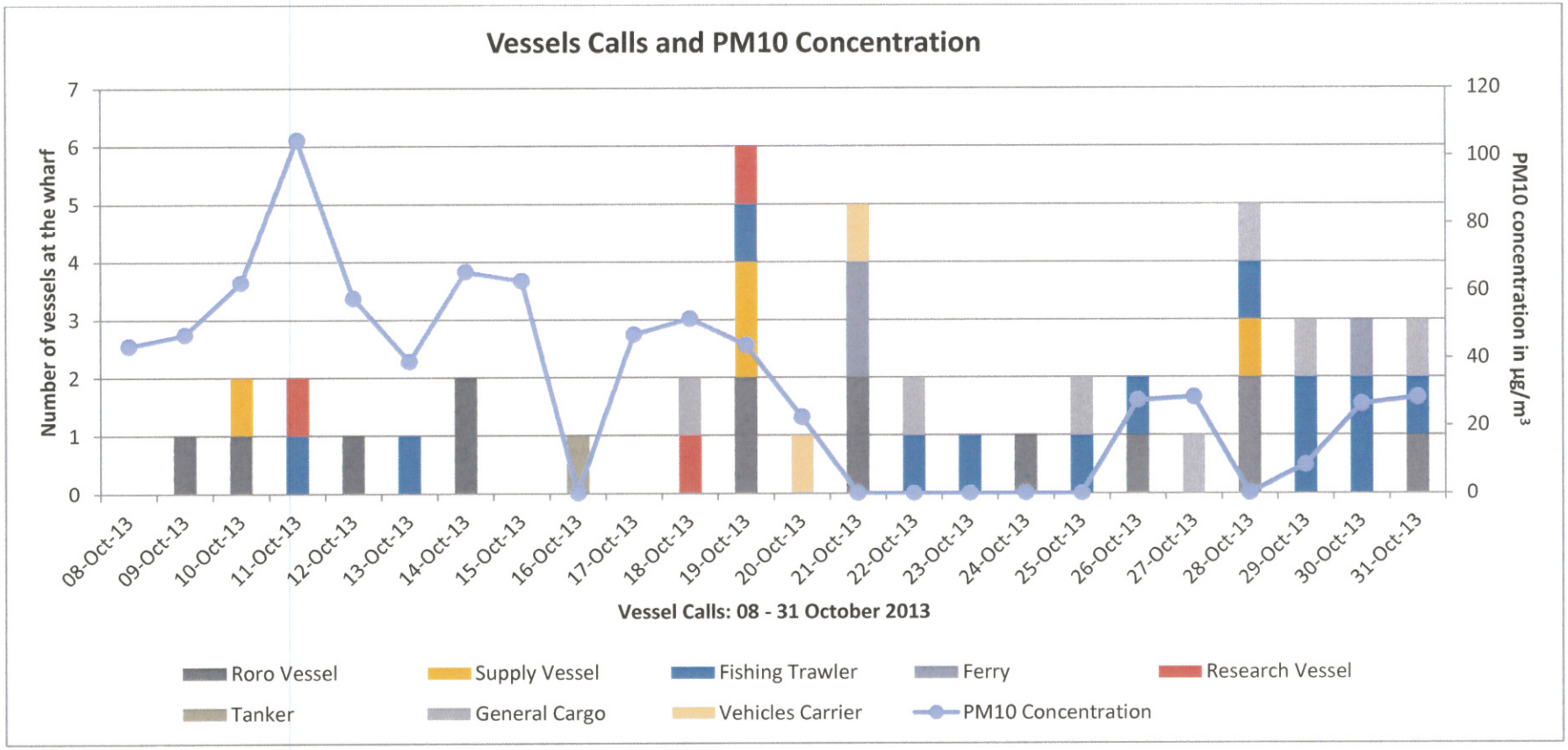


Figure 24: Correlation between the number of vessel calls and the PM_{10} concentration

On the 15 October 2013, even if no vessels moored at the wharf, an exceedance of 62.8 $\mu g/m^3$ was still registered. Moreover, on the 19 October when 6 vessels called on that same day, only a PM_{10} concentration of 43.8 $\mu g/m^3$ was recorded.

An association can neither be attributed to the vessel type as when exceedances took place different types of vessels called. It has to be noted that on the 18 October, grain was unloaded from the general cargo carrier.

7. Conclusion

The air quality monitoring assessment monitored the concentration of particulate matter prior to the construction of the cement handling and storage facility at Laboratory Wharf, Kordin. A 21-day campaign was undertaken between the 8 – 13 October 2013 during which the concentrations of PM_{10}, $PM_{2.5}$ calcium and magnesium ions were recorded.

The PM_{10} concentrations exceeded the limit value of 50 $\mu g/m^3$ on 6 out of 21 days, namely 10-12, 14-15 and 18 October 2013; however no correlation could be identified either with the number of vessel calls on the specific days or with the vessel type. Out of the 21 days, power interruption occurred on 3 days on which no value could be recorded.

From the filters of PM_{10} the values of calcium and magnesium ions were calculated. Magnesium always read below the limit of quantification of the instrument (<0.09 $\mu g/m^3$). The average percentage calcium in PM10 was calculated as 10.2% or 6.52% if the abnormal value of 29 October (70%) is disregarded. The range of 6.52 – 10.2% is considered coherent with that registered in other projects in Malta and in Italy and can therefore be attributed to natural sources and not to any anthropogenic activity.