Report on Turnkey Osiris Particle Results at the Southampton Hotel, Weighbridge for 2004

Executive Summary:

The Health Protection Department have monitored air quality since 1994. This initial monitoring involved nitrogen dioxide (NO_2), volatile organic compounds (VOCs) and sulphur dioxide (SO_2). However, in 2002 a Turnkey Osiris particle measurement unit was purchased which allowed real time particles measurement (PM_{10}). This unit was sited on a balcony at the Southampton Hotel at the Weighbridge, St Helier. In 2004 a second unit was sited at the Market, Halkett Street, St Helier. Particles include dust and smoke and have a well documented respiratory effect on human health.

Results for 2004 for a 10 months period at the Southampton Hotel exceeded the EC and UK Air Quality objectives by 8 times. Results for 2004 for a 6 months period at the Market exceeded the EC and UK Air Quality objectives 8 times. These objectives only allow 7 exceedances per calendar year and should be complied with by 2010 in the UK.

The results give additional support to the importance of the Air Quality Strategy (see www.health.gov.je).

Further work is necessary to assess levels of particulates in Jersey compared to traffic numbers, mix and speed, also meteorological conditions.

In December 2004 after a period of testing the results are now uploaded daily to Jersey Meteorological Website www.jerseymet.gov.je for easier public access.

Comparisons with the 2002 and 2003 data for the Southampton Site show there were less exceedances in 2004 (ie 8 in 2004: 10 months data) compared to 2002 and 2003 (ie 20 in 2003: 8 months data) and (ie 20 in 2002: 7 months data). However the results when compared against the Air Pollution Bandings indicate that air quality was worse in 2003 with 5 days of high air pollution and 3 days of very high air pollution.

The market site had 8 exceedances in a 6 month period. This can be partly explained by the presence of delivery vehicles close to the measurement site resulting in high levels of air pollution. The market have been asked to remind all delivery companies to switch off engines as far as is practicable whilst parked.

Particles: Sources and Health Effects

Particles in the atmosphere originate from a wide variety of sources. They take the form of dust; smoke of very small liquid or solid particles called aerosols. Particles may be either emitted directly into the atmosphere (ie primary particles) or formed subsequently by chemical reactions (ie secondary particles). PM_{10}, (particles are defined as having an average particle size of 10 microns in diameter (10 millionths of a metre), and have well documented respiratory effects on human health. These include effects on the respiratory and cardiovascular systems, asthma and mortality. PM_{10} particles are composed of primary combustion derived carbon-centred particles e.g. ultrafines, secondary particles from atmospheric chemistry eg ammonium nitrate, natural minerals e.g. soil, wind-blown, biological e.g. spores, bacteria and metals.

Studies have shown that most of the inflammation in the lungs could be explained by the mass of particulate instilled, however, mass could not account for all of the variability in the data. It is believed the presence of metals such as iron, zinc, lead and nickel content of PM_{10} had the best association with inflammation out of all of the compositional measurements analysed. Primary particulate content of PM_{10} was also positively associated with inflammation.

Ref: Adverse Health Effects of Particulate Air Pollution V. Stone1, J.H. Lightbody, L. Hibbs, C.L. Tran, M. Heal, and K. Donaldson. Napier University University of EdinburghIOM, Edinburgh

The Expert Panel on Air Quality Standards (EPAQS) concluded that particle air pollution episodes are responsible for causing excess deaths among those with pre-existing lung and heart disease. EPAQS also believe that any risk of lung cancer from the concentrations found in the streets of the UK is likely to be exceedingly small. However prolonged exposure for example 20 - 30 years to particles, which are likely to be combined with Polycyclic Aromatic Hydrocarbons (PAH) originating from unburnt or partially burnt fuel, is likely to be carcinogenic.

There is a wide range of human activities that produce particulate emissions, including; motor vehicles (mainly diesel), solid fuel burning, industrial processes, power stations, incinerators and construction activity.

Emissions from mainland Europe may make a significant contribution to secondary particles in Jersey. The UK Airborne Particles Expert Group's findings suggest that in a typical year with typical meteorology, about 15% of the UK's total annual average PM_{10} concentrations (about 50% of secondary particles) are derived from mainland Europe. In years of higher frequency of easterly winds, with large movements of air from mainland Europe, emissions in mainland Europe account for a considerably higher proportion of PM_{10} concentrations, particularly in south and east England. No work has been carried out to try and establish the contribution of secondary particles originating from Europe onto Jersey.

A UK government Air Quality Strategy Objective and a European Community Directive regulates concentrations of PM_{IO} in the UK (see below). The States of Jersey has agreed to work towards the limits set out in the European Daughter Directive 99/30/EC which deals with particles, sulphur dioxide, nitrogen dioxide, and lead. The main issues around air quality in Jersey relate to local air quality and the health impacts associated with high levels monitored mainly at road junctions and along canyon streets.

The BBC reports that the amount of solar energy reaching the Earth's surface has declined significantly between the 1950s and the 1990s, apparently due to particulate air pollution. Scientists are worried that this global dimming may be disrupting the pattern of the world's rainfall. Most alarmingly, it may have led us to greatly underestimate the greenhouse effect: with particulate pollution being brought under control, a global temperature rise of 10 degrees Celsius by 2100 could be on the cards, rendering many parts of the world uninhabitable. It is interesting to see the link between local air quality and global effects. Ref: Horizon BBC2 15/01/05

http://news.bbc.co.uk/2/hi/science/nature/4171591.stm

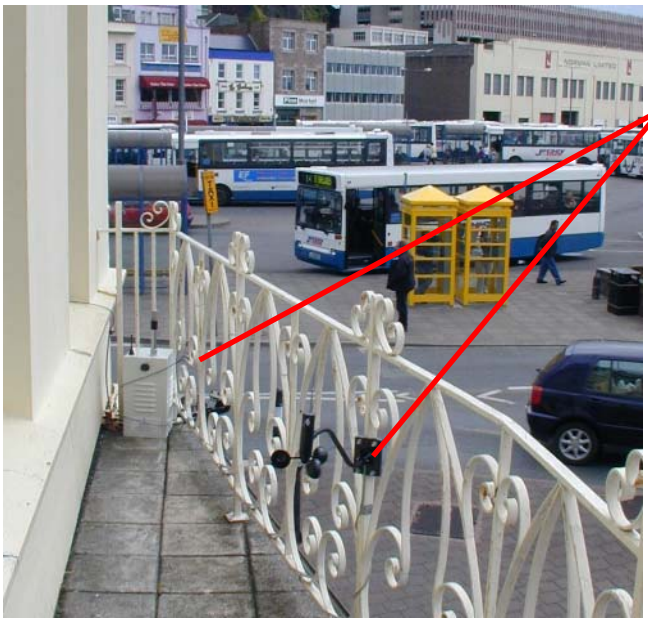
Background

The Turnkey Osiris Particle Monitors (Optical Scattering Instantaneous Respirable Dust Indication System) (see the photograph below) were purchased in March 2002 and 2003. They are designed to continuously monitor particle levels in particular Total suspended particles (TSPs), PM_{10} (Particles with an aerodynamic diameter of 10 microns) $PM_{2.5}$ and $PM_{1.0}$.

A wind direction and speed monitor at the Southampton Hotel site was also provided to give meteorological information. The Osiris units are served by a GSM modem which allows Officers from this Department to dial it up at any time and download the results using the Air Q 32 Software (see Appendix 5). The data from both sites is now uploaded and emailed daily to the Jersey Meteorological Department and they are able to put it on to their website ie www.jerseymet.gov.je. This provides easier public access to the data.

The Osiris units are also fitted with a filter, which traps particles as they are sized and counted. The filter in the market Osiris unit was changed at 10.30am on the 19th October 2004 and sent to TES Bretby UK Ltd for further analysis. A new pre weighed filter was placed into the unit. The filter analysis allows the weight of particles to be determined and compared with the Osiris' computer calculated weight (ie to assess the accuracy of the Osiris). The analysis by TES Bretby of the filter also allows the sources of particle and percentage contribution to be determined. The results are provided in Appendix 1.

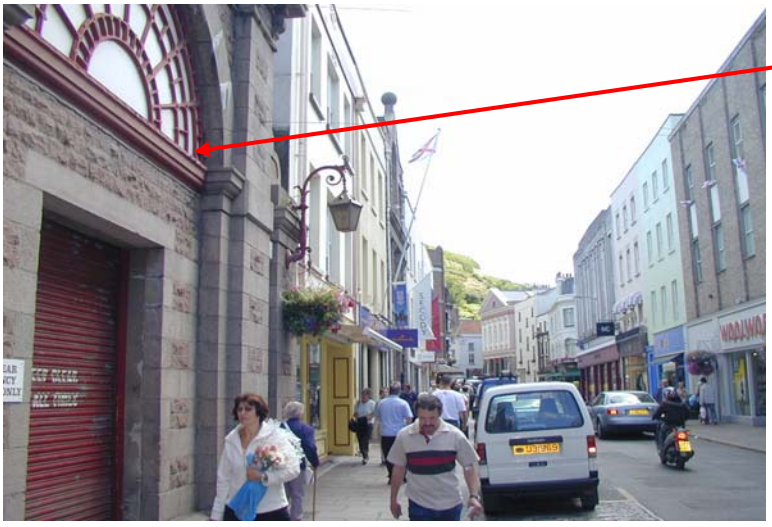
The unit at the Southampton Hotel is sited on a balcony approximately 4 m above the pavement and approximately 5 m from Mulcaster Street/Esplanade (see the photograph below). The Osiris samples particles as 15 minute averages.



Osiris particle monitor and weather station at the Southampton Hotel

It was decided to position the Osiris at this particular site because it is believed has generally the poorest air quality compared to the other sites in Jersey. Unfortunately the Public Services Department were not been able to provide a traffic monitor at the site. Therefore there is limited data on the speed, volume or mix of traffic using Mulcaster Street. However the Nitrogen dioxide diffusion tube sited on the Police Surveillance tower suggests that the older type buses and taxis contributed to the poor results. Observations on site indicate that particle levels increase substantially with larger vehicles (eg lorries and buses).

The second Osiris unit is sited at the market on Halkett Place (see photograph below) approximately 12 feet above pavement level. It is sited at this height to prevent vandalism. Studies have shown particle levels remain high within 5-6 metres from busy roads.

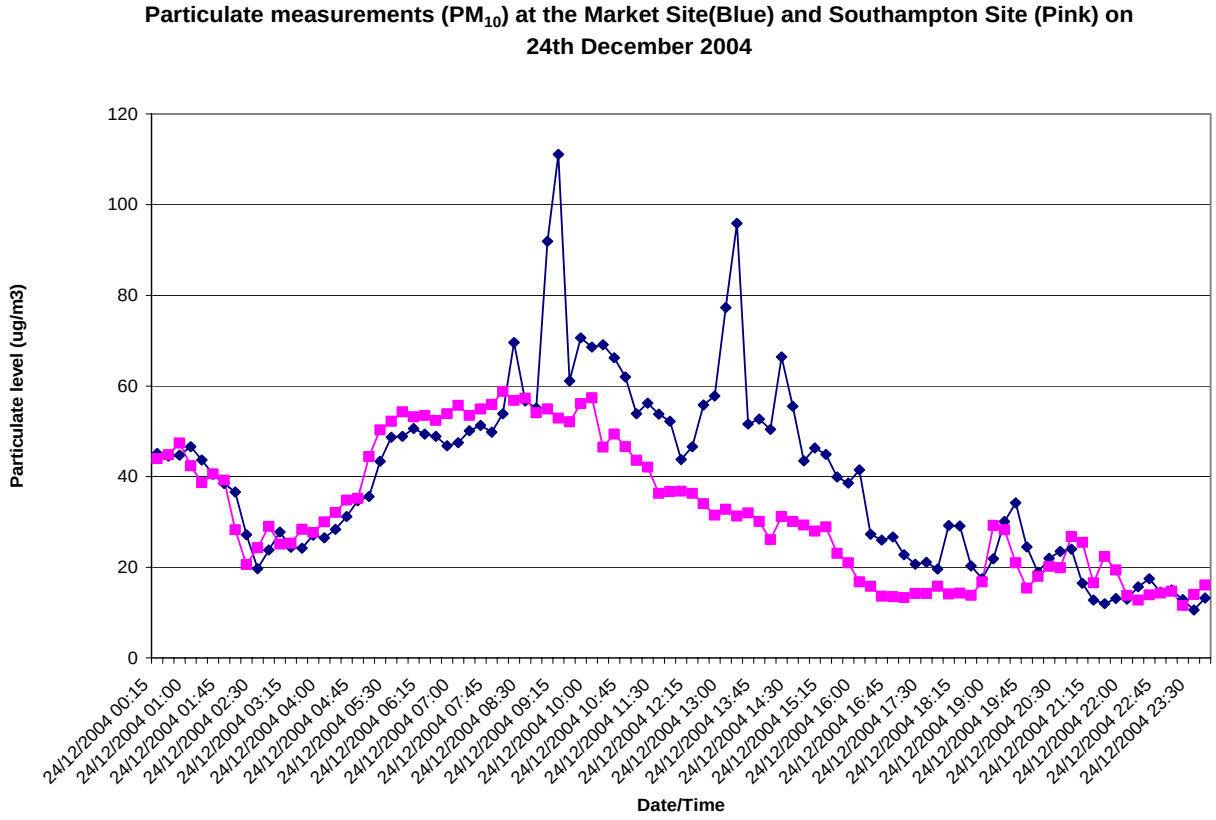


Osiris particle monitor at Jersey Market measuring traffic emissions on Halkett Place

Results

The particulate exceedances (ie PM_{10}) are presented below. Unfortunately approximately ten months data in the case of the Osiris at the Southampton Hotel was obtained rather than 12 months due to calibration in the UK, technical problems with the equipment and computer software. Six months of data were obtained from the market as the Osiris unit was installed in June 2004. Figure 1 below shows the particle levels over a 24 hour period for the 24th December 2004 ie levels of particulates increase up to lunch time at both sites however there are a number of peaks at the market site at around 9.30 am and 1.45pm associated with traffic and then reduce into the late afternoon and evening. Particulate levels tend to follow traffic volume and mix.

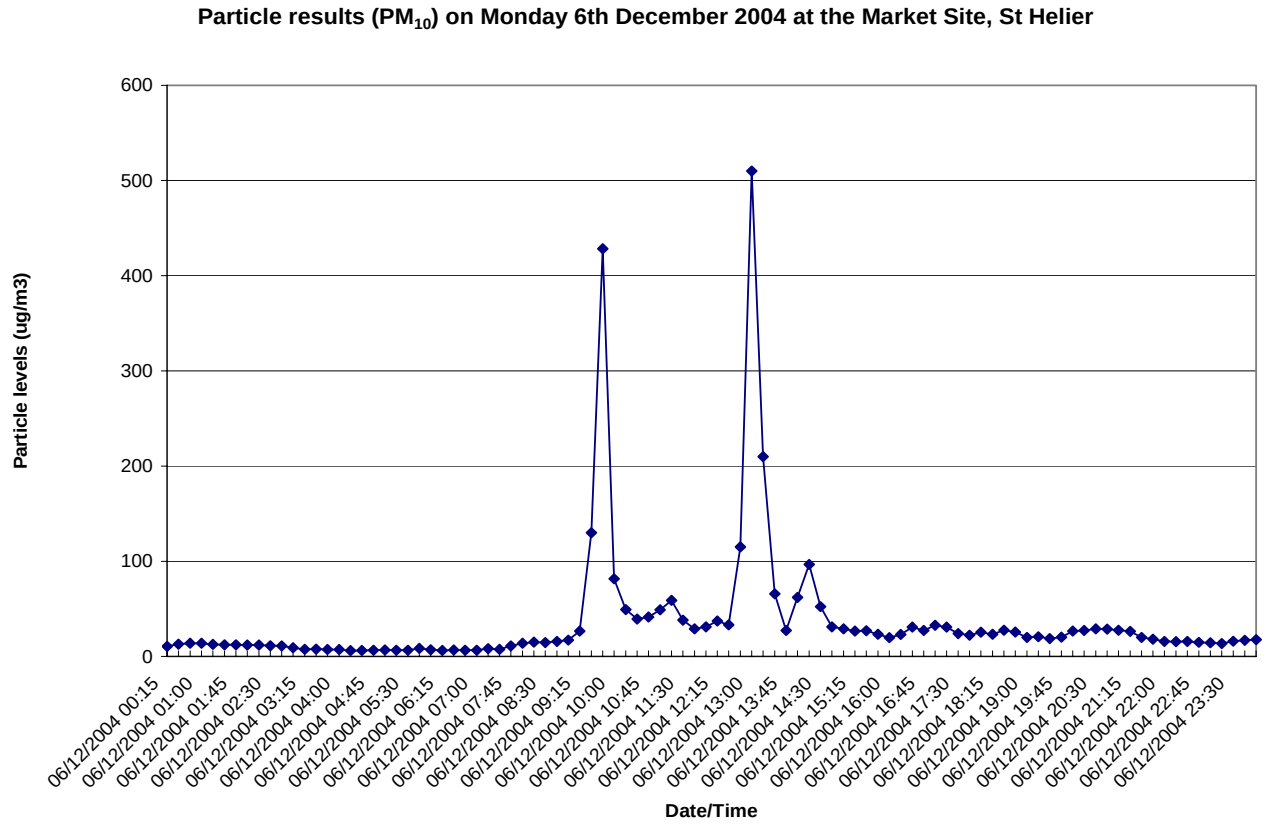
Figure 1: eg Particulate measurements (PM_{10}) at the Market Site and Southampton Site on 24th December 2004



The Turnkey Osiris Particle Monitor uses a heated inlet (50°C) to evaporate water vapour particles which would result in inaccurate readings, however it is believed that evaporation of volatiles/particles also occurs resulting in lower than normal results. Research has suggested that such results should be increased by up to 30% to increase their accuracy. However there are uncertainties as to whether 30% is the appropriate in all cases and areas of the UK. Details of the Osiris are provided in Appendix 1.

The European Union requires the use of a gravimetric (filter based) method to prove compliance, and the UK has suggested that its preferred Tapered element oscillating microbalance (TEOM) measuring devices are adequate if the results are multiplied by up to 1.3. It is this blanket nationwide uplift factor which may produce false exceedances. The Osiris although not as accurate as the TEOM provides useful indicative results.

The results for the 8th December 2004 indicate very high levels at around 10.00am and 1.30am This can explained by the presence of delivery/refuse vehicles close to the measurement site resulting in high levels of air pollution. The market have been asked to remind all delivery companies to switch off engines as far as is practicable whilst parked. Figure 2 below shows elevated levels at the Market Site associated with delivery vehicles.



The uncorrected exceedances for both sites are shown in Table 1 below.

Table 1 Exceedances at each site

Exceedance: greater than: 50 mg/m^3 as 24 hour average -
(7 exceedances allowed per year to be achieved by 31/12/10)

PM_{10} (µg/m^3)	**Market Results**		**Southampton Results**		
11/07/04	63.7	July 1 Exceedance	09/01/04	56.7	January 1 Exceedance
6/09/04	54.9		10/01/04	63.3	
07/09/04	73.1	September : 5 Exceedances	01/02/04	67.1	February 3 Exceedances
08/09/04	94.4		05/02/04	73.3	
17/09/04	51.7		06/02/04	53	
29/09/04	154.1		07/03/04	61.5	March 2 exceedances
10/12/04	70.1	December: 2 Exceedances	30/03/04	74.2	
11/12/04	56.8		10/12/04	52.08	December 1 exceedance
Total 8 exceedances			Total 8 exceedances		

(uncorrected results)

In the 2004 there have been eight exceedances at each site (uncorrected) of the European Union Daughter Directive 1999/30 and UK Air Quality Strategy limit value (ie 24 hour mean of 50 mg/m^3 both to be achieved by the end of 2010, 7 exceedances allowed per calendar year). Both sites exceed this limit value.

The results from the filter analysed by TES Bretby in the UK are shown in Appendix 1. The examination procedure is based on the assessment of approximately 50 individual particles selected at random. The estimated percentage is based on a comparison of the relative number of particles counted in each category. The filter was exposed for 26278 min (437 hours) and mass was 3.09mg. Examination revealed that the collected deposit was mainly plant/animal fragments (48%), carbonaceous matter (23%) associated with vehicular emissions. A number of amorphous dirt particles (ie irregular shaped particles containing Aluminium, Silicon, Calcium, Potassium and Iron in varying proportions) were also observed (15%), small amounts of sodium/chlorine rich (salt) particles were also detected (2%). Care must be taken interpreting theses results as only a very small number of particles were analysed. Unfortunately the costs are prohibitive for greater in depth analysis.

EU and UK Guidelines

Under the EC Air Quality Framework Directive (96/62/EC), all Member States have to assess their existing air quality and implement a programme of monitoring, dependent upon population, population density, emission sources and proximity of the general public to these sources.

Under the Framework Directive, a Member State MUST undertake continuous monitoring (using appropriate instrumentation) at least ONE site.

The subsequent Daughter Directives (1st for NO_2 and SO_2, 2nd for CO and Benzene, and the newly published 3rd for O_3), all prescribe exactly how and where monitoring should be undertaken. However, the mass of monitoring evidence collected strongly suggests that concentrations of CO and SO_2 are likely to be below the lower assessment threshold, and that there is little benefit in measuring O_3, as emissions from the island will have very little impact on island ozone concentrations.

NETCEN recommend, therefore, that the island undertakes continuous monitoring for NO_2 and PM_{10}. For the first year at least, this should be at the highest known pollution "hotspot" (Weighbridge). Once compliance with the Daughter Directive(s) is confirmed at this location, the site could be relocated to an area more representative of general population exposure (eg residential or urban background)

The EU Directive also details an: (24 hour limit value)

(a) **Upper Assessment threshold**: 60% of the limit value ($30\mu g/m^3$) not to be exceeded more than 7 times in any calendar year.

(b) **Lower Assessment threshold**: 40% of the limit value ($20\ \mu g/m^3$) not to be exceeded more than 7 times in any calendar year.

The upper Assessment threshold is presently being exceeded. Improvement in traffic management flow reduction will be needed to ensure the Upper Assessment threshold (UAT) is not exceeded in 2010.

Improvement should occur in the next few years with the improvement in engine design, relocation of the bus station to the Island site and road changes as part of the St Helier Life program. Concentrations of all pollutants appear to be falling slightly with time. This is likely to be due to improved fuel composition and engine design (Ref NETCEN). However directive limits are becoming tighter and more health information is becoming available.

The UK guidelines include:

(a) **Air Pollution Bandings:** As a running 24 Hour mean

Low Air Pollution: <50 µg/m^3 (464 results: both sites)
Moderate Air Pollution: 50 - 74 µg/m^3 (14 results: both sites : 6 Market Site, 8 Southampton Site)
High Air Pollution: 75 - 99 µg/m^3 (1 result: Market Site)
Very High Air Pollution: >= 100 µg/m^3 (1 result: Market Site)

(b) **The UK Air Quality Strategy Objective for 31st Dec 2004**:

24 Hour daily mean: 50 mg/m^3 not to be exceeded more than 7 times per calendar year. (Exceeded 16 times based on 464 results)

Calendar Year Annual Mean: 40 mg/m^3 (37.35 µg/m^3 Market; 31.56 µg/m^3 Southampton Hotel based on 464 results)

The PM_{10} particle results for both sites exceeded the UK 24 hour limit value of 50mg/m^3 although they comply with the annual mean value of 40mg/m^3 (NB Not a full calendar year of results). According to the Air Pollution Bandings the air pollution at the Southampton Hotel /Market sites was low on 464 days, Moderate on 14 days and high on 1 day and very high on 1 day).

Comparison with other sites in Jersey and UK

Particle measurements carried out at other sites in Jersey are generally lower than at this site. Surveys have been carried out at:

(a) Halkett Place 1997 and 2000 Jan - March: Average PM_{10} levels in 1997 and 2000 were 27mg/m^3.

(b) New Street: Levels of PM_{10} in January 2000 varied between 13 - 27 mg as a running 24 hour average and no exceedances.

(c) Savile Street: Levels of PM_{10} varied in January - February, 2001 from 21 mg/m^3 to 59 mg/m^3 as a running 24 hour average with one exceedance.

PM_{10} concentrations in Jersey were generally higher than the UK comparison sites (Ref NETCEN) but broadly similar to those found in London and Bristol. Levels at the Weighbridge and Market sites are broadly what could be expected at a roadside location in the UK.

Particle levels from other sources such as the power station have reduced with the use of the two cable links to France (ie up to the end of September 2003 97% of electricity used in Jersey originated from France).

The Easy link coach service began on the 19th April 2003. There are 10- 15 buses operating with poor emissions compared to the cleaner Connex buses which have Euro 3 engines. When these engines are used in conjunction with low-sulphur diesel, emissions are very low. An aim should be to fit continuously regenerating particulate traps to Euro 2 and earlier diesel engines. (The cost is approx about £2 - 3,500 per vehicle, 90% of particles can be removed).

Other options are to move towards gaseous fuels such as the vehicles operated by Jersey Gas. The availability of bio-diesel in Jersey in the near future should lead to improvements. In London the trialling of water diesel emulsion is occurring which is claimed to halve particle emissions and cut NOx (i.e. Oxides of Nitrogen) by 23%.

Other improvements include:

(A) 2 new cremators which comply with the UK Environmental Protection Act 1990 Process Guidance notes

(B) A new waste to energy plant to be built in 2005-2008 with improved emissions

(C) New Building Byelaw Part L to improve insulation etc in domestic properties thereby reducing greenhouse gas emissions. Interestingly British Gas now offer a grant to improve the thermal insulation of domestic houses.

Comparisons with the 2003 data

1. There were less exceedances in 2004 (8 exceedances) at the Southampton Hotel site compared to 2003 and 2002 (ie 20 each year) (2002: 7 months data) and (2003: 8 months data).

2. Calendar mean for 2004: 37.35 mg/m^3 Market; 31.56 Southampton Hotel. 2003: Southampton Hotel only 32.35mg/m^3 and Southampton Hotel only 2002: 33.10mg/m^3

3**.** Air Pollution Bandings**:** As a running 24 Hour mean

Southampton Hotel Site: 2004

Low Air Pollution:	<50 mg/m^3	(292 results)
Moderate Air Pollution:	50 - 74 mg/m3	(6 results)
High Air Pollution:	75 - 99 mg/m^3	(1 result)
Very High Air Pollution:	>= 100 mg/m^3	(1 result)

Market Site: 2004

Low Air Pollution:	<50 ug/m^3	(172 results)
Moderate Air Pollution:	50 - 74 ug/m3	(8 results)
High Air Pollution:	75 - 99 ug/m^3	(0 results)
Very High Air Pollution:	>= 100 ug/m^3	(0 results)

4. The upper assessment threshold UAT (ie daily 24 hour average: 30 ug/m^3) was exceeded at both sites). The UAT was exceeded in 2004, 2003 and 2002.

The results indicate that air quality was better in 2004 with only 1 day of high air pollution and 1 day of very high air pollution.

Conclusions

1. The Turnkey Osiris particulate monitors were set up on the Southampton Hotel's balcony at the Weighbridge in May 2002 and main Market, Halkett Place in June 2004 to measure particles in real time (ie Total Suspended Particles TSP, Particles of a mean aerodynamic diameter of 10 microns PM10, Particles of a mean aerodynamic diameter of 2.5 microns PM 2.5 and Particles of a mean aerodynamic diameter of 1 micron PM 1.0 as 15 minute averages.

2. Particles are associated with a range of health effects. These include effects on the respiratory and cardiovascular systems, asthma and mortality. The Expert Panel on Air Quality Standards (EPAQS) concluded that particle air pollution episodes are responsible for causing excess deaths among those with pre-existing lung and heart disease. EPAQS also believe that any risk of lung cancer from the concentrations found in the streets of the UK is likely to be exceedingly small. However prolonged exposure for example 20 - 30 years to particles, which are likely to be combined with Polycyclic Aromatic Hydrocarbons (PAH) originating from unburnt or partially burnt fuel, is likely to be carcinogenic.

3. The results show that the EU Directive health limit was exceeded 8 times for each site in 10 months: Weighbridge and 6 months: Market sampling periods. The EU Directive allows 7 exceedances and is to be achieved by the end of 2010.

4. The particle results follow traffic movements as particle levels increase up to lunchtime and remain high into the afternoon. Levels at the market are also influenced by deliveries/refuse collections.

5. The relationship between meteorological conditions and particle levels is not clear. As wind speed increase particle levels reduce, however the position of the monitor at the Soythampton Hotel is sheltered to northerly and north easterly winds. The monitor at the Market site is in a canyon street which reduces dispersion/dilution of particles.
As wind passes over the tops of the buildings eddying effects occur which cause circular dispersion.

6. The Osiris has a glass fibre filter which collects particle material, which was further analysed to determine the sources of the particles and percentage contribution. Examination revealed in 2003 that the collected deposit was mainly carbonaceous matter with particle size of <10 microns associated with vehicular emissions. A number of amorphous dirt particles were also observed, small amounts of sodium/chlorine rich (salt) particles were also detected. In 2004 examination revealed that the collected deposit was mainly plant/animal fragments (48%), carbonaceous matter (23%) associated with vehicular emissions. A number of amorphous dirt particles (ie irregular shaped particles containing Aluminum, Silicon, Calcium, Potassium and Iron in varying proportions) were also observed (15%), small amounts of sodium/chlorine rich (salt) particles were also detected (2%). Care must be taken interpreting these results as only a very small number of particles were analysed. Unfortunately the costs are prohibitive for greater in depth analysis.

7. Exceedances occurred in January (1), February (3), March (2), December (1) 2004 at the Southampton site. At the market site there were exceedances in July (1) September (5) and December (2). Exceedances at the market were partly due to delivery vehicles and refuse vehicles leaving engines running. Communications with Jersey markets have occurred requesting delivery vehicles switch engines off whilst parked.

8. PM10 concentrations in Jersey were generally higher than the UK comparison sites (Ref NETCEN) but broadly similar to those found in London and Bristol. Levels at the Weighbridge and Market sites are broadly what could be expected at a roadside location in the UK.

9. Concentrations of all pollutants appear to be falling slightly with time. This is likely to be due to improved fuel composition and engine design (Ref NETCEN). However directive limits are becoming tighter and more health information is readily available.

10. Particle levels from other sources such as the power station have reduced with the use of the two cable links to France (ie up to the end of September 2003 97% of electricity used in Jersey originated from France).

11. The main issues around air quality in Jersey relate to local air quality and the health impacts associated with high levels monitored mainly at road junctions and along canyon streets.

12. Particles have been implicated in global dimming and highlight the relationship between local air quality and global warming.

13. Particle air pollution has improved when compared to 2002 and 2003.

Recommendations

1. Further long term research (until at least 2010) should be carried out to assess levels of $PM_{10}/PM_{2.5}$ in Jersey compared to traffic numbers, mix and speed and meteorological conditions to establish trends and assess compliance with the European Union Daughter Directive objectives. This forms part of the integrated Air Quality Strategy. The results are now uploaded to Jersey Mets web site www.jerseymet.gov.je for easier public access.

2. Traffic data (eg volume, mix and speed) should be made available to allow more meaningful comparison with particle results.

3. Further work is needed to assess the relationships between meteorological data and particle levels.

4. It is possible reductions in particle levels will occur because of the re-location of the bus station to the Island Site and road changes associated with the St Helier Street Life program.

5. Those objectives which impact on air quality in the Department's Air Quality Strategy need to be included in the draft Sustainable Traffic and Transport Plan.

6. Further work is needed to assess the contribution of secondary particles from mainland France to Jersey. Also analysis should be carried out to confirm that the 30% increase in figures associated with heated inlets is correct for this particular monitoring site.

7. An aim should be to fit continuously regenerating particulate traps to Euro 2 and earlier diesel engines. (The cost is approx about £2 - 3,500 per vehicle, 90% of particles can be removed). The provision of incentives to use LPG and biodiesel fuels. Reduction in Jersey's Vehicle Registration duty for cleaner vehicles.

8. Good quality data is needed to assess improvements in tends in air quality, usage of public transport etc

9. The Department's Air Quality Strategy (AQS) needs updating progressing and the profile of air quality raising.

10. The main issues around air quality in Jersey relate to local air quality and the health impacts associated with high levels monitored mainly at road junctions and along canyon streets.

11. The provision of an Auto TEOM particle analyser as part of a base station at approximately £18,000 which would be combined with a NOx sampler at approximately £7,000. This combined with a M Type enclosure makes a total cost of £30,000. This money is already been earmarked for such in the Environment Fund.

Appendix 1: The Turnkey Osiris Particle Monitor

Osiris stands for *Optical Scattering Instantaneous Respirable Dust Indication System*.

The Osiris is an investigational instrument that fulfils the dual role of a portable instrument or permanent installation.

The instrument is housed in a sturdy die cast metal box with internal rechargeable battery. The external power source was connected for the long term monitoring. The internal memory was used to record PM_{10}, $PM_{2.5}$, $PM_{1.0}$ and Total Suspended Particles (TSP) as 15 minute averages for the monitoring periods. Each 24 hour period is saved in a folder for downloading to a computer and analysing with the Air Quality Programme for Windows. The Air Quality programme allows the data to be graphed and copied into Microsoft Excel for further analysis.

The instrument measures and records the concentration of airborne particles using a proprietary laser (nephelometer). An internal pump continuously draws an air sample through the nephelometer which analyses the light scattered by individual particles as they pass through a laser beam. These same particles are then collected on the reference filter. The nephelometer's dedicated microprocessor can analyse the individual particles even if there are millions of them per litre. This allows the size fractions to be determined at concentrations up to several milligrams/m^3.

The light scattered by the individual particles is converted into an electrical signal which is proportional to the size of the particle. A unique feature of the Turnkey nephelometer is that only light scattered through very narrow angles 10 degrees or less is measured. At this narrow angle the amount of light scattered is virtually the same for say black diesel or white limestone particles of the same size. That is, it doesn't depend on the material composition of the particle. On the other hand, the easier to measure right angle 90° scatter used by some earlier scattering instruments is highly dependant on material composition with white particles apparently scattering much more light than black ones of the same size.

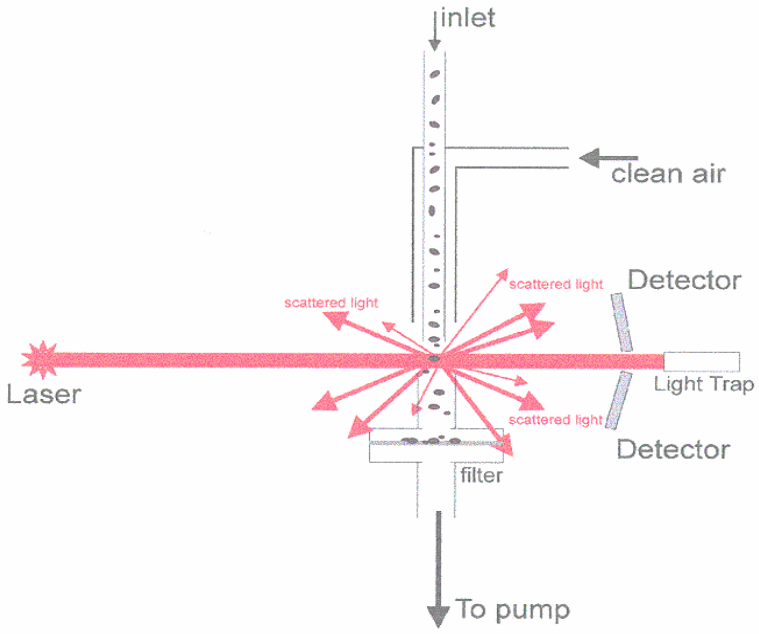
The light scattered by airborne particles can be thought of as consisting of three components. Light reflected from the surface of the particle, light refracted through the particle and light which is diffracted from its original path by the presence of the particle. The intensity of the light scattered by reflection or refraction strongly depends on the type of particle. Thus a white limestone particle will reflect much more light than a black diesel fume particle of the same size. On the other hand the diffracted component depends only on the size of the particle and is independent of its material composition.

For irregularly shaped particles, light, which is reflected and refracted, tends to be scattered over all possible directions. The diffracted component, however, tends to be scattered only through very small angles. For example, for a 5 micron diameter particle, 90% of the diffracted light is scattered by less than 10 degrees from the original direction of the light beam.(42)

The intensity of the light pulse is therefore an indicator of particle size, from this the microprocessor is able to calculate the expected mass of the particle. It assumes the material density of the particle is 1.5 grams per cc, which for most airborne dusts is a good approximation but the mass calibration factor can be adjusted to compensate for different material types.

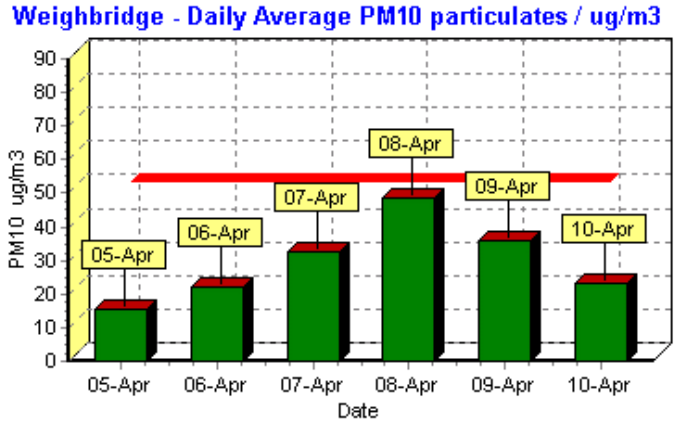
Having evaluated the mass of the particle, the microprocessor then evaluates the likely chance of deposition of the particle according to the sampling convention being used (PM_{10}, thoracic, and so on) as shown in figure 19 below. Thus for the thoracic convention a 6 micron particle has an 80.5% chance of deposition, hence only this percentage of its evaluated mass is accumulated.(42)

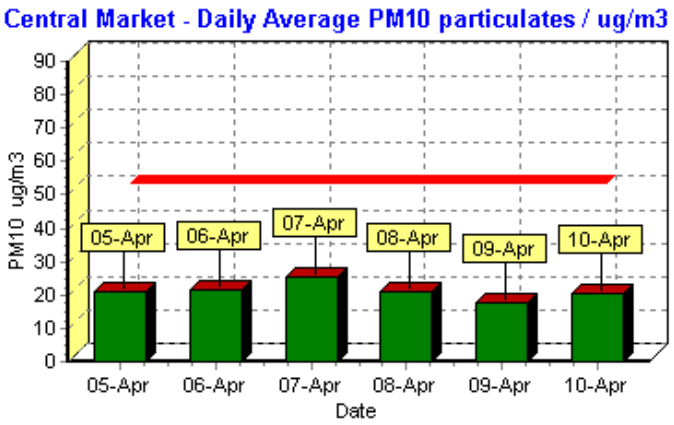
Diagram of the Osiris particle monitor



Appendix 2: Example of the Air Quality Information on Jersey Meteorological's Website: www.jerseymet.gov.je

Latest 24 hr average PM10 readings from the Weighbridge and Market sites, St. Helier





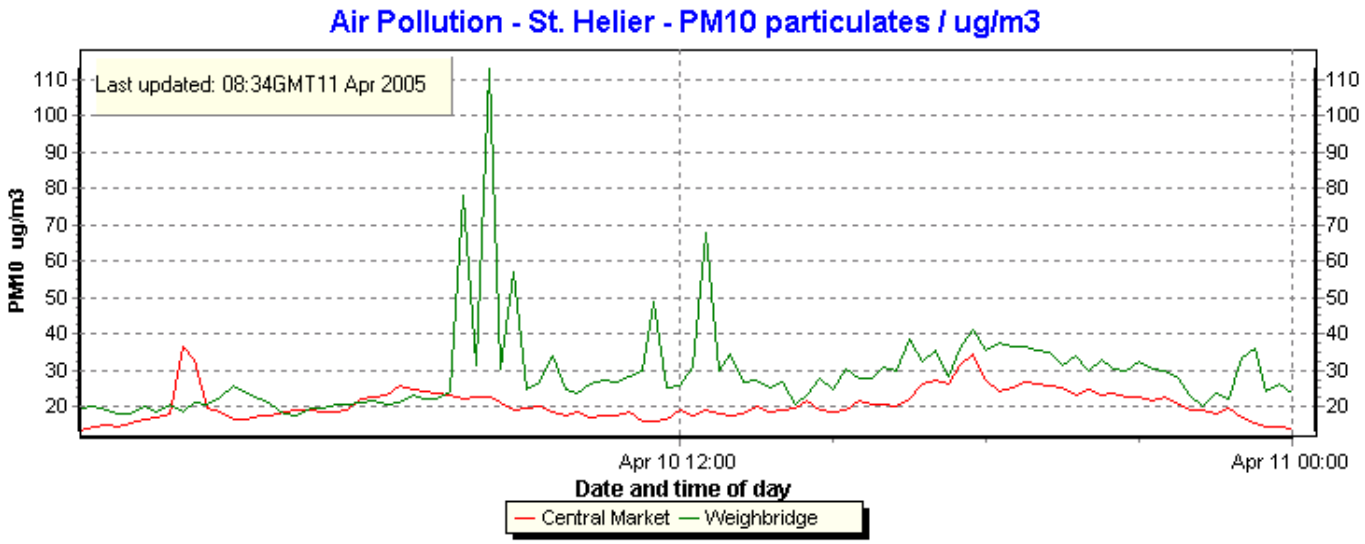
Note 1) The exceedances at the Market site are partly due to deliveries and refuse collection operations on Halkett Place. Delivery and refuse vehicles have been ask to switch their engines off as far as possible in this area.

2) The Weighbridge exceedances are due to the refurbishment of the Pomme d'Or Hotel and the storage and use of materials, cement dust etc nearby.

The following table of Air Pollution Bandings gives an assessment of the impact on health of individuals who are sensitive to Air Pollution.

Air Pollution Bandings: PM10s as a running 24 hour mean and Impact on Human Health		
Air Pollution Band	**PM10 concentration**	**Effects**
Low Air Pollution	<50 µg/m^3	Effects are unlikely to be noticed by individuals who know they are sensitive to air pollutants.
Moderate Air Pollution	50 - 74 µg/m^3	Mild effects, unlikely to require action, may be noticed amongst sensitive individuals.
High Air Pollution	75 - 99 µg/m^3	Significant effects may be noticed by individuals and action to avoid or reduce these effects may be needed (e.g. reducing exposure by spending less time in polluted areas outdoors). Asthmatics will find that their 'reliever' inhaler is likely to reverse the effects on the lung.
Very High Pollution	>= 100 µg/m^3	The effects on sensitive individuals described for 'High' levels of pollution may worsen.

Latest near real time PM10 readings from the Weighbridge and Market sites, St. Helier:-



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The Health Protection Department in consultation with the Environment and Public Services Department have produced Jersey's first draft

Air Quality Strategy which is available from the Department or via the Resources section of www.health.gov.je.

You can get further information on air pollution in the UK from:
www.airquality.co.uk/archive/index.php

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