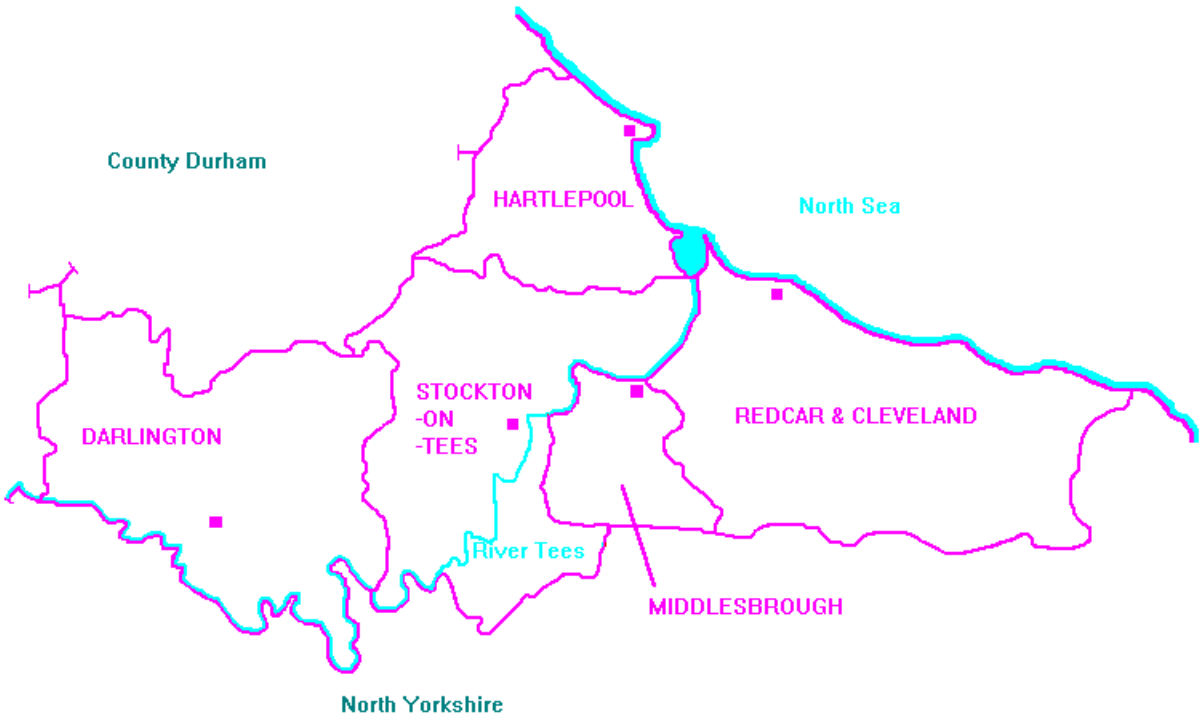
TEES VALLEY ENVIRONMENTAL PROTECTION GROUP

ANNUAL REPORT 2010

AIR QUALITY

in the

TEES VALLEY 2006 – 2009



a comparison with

National Air Quality Objectives

Published by the Tees Valley Environmental Protection Group - June 2010

Contents

SUMMARY

The UK Government has regulated for thirteen air quality objectives covering seven air pollutants, against which local authorities are required to measure local air quality. A further three air pollutants have objectives set, but these are not yet part of regulation.

If any regulated objective is unlikely to be met by its due date, in any areas where there may be relevant public exposure, a local authority is obliged to declare an Air Quality Management Area (AQMA), and draw up an action plan to reduce air pollution.

The five Tees Valley Councils have annually reviewed their air quality since year 2000, and have each concluded that air quality was sufficiently good not to require any AQMA within their boundaries. The Department for Environment, Food and Rural Affairs (Defra) has accepted these findings.

This report is a joint Council annual report recording all air quality monitoring carried out within the Tees Valley over the period 2006 – 2009, and comparing the results with the air quality objectives. Historical trend graphs are also provided. The report supports the 2010 Progress Report for each of the Tees Valley Councils, as required by Defra.

The latest air quality data confirms that air quality in the Tees Valley continues to meet the regulated objectives, and there is no need for any Air Quality Management areas.

In particular, those air pollutants mainly associated with industry, such as sulphur dioxide, benzene and 1,3 butadiene, have stabilised at historically low levels. Those pollutants mainly associated with road transport, nitrogen dioxide and particulates, have also stabilised, with any reduction in emission levels per vehicle being largely offset by increases in traffic flow. Indeed, any change in concentrations year on year is usually associated with weather variations, for example long periods of high pressure can lead to a build-up of pollutants in the atmosphere, particularly alongside congested roadside areas.

Two of the unregulated pollutants, ozone, and polycyclic aromatic hydrocarbons (PAHs), are less likely to meet their objectives.

Ozone is formed by the chemical reaction of other air pollutants in the atmosphere, particularly during the summer months. High levels are recorded along the coastal areas, usually as a result of easterly winds transporting air pollutants from the continent. In areas of high traffic flow, ozone levels are reduced by further chemical reaction, so that inland urban areas tend to show lower ozone concentrations. Even so, in years of good summer weather, much of the Tees Valley is likely to show an exceedance of the ozone objective. It is recognised by Defra that there is little action that can be taken at local authority level to change this, and pan-European action is required to reduce all primary air pollutants.

PAH is a term for a range of hydrocarbon pollutants associated with coal and wood burning. Monitoring at ground level only started in 2008, and early results suggest that an exceedance of the objective is possible in areas along the south side river Tees estuary. Additional monitoring is required.

PAH is a potential problem associated with other industrial areas of the UK where coke ovens are situated, and further investigation is being carried out by Defra and the Environment Agency in respect of accuracy of measurement, and emission source.

This report is held by each Tees Valley Council on their web-site, with a hard copy held in each of the Council reference libraries.

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INTRODUCTION

NATIONAL AIR QUALITY STRATEGY POLLUTANTS 2007

POLLUTANT	OBJECTIVE (maximum)	Maximum Exceedances / year	DUE DATE
nitrogen dioxide (NO_2)	40 µg/m³ as an annual mean	no exceedances	31.12.2005
	200 µg/m³ as a 1 hour mean	18 exceedances	31.12.2005
particulate PM_{10} (PM_{10}) (see note 1 below)	40 µg/m³ (gravimetric) as an annual mean	no exceedances	31.12.2004
	50 µg/m³ (gravimetric) as a 24 hour mean	35 exceedances	31.12.2004
sulphur dioxide (SO_2)	125 µg/m³ as a 24 hour mean	3 exceedances	31.12.2004
	350 µg/m³ as a 1 hour mean	24 exceedances	31.12.2004
	266 µg/m³ as a 15 minute mean	35 exceedances	31.12.2005
carbon monoxide (CO)	10 mg/m³ as an 8 hour running mean	no exceedances	31.12.2003
benzene (BEN)	16.25 µg/m³ as a running annual mean	no exceedances	31.12.2003
	5.00 µg/m³ as an annual mean	no exceedances	31.12.2010
1,3-butadiene (BUT)	2.25 µg/m³ as a running annual mean	no exceedances	31.12.2003
lead	0.5 µg/m³ as an annual mean	no exceedances	31.12.2004
	0.25 µg/m³ as an annual mean	no exceedances	31.12.2008
particulate $PM_{2.5}$ ($PM_{2.5}$)	*25 µg/m³ as an annual mean*	*no exceedances*	*31.12.2020*
	with a target of 15% reduction in concentrations at urban background locations measured as a 3-year mean		*Between 2010 and 2020*
polycyclic aromatic hydrocarbons (PAHs)	*0.25 ng/m³ as an annual mean*	*no exceedances*	*31.12.2010*
ozone (target only) (O_3)	*100 µg/m³ as an 8 hour running mean*	*10 day exceedances*	*31.12.2005*

Notes :

1. One particulate PM2.5 objective has replaced the two proposed 2010 objectives for particulate PM10 in the revised UK Air Quality strategy for England.

INTRODUCTION

UK AIR QUALITY POLICY

The UK Government has set air quality objectives for ten air pollutants against which local authorities can monitor and judge the quality of air (reference 1 inside back cover).

The pollutants are :

pollutant	regulated	unregulated
nitrogen dioxide	2 objectives	
particulate PM_{10}	2 objectives	
sulphur dioxide	3 objectives	
carbon monoxide	1 objective	
benzene	2 objectives	
1,3-butadiene	1 objective	
lead	2 objectives	
particulate $PM_{2.5}$	-	1 objective
polycyclic aromatic hydrocarbons	-	1 objective
ozone	-	1 objective
	----------	----------
	13 objectives	3 objectives

Details of the regulated objectives and proposed objectives are shown opposite.

Thirteen objectives are regulated, and local authorities are obliged to review air quality to see if the objectives will be met by the due date, ranging from December 31st 2003 and December 31st 2010. If any objective is unlikely to be met by the due date, in any area where relevant public exposure may realistically exist (see 'Relevant Public Exposure' section overpage), a local authority is obliged to declare an Air Quality Management Area for that area, and draw up an action plan with all interested parties to reduce the level of air pollution.

All five Tees Valley Councils have completed four full review and assessments of air quality against these objectives (2000, 2003, 2006 and 2009), and have concluded that there is no need to declare Air Quality Management Areas. The Department for Environment, Food & Rural Affairs (DEFRA) has accepted this.

This report is the 2010 annual report providing details of the latest monitoring information within the Tees Valley, and historical trend graphs. The report supports the 2010 Progress Report submissions by each Tees Valley council.

A revised Air Quality Strategy was published by Defra in July 2007. Two earlier proposals for particulate PM_{10} have been replaced (in England) by a new annual mean objective for particulate $PM_{2.5}$. The proposals for ozone and polycyclic aromatic hydrocarbons are now objectives. These three pollutants are not yet regulated, but monitoring data is included in this report for information.

Four other air pollutants are also being considered within the UK and the EU, and are likely to be included in the UK air quality strategy at a later date. Relevant monitoring data is also included for information.

The pollutants are:

cadmium arsenic nickel mercury

For further information, see the DEFRA air quality web-site (reference 2 inside back cover).

RELEVANT PUBLIC EXPOSURE

The air quality objectives only apply to areas where there may be relevant public exposure. The definition of this depends on the averaging period of the objective, with a short 15 minute averaging period affecting a wider range of the public than an annual average.

Government guidance is as follows:

Averaging Period (relevant pollutants)	Objectives should apply at:	Objectives should generally not apply at:
Annual Mean (nitrogen dioxide, particulate PM10, particulate PM2.5, benzene, 1,3-butadiene, lead, polycyclic aromatic hydrocarbons)	All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes etc.	Building façades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
24-hour mean and 8-hour mean (particulate PM10, sulphur dioxide, carbon monoxide, ozone)	All locations where the annual mean objective would apply, together with hotels. Gardens of residential properties, in particular around seating or play areas, but garden boundary extremities or front gardens are less likely..	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
1-hour mean (nitrogen dioxide, sulphur dioxide)	All locations where the annual mean and 24-hour and 8-hour mean objectives would apply. Kerbside sites (e.g. pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc., which are not fully enclosed, where the public might reasonably be expected to spend 1 hour or more. Any outdoor locations to which the public might reasonably be expected to spend 1 hour or longer.	Kerbside sites where the public would not be expected to have regular access.
15-minute mean (sulphur dioxide)	All locations where members of the public might reasonably be exposed for a period of 15 minutes or longer.	

HEALTH EFFECTS

The air quality objectives have been set at levels of pollution that are unlikely to cause harm to the vast majority of the public, based on current world-wide health advice available to the Government. If pollution levels exceed the objective levels, there is increasing risk to the public, with those suffering from existing health problems such as lung and heart disease, at greatest risk. Three of the ten air quality strategy pollutants are known carcinogens, for which it is acknowledged there are no completely safe limits. The objectives set in these cases have a 10 fold safety factor built in, and are at levels where there is considered to be minimal risk to members of the public.

The health effects of excess pollution attributable to each of the pollutants is summarised as follows:

Pollutant (objective averaging periods)	**Health effects**
Nitrogen dioxide (annual mean, 1 hour mean)	Nitrogen Dioxide can irritate the lungs and lower resistance to respiratory infections such as influenza. Continued or frequent exposure to concentrations much higher than those normally found in the ambient air may cause increased incidence of acute respiratory illness in children.
Particulate PM_{10} / $PM_{2.5}$ (annual mean, 24 hour mean)	Particles are measured in a number of size fractions according to their mean aerodynamic diameter. Most current monitoring is currently focused on PM_{10}, but the finer fractions such as $PM_{2.5}$ and PM_1 are becoming of increasing interest in terms of health effects. Fine particles can be carried deep into the lungs where they can cause inflammation and a worsening of the condition of people with heart and lung diseases. In addition, they may carry surface-absorbed carcinogenic compounds into the lung.
Sulphur dioxide (24 hour mean, 1 hour mean, 15 minute mean)	Even moderate concentrations may result in a fall in lung functions of asthmatics. Tightness in the chest and coughing occur at high levels, and lung function of asthmatics may be impaired to the extent that medical help is required. Sulphur dioxide pollution is considered more harmful when particulate and other pollution concentrations are high.
Carbon Monoxide (8 hour mean)	This gas prevents the normal transport of oxygen by the blood. This can lead to a significant reduction in the supply of oxygen to the heart, particularly in people suffering from heart disease.
Benzene (annual mean)	Possible chronic health effects include cancer, central nervous system disorders, liver and kidney damage, reproductive disorders, and birth defects.
1,3-butadiene (annual mean)	Possible chronic health effects include cancer, central nervous system disorders, liver and kidney damage, reproductive disorders, and birth defects.

HEALTH EFFECTS (continued)

Pollutant (objective averaging periods)	**Health effects**
Lead (annual mean)	Even small amounts of lead can be harmful, especially to infants and young children. In addition, lead taken in by the mother can interfere with the health of the unborn child. Exposure has also been linked to impaired mental function, visual-motor performance and neurological damage in children, and memory and attention span.
Ozone (8 hour mean)	Exposure to high levels of ozone is associated with slight irritation to the eyes or nose. Very high levels of exposure (in excess of 10 times the proposed objective level) over several hours can cause damage to the airway lining followed by inflammatory reaction. At levels of ozone above 200 µg/m³ as an eight hour concentration (2 times the proposed objective), an effect in healthy individuals has been clearly demonstrated.
Polycyclic Aromatic Hydrocarbons (PAHs) (annual mean)	Exposure to polycyclic aromatic hydrocarbons is associated with an increased incidence of tumours of the lung, skin, and other sites, with lung cancer most obviously linked to exposure through inhaled air. The objective level of 0.25 ng/m³ as an annual average is considered to represent a risk to health so small as to be undetectable.

AIR QUALITY MONITORING in the TEES VALLEY

This report records the air quality results, from 2006 - 2009, at all of the monitoring stations across the Tees Valley, and compares them with the thirteen regulated objectives and the three proposed objectives of the National air quality strategy. **All results are final ratified results** (see Appendix 1).

Particulate $PM_{2.5}$ monitoring started at Middlesbrough (Breckon Hill) and Stockton (Eaglescliffe) AURN stations towards the end of 2008, with the first full year of results in 2009.

The majority of results are from continuous monitoring stations, which are the most accurate. Three fixed continuous monitoring stations are part of the national Automatic Urban and Rural Network (AURN stations), whose results are published on the Internet (reference 3 inside back cover). The remaining nine fixed continuous monitoring stations are Local stations, results from which are held by the local authority.

Non-continuous monitoring equipment is also used to measure NO2 (annual), benzene, and polycyclic aromatic hydrocarbons, and the results from these are also included.

The locations of the monitoring sites, and pollutants measured, are as follows:

National network (AURN) continuous monitoring stations 2008

station	start year	pollutants measured	site description
Middlesbrough (Breckon Hill)	1993 / 5 / 2007	NO_2, PM_{10}, $PM_{2.5}$, SO_2, CO, O_3	urban industrial
Stockton, Billingham (Cowpen Depot)	1987	NO_2	urban industrial
Stockton (Eaglescliffe)	2008 / 9	NO_2, PM_{10}, $PM_{2.5}$	roadside
Stockton (Yarm High Street *)	2000 / 2 - 2008	NO_2, PM_{10}, (site moved to Eaglescliffe Q4 2008)	kerbside

* carbon monoxide monitoring was removed from the Stockton Yarm station from October 2007.

Local continuous monitoring stations 2008

station	start year	pollutants measured	site description
Stockton, Billingham (Cowpen Depot)	1996 / 8	PM_{10}, SO_2, O_3	urban industrial
Redcar (Corporation Road *)	1998 (as AURN)	NO_2, PM_{10}, SO_2, CO, O_3 (all from 1.10. 2007)	suburban
Hartlepool (Stockton Road)	2003	NO_2, PM_{10}, SO_2, CO (all from 1.5.2003) (site not fully operational 2007 / 2008 / 2009)	roadside
Middlesbrough (MacMillan College)	2000	NO_2, PM_{10}	urban background
Middlesbrough (Elm Street)	2001 / 3	NO_2, PM_{10}	roadside
Darlington (Cockerton Bridge)	2004	NO_2, PM_{10}	roadside
Darlington (St Cuthberts Way)	2005	NO_2, PM_{10}	kerbside
Stockton (Eaglescliffe)	2008	O_3	roadside
Stockton, Yarm (High Street)	2001 - 2008	O_3 (site moved to Eaglescliffe Q4 2008)	kerbside

* following a Defra review of the AURN network, Redcar Corporation Road was removed from the AURN network from October 2007, but continues as a Local station operated by Redcar & Cleveland Council.

National network diffusion tube sites 2007 (benzene / 1,3-butadiene annual mean) - non-continuous
(benzene is a pumped diffusion tube system, 1,3-butadiene is a standard diffusion tube system)

station	start year	pollutant	site description
Middlesbrough, Breckon Hill	February 2002 April 2003	benzene 1,3-butadiene (to September 2007)	urban industrial
Stockton, Eaglescliffe	Q4 2008	benzene	roadside
Stockton, Yarm High Street	2002 - Q3 2008	benzene	kerbside

Diffusion tube sites 2008 (nitrogen dioxide annual mean) - non-continuous

Diffusion tubes are non-continuous monitoring equipment used to measure the annual mean for nitrogen dioxide at a range of mainly roadside locations. Some locations are part of a national Diffusion Tube network, whose results are published on the Internet (reference 3). Other locations are Local sites, results from which are held by the local authority. Year 2009 sites are listed below.
Middlesbrough sites were closed during March 2002, to concentrate on more accurate continuous monitoring at three permanent sites.
Redcar & Cleveland have not used diffusion tubes on a regular basis, preferring continuous monitoring.
Stockton has a triple tube co-location study at their Eaglescliffe and Billingham continuous monitors. The Eaglescliffe study was transferred from Yarm High Street in Q4 2008. The bias factors derived from these results is used to correct Stockton and Hartlepool diffusion tube readings. The Darlington diffusion tube readings are corrected using tube supplier bias factors.

site	Darlington	Hartlepool	Stockton
National	Northgate Salters Lane Hundens Depot Arts Centre	Victoria Road 1 Victoria Road 2 Granville Avenue Torquay Avenue	Prince Regent Street Wellington Street Dovecot Road Clifton Avenue
Local	Woodland Road Blackwell Bridge North Road Station Haughton Green Yarm Road Middleton-One-Row	Hart Lane Stockton St central Stockton St Owton	Prince Regent Street (set back) Yarm High Street Eaglescliffe (3) Thornaby Road Cowpen Depot, Billingham (3) New Road, Billingham Clarences Long Newton Norton BASF (Seal Sands)

Lead monitoring stations (annual mean) - non-continuous

Stockton monitored airborne lead levels, using a pump and special filter system, at three locations as part of a heavy metal monitoring programme until 2007. The locations were Redmarshall, Eaglescliffe, and Seal Sands.

There is also a National network of heavy metal monitoring stations, mainly based in the major cities but also around known industrial metal processing sites. Upstream / downstream heavy metal monitors were installed during 2008 around the Redcar steelworks, and the lead results from these are given, along with a wider selection of results for comparison purposes.

National network Toxic Organic Micropollutants (TOMPS) station - non-continuous

(18 PAH sites, 9 of which measure PCBs, Dioxins and Furans)

station	start year	comment
Middlesbrough, Longlands College (site closed December 2007)	April 1993	Measures polycyclic aromatic hydrocarbons (PAHs) (also PCBs, Dioxins and Furans)

National network Polycyclic Aromatic Hydrocarbon (PAH) Station - non-continuous

(to be expanded to 25 sites)

station	start year	comment
Middlesbrough, Breckon Hill	Q4 2007	Measures polycyclic aromatic hydrocarbons (PAHs)

Reporting starts January 2008.

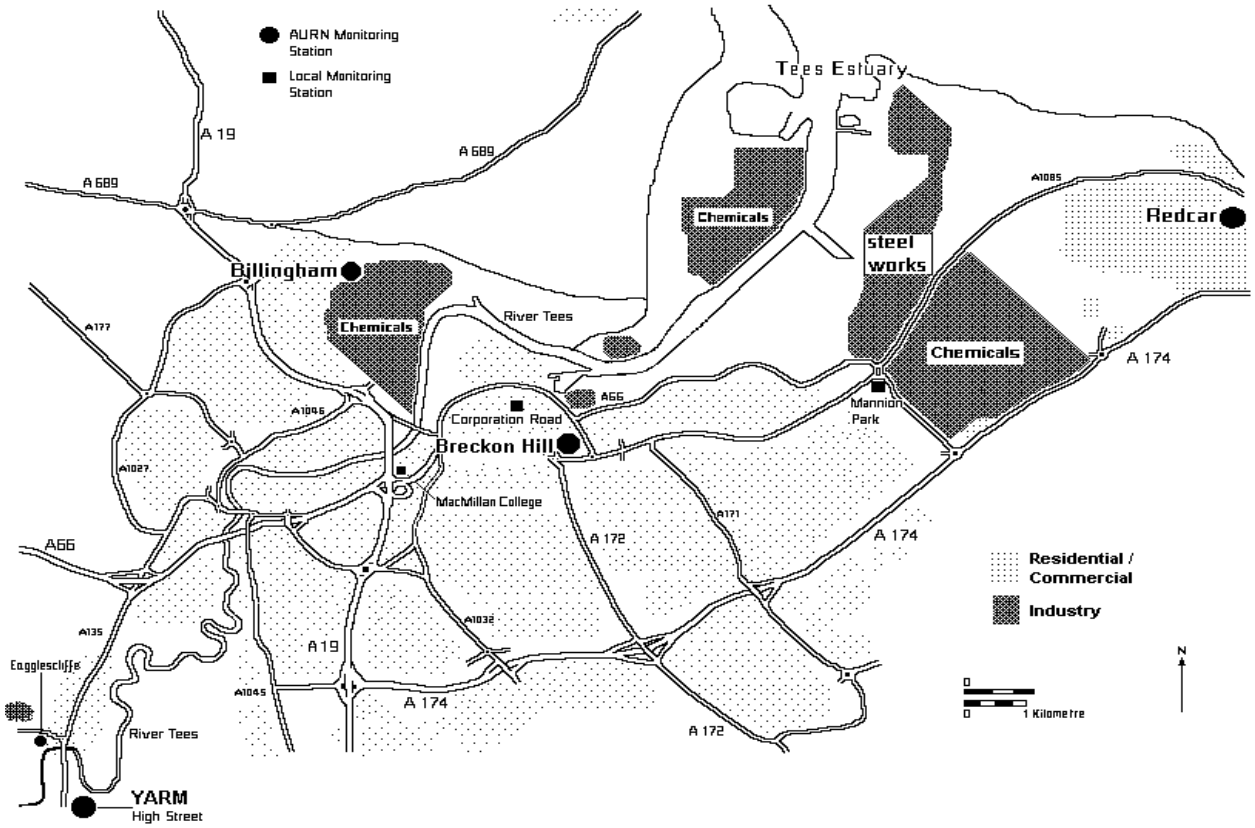
Cadmium, Arsenic, Nickel, Mercury

These elements are not yet part of the UK national air quality strategy, and do not have set UK objectives. The EU has set targets for Cadmium, Arsenic and Nickel.

Stockton monitored airborne levels of the four elements, Cadmium, Arsenic, Nickel, Mercury, using a pump and special filter system, at three locations as part of a heavy metal monitoring programme until 2007. The locations were Redmarshall, Eaglescliffe, and Seal Sands.

There is also a national network of twenty four industrial and major city sites monitoring annual concentrations in air for up to 13 metals, including Cadmium, Arsenic, Nickel, Mercury. Following a review of site requirements in 2007, Defra introduced two monitoring locations within the Redcar & Cleveland Council boundary of the Tees Valley, operational from January 2008. A selection of the other results is given for comparative purposes.

STOCKTON, MIDDLESBROUGH and REDCAR



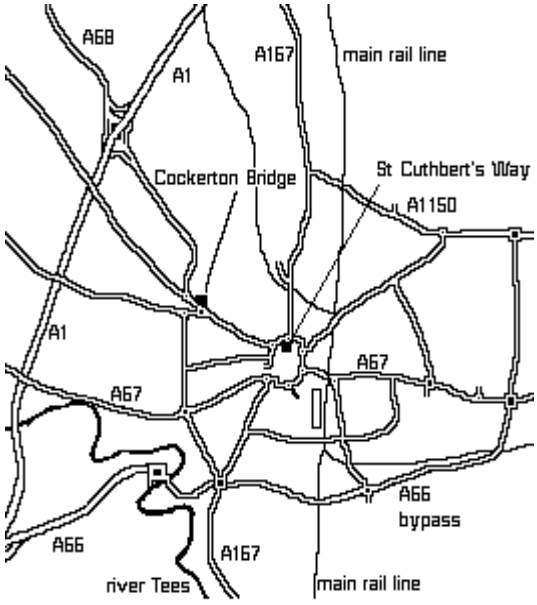
8 stations

Stockton Council
Billingham (AURN / Local)
Yarm High Street (to October 2008)
Eaglescliffe (AURN / Local from 2009)

Middlesbrough Council
Breckon Hill (AURN)
MacMillan College (Local)
Elm Street, Corporation Road (Local)

Redcar & Cleveland Council
Corporation Road (AURN to 2007/ Local)
Mannion Park (Local, closed July 2005)

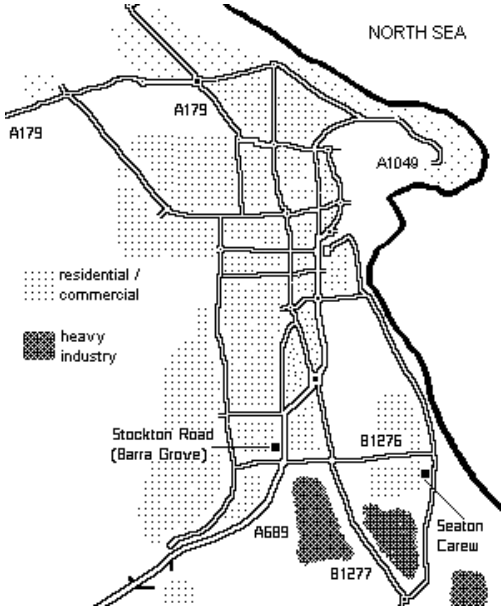
DARLINGTON CENTRAL AREA



2 local stations – NO2, PM10

St Cuthbert's Way 2000 – 2003, 2005 -
Cockerton Bridge 2004 –

HARTLEPOOL CENTRAL AREA



1 local station – NO2, PM10, SO2, CO

Seaton Carew 2000 - 2002
Stockton Road 2003 –

LOCATIONS OF FIXED CONTINUOUS MONITORING STATIONS

The maps opposite show the general locations of the fixed monitoring sites relative to residential / commercial properties, and to heavy industry. Darlington does not have any significant heavy industry, and most of the area shown covers residential / commercial land-use.
The sites are generally described below. The older sites have been located close to industrial sites, as they were seen as the major source of air pollution. More recent sites have concentrated on monitoring road traffic emissions, which are now recognised as the main source of air pollution at ground level.

Stockton Council area

Billingham (Cowpen Depot) is one of the earliest AURN nitrogen oxide stations in the country, starting in 1987. It is located in a Council building close to one of the older chemical manufacturing areas that specialises in nitrogen-based technology. The unit is based between the industrial boundary and residential properties, but is not an area of relevant public exposure.
Pollutants monitored as a Local station now also include particulate $PM_{10,}$ with historical results for sulphur dioxide and ozone.

Eaglescliffe started as an AURN station in Q4 2008, having been moved approximately 1 km from the Yarm High Street location. The site is an area of relevant public exposure within school grounds. As an AURN station, the site monitors nitrogen oxides, along with particulates PM_{10} and $PM_{2.5}$. As a Local station, the site monitors ozone. The national network pumped diffusion tube monitor for benzene has also been relocated.

Yarm High Street was the earlier AURN station (started 2000, closed 2008) measuring nitrogen oxides, particulate PM_{10} and carbon monoxide (to 2007) at a kerbside location in the middle of a busy high street. The site was not an area of relevant public exposure, but did reflect one of the most congested kerbside locations in the Tees Valley. The site was expanded as a Local station to measure ozone, and had a pumped diffusion tube monitor for benzene as part of the national network. These historical results are included in this report

Middlesbrough Council area

Breckon Hill is a long standing (1993) AURN station measuring nitrogen oxides, particulate PM_{10}, sulphur dioxide, carbon monoxide and ozone, along with a national network continuous hydrocarbon monitor measuring benzene and 1,3-butadiene amongst others. The hydrocarbon monitor was closed in 2000, replaced by a pumped diffusion tube system monitoring benzene in 2002, and a standard diffusion tube system monitoring 1,3-butadiene in 2003.
In Q4 2008, the station was upgraded to monitor particulate PM_{10} and particulate $PM_{2.5,}$ using gravimetric equivalent instruments.
Following a Defra review of hydrocarbon and PAH monitoring sites in 2007, 1,3-butadiene diffusion tube monitoring was discontinued in August 2007. PAH monitoring started during Q4 2007.

The site is in school grounds and is an area of relevant public exposure. It lies on a north / north-easterly wind direction from the main industrial areas, with a wind from this direction expected about 15% of the year, and contributes to evidence of industrial emissions in addition to traffic emissions. The school is in a residential area, which is surrounded by busy commuter roads.

MacMillan College is a Local station measuring nitrogen oxides and particulate PM_{10}. It is in the grounds of a school, and is an area of relevant public exposure. The site is within 250 metres of the main A19 and A66 trunk routes, which have high, but relatively free flowing, traffic flows.
Industrial sources of pollution are a few kilometres away.

Elm Street (Corporation Road) is a Local station measuring nitrogen oxides and particulate PM_{10}. It is in the heart of Middlesbrough, close to the town hall and shopping centre, but is only an area of relevant public exposure for the nitrogen dioxide 1 hour mean. Road traffic is slow moving, and levels measured are typical of the town centre.
Industrial sources of pollution are a few kilometres away.

LOCATIONS OF FIXED CONTINUOUS MONITORING STATIONS (continued)

Redcar & Cleveland Council area

Corporation Road, Redcar, is also a long standing (1997) AURN station measuring nitrogen oxides, particulate PM_{10}, sulphur dioxide, carbon monoxide and ozone. It was later expanded (1998) as a Local station with a continuous hydrocarbon monitor measuring benzene and 1,3-butadiene amongst others. The site is in the grounds of a local college and is an area of relevant public exposure. The area is suburban, with relatively light traffic, but is generally on the prevailing (70% of the year) wind direction and within 4 km of the main industrial chemical and steel complexes. It is a key site for monitoring industrial source pollution.

Following a Defra review of AURN stations in 2007, this site was removed from the AURN network at the end of September 2007. Redcar & Cleveland Council is continuing the site as a Local site, and from July 2009 arranged for data to be collected and ratified externally to the same standard as AURN stations.

The hydrocarbon Local monitor has had operational and resource problems during 2005 – 2007, with no results available. The monitor was closed in January 2008.

Darlington Council area

St Cuthbert's Way is recent (year 2000) Local station measuring nitrogen oxides and particulate PM_{10}. The site is on the edge of the main shopping area, at a kerbside location on the busy inner ring road where traffic is generally slow moving at a major roundabout. The site is a an area of relevant public exposure for the nitrogen dioxide 1 hour mean.

Cockerton Bridge is the new location for the monitoring unit, starting May 2004. It is a roadside location on one of the main radial routes to the town centre. Traffic is heavy, but relatively free flowing.

Hartlepool Council area

Stockton Road (Barra Grove) started May 2003, having been moved from a Seaton Carew site. The station measures nitrogen oxides, particulate PM_{10}, sulphur dioxide and carbon monoxide, and is a roadside location on the main dual carriageway into town centre. Traffic is relatively heavy, but free flowing. It is not an area of relevant public exposure, but lies between the kerbside and residential property set further back.

The site has had a series of operational difficulties since 2005, with limited results for 2006 / 7 (which are included in this report) , and no results for 2008 or 2009. This station is to be closed, with two new nitrogen oxide / particulate PM10 units to be installed elsewhere during 2010.

MONITORING RESULTS AND ANALYSIS

nitrogen dioxide annual mean

nitrogen dioxide 1 hour mean

particulate PM_{10} annual mean

particulate PM_{10} 24 hour mean

particulate $PM_{2.5}$ annual mean

sulphur dioxide 24 hour mean

sulphur dioxide 1 hour mean

sulphur dioxide 15 minute mean

carbon monoxide 8 hour running mean

benzene running annual mean

1,3-butadiene running annual mean

lead annual mean

ozone 8 hour running mean and day exceedance

polycyclic aromatic hydrocarbons (PAHs) annual mean

NITROGEN DIOXIDE

Annual mean objective (2005) **maximum 40 µg/m³** **no exceedances**

Continuous monitoring stations - all results µg/m³ as the annual mean

AURN Stations	2009	2008	2007	2006
Stockton, Billingham (1987) (Cowpen Depot)	27	27	28	29
Middlesbrough (1993) (Breckon Hill)	19	21	21	22
Stockton (2009) (Eaglescliffe)	17	-	-	-
Stockton (2000 - 2008) (Yarm High Street)	-	35 #	39	38

 # - Monitoring station moved to Eaglescliffe October 2008. No Q4 results

Local Stations	2009	2008	2007	2006
Darlington (2004) (Cockerton Bridge)	27	20	23	23
Darlington (2001) (St Cuthbert's Way)	49	44	35	42
Hartlepool (2003) (Stockton Road)	-	-	16 *	20
Middlesbrough (2000) (MacMillan College)	24	25	24	26
Middlesbrough (2001) (Elm Street)	26	27	24	26
Redcar (1998) ^ (Corporation Road)	18 #	15	18 ^	22

^ - AURN status removed September 2007, local station Q4 results 2007 included.

*** - less than 6 months data. Data annualised using Stockton (Yarm) AURN station**.

 # - less than 6 months data. Data annualised using Middlesbrough (Breckon Hill) AURN station.

NITROGEN DIOXIDE **continuous monitors**

Objective 1 of 2: Annual mean of 40 µg/m³ (21 ppb) maximum, with no exceedances

Relevant Exposure is where members of the public may be exposed to levels of nitrogen dioxide above 40 µg/m³ as an annual mean by December 31st 2005.

This includes all locations where members of the public might be regularly exposed, and the building façades of residential properties, schools, hospitals, care homes etc.

Generally excluded are the building façades of offices or other places of work where members of the public do not have regular access; hotels, unless people live there as their permanent residence; gardens of residential properties; kerbside sites (as opposed to locations at the building façades), or any other location where public exposure is likely to be short term.

Sources

Nitric oxide (NO) is mainly derived from road transport emissions and other combustion processes such as the electricity supply industry. Nitric oxide is not considered to be harmful to health. However, once released to the atmosphere, NO is usually very rapidly oxidised, mainly by ozone (O_3), to nitrogen dioxide (NO_2), which can be harmful to health. NO_2 and NO are both oxides of nitrogen and together are referred to as nitrogen oxides (NO_x).

Results (see opposite)

The results from the fixed AURN and Local monitors show a good degree of consistency on a year by year basis, but with no clear signs that nitrogen dioxide levels are reducing. 2009 results have tended to show a slight decrease over 2008, but this probably reflects the poor weather conditions rather than a downward trend.

The Darlington (St Cuthbert's Way) site is now the only town centre kerbside site following the closure of Yarm High Street site, and continues to demonstrate the significant effect that slow moving, heavy traffic has on ground level concentrations of nitrogen dioxide. The Darlington site shows an exceedance of the objective for 2009, but is not an area of relevant public exposure, the nearest one being 40 metres away. Earlier DMRB modelling of the nearest public exposure location has comfortably shown no exceedances, and the LAQM distance calculator indicates a maximum 2009 annual mean of 32 µg/m^3, well within the objective level. The Stockton (Yarm) site was moved in August 2008 to a public exposure location in Eaglescliffe, one kilometre distant.

The Middlesbrough (Elm Street), Darlington (Cockerton Bridge), and Stockton Eaglescliffe sites are also close to heavy traffic, but are set back from kerbside towards the building line. The results show that nitrogen dioxide levels normally quickly fall with distance from kerbside as long as there is a generally open aspect. This is confirmed by results at the Middlesbrough Breckon Hill and MacMillan College sites, both of which are public exposure locations in areas generally surrounded by roads with heavy traffic, but with lower nitrogen dioxide levels which are comfortably within the objective level.

The Redcar (Corporation Road) site is an urban background site with significantly less traffic in the vicinity, reflected in the lower nitrogen dioxide levels. These levels, at around half of the objective level, are likely to represent those to be found at most public exposure locations in the Tees Valley. The Redcar site also shows no sign of any significant contribution to ground level concentrations from industrial sources along the river estuary.

Overall, road traffic is the major source of nitrogen dioxide at ground level within the Tees Valley. The generally open aspect of the road system and trunk road corridors means that areas where public exposure may be present will have nitrogen dioxide levels well below the objective.

Health effects : Long term exposure to nitrogen dioxide may affect lung function, and enhance the response to allergens in sensitised individuals.

NITROGEN DIOXIDE

Annual mean objective (2005) maximum 40 µg/m³ no exceedances

Diffusion tube sites - all results µg/m³ as the annual mean. Darlington results adjusted by triple co-location studies for 2005, and laboratory overall bias factor (April) for years 2006 – 2009. Stockton and Hartlepool results adjusted by two triple co-location studies at Stockton for years 2005 - 2009. Tubes all 50% TEA in acetone.

		2009	2008	2007	2006
Darlington (Gradko Laboratory)	bias factor	0.99	0.85	0.93	1.04
National Survey sites					
Northgate	kerbside	42	37	38	39
Salters Lane	kerbside	37	32	35	30
Hundens Depot	background	19	17	18	23
Arts Centre	background	16	14	15	16
Local sites					
Woodland Road	kerbside	41	33	39	39
Blackwell Bridge	kerbside	41	37	37	39
North Road Station	kerbside	37	31	34	35
Haughton Green	kerbside	38	32	39	40
Yarm Road	kerbside	31	27	29	30
Middleton One-Row	kerbside	13	10	11	12

		2009 #	2008	2007	2006
Hartlepool (Jesmond Dene)	bias factor	0.83	0.91	0.81	0.84
National Survey sites					
Victoria Road 1	kerbside	44 (2mths)	43	42	42
Catcote Road	kerbside	25 (2mths)	30	46	33
Granville Avenue	background	18 (2mths)	19	22	19
Torquay Avenue	background	18 (2mths)	21	26	23
Local sites					
Stockton St (central)	kerbside	51 (2mths)	50	35	54
Stockton St (Owten)	kerbside	36 (2mths)	35	36	35

2009 data 2 months only due to diffusion tube losses

		2009	2008	2007	2006
Stockton (Jesmond Dene)	bias factor	0.83	0.91	0.81	0.84
National Survey sites					
Prince Regent Street	kerbside	49	54	53	50
Wellington Street	kerbside	23	30	31	30
Dovecot Street	background	24	28	27	29
Clifton Avenue	background	18	19	19	20
Local sites					
Yarm High Street	shop front	28	38	30	32
Thornaby Road	roadside	21	23	21	23
Prince Regent Street (set back)		31	36	29	-
New Rd (Billingham)		21	26	26	24
Long Newton		18	20	21	21
Norton (South Road)		27	31	30	28
Cowpen Depot		23	27	26	25
BASF (Seal Sands)		24	31	31	34
Eaglescliffe AURN (3)*	roadside	18	47	40	41
Billingham AURN (3)*		25	27	27	26
(* Triple collocation studies with continuous monitor to October 2008, moved to Eaglescliffe Q1 2009)					

NITROGEN DIOXIDE **diffusion tubes**

Objective 1 only : Annual mean of 40 µg/m³ (21 ppb) maximum, with no exceedances

Relevant Exposure is where members of the public may be exposed to levels of nitrogen dioxide above 40 µg/m³ as an annual mean by December 31st 2005.

This includes all locations where members of the public might be regularly exposed, and the building façades of residential properties, schools, hospitals, care homes etc.

Generally excluded are the building façades of offices or other places of work where members of the public do not have regular access; hotels, unless people live there as their permanent residence; gardens of residential properties; kerbside sites (as opposed to locations at the building façades), or any other location where public exposure is likely to be short term.

Sources

Nitric oxide (NO) is mainly derived from road transport emissions and other combustion processes such as the electricity supply industry. Nitric oxide is not considered to be harmful to health. However, once released to the atmosphere, NO is usually very rapidly oxidised, mainly by ozone (O_3), to nitrogen dioxide (NO_2), which can be harmful to health. NO_2 and NO are both oxides of nitrogen and together are referred to as nitrogen oxides (NO_x).

Results (see opposite)

Diffusion tubes are inherently less accurate than continuous monitors, but are a cost-effective way to measure annual averages of nitrogen dioxide over a wider area. Within the Tees Valley, they are mainly used to identify potential hot-spots of air pollution for further investigation. There is evidence that diffusion tubes at kerbside sites tend to read up to 20% higher than continuous monitors, and tend to be affected by prolonged calm weather conditions.

Three of the Tees Valley Councils have participated in the national survey with four diffusion tube sites, as well as monitoring at other sites. Middlesbrough Council discontinued diffusion tube monitoring in 2002 to concentrate on continuous monitoring, and Redcar & Cleveland Council does not use diffusion tubes on a regular basis.

Kerbside sites, where there tends to be slow moving or frequently stationary traffic, show the highest levels. While some site measurements show an exceedance of the objective level, they are not areas of relevant public exposure. However, the sites were further investigated using the DMRB air quality model in 2005. Results consistently showed that kerbside diffusion tubes read significantly higher than continuous monitors. The sites will be checked again when the updated DMRB model is published, sometime in 2010. The highest kerbside site reading in 2009 (full year results) was Prince Regent Street in Stockton centre. A new diffusion tube site was set back towards residential areas in 2007, and has shown a substantially lower reading, confirming the quick fall off in NO_2 concentrations away from kerbside.

Other roadside and intermediate sites, which are set back further from the kerbside and more representative of relevant public exposure, have lower levels that are comfortably within the objective level. These results were also closer to continuous monitor levels than those from the kerbside sites.

Background sites tend to be consistently well below the objective level.

Overall, the results from each Council are similar at the various category of site. With diffusion tubes tending to read high, particularly at kerbside sites, and the expectation of reducing nitrogen oxide emissions from vehicles, there have been no areas of relevant public exposure identified where the objective will be exceeded.

Health effects : Long term exposure to nitrogen dioxide may affect lung function, and enhance the response to allergens in sensitised individuals.

NITROGEN DIOXIDE

1 hour mean objective (2005) **maximum 200 µg/m³** **maximum 18 exceedances / year**

Continuous monitoring stations - all results µg/m³ as the maximum of 1 hour means

(any exceedances are shown in brackets)

Figures shown below the 1 hour maximums are the 99.8th percentile of the 1 hour means, which provides a direct comparison with the objective level.

AURN Stations		2009	2008	2007	2006
Stockton, Billingham (1987) (Cowpen Depot)	99.8 %ile	223 (3) 143	244 (5) 159	506 (7) 157	298 (5) 148
Middlesbrough (1993) (Breckon Hill)	99.8 %ile	99 83	118 90	138 95	105 86
Stockton (2009) (Eaglescliffe)	99.8 %ile	136 96	- -	- -	- -
Stockton (2000 - 2008) (Yarm High Street)	99.8 %ile	- -	273 (1) # 103	153 (0) 118	351 (2) 118

 # - Monitoring station moved to Eaglescliffe October 2008. No Q4 results

Local Stations		2009	2008	2007	2006
Darlington (2004) (Cockerton Bridge)	99.8 %ile	176 92	151 84	122 86	108 83
Darlington (2001) (St Cuthbert's Way)	99.8 %ile	162 122	206 (1) 102	162 113	144 104
Hartlepool (2003) (Stockton Road)	99.8 %ile	-	-	133 * 68	105 66
Middlesbrough (2000) (MacMillan College)	99.8 %ile	107 90	123 87	153 93	88 77
Middlesbrough (2001) (Elm Street)	99.8 %ile	97 86	107 89	154 84	84 73
Redcar (1998) ^ (Corporation Road)	99.8 %ile	90 * 78	95 53	115 ^ 71	94 76

*** - less than 6 months data**

^ AURN status removed September 2007, local station Q4 results 2007 included.

NITROGEN DIOXIDE **continuous monitors**

Objective 2 of 2: 1 hour mean of 200 µg/m³ (105 ppb) maximum, with up to 18 exceedances per year

Relevant Exposure is where members of the public may be exposed to levels of nitrogen dioxide above 200 µg/m³ as a 1 hour mean by December 31st 2005.

This includes all outdoor locations where members of the public might be regularly exposed, the gardens of residential properties, any outdoor locations to which the public might reasonably be expected to spend one hour or more, kerbside sites (eg pavements of busy shopping streets), those parts of car parks, bus stations and railway stations etc. which are not fully enclosed, and the building façades of residential properties, schools, hospitals, care homes, hotels etc.

Generally excluded are kerbside sites where the public would not be expected to have regular access.

Sources

Nitric oxide (NO) is mainly derived from road transport emissions and other combustion processes such as the electricity supply industry. Nitric oxide is not considered to be harmful to health. However, once released to the atmosphere, NO is usually very rapidly oxidised, mainly by ozone (O_3), to nitrogen dioxide (NO_2), which can be harmful to health. NO_2 and NO are both oxides of nitrogen and together are referred to as nitrogen oxides (NO_x).

Results (see opposite)

1 hour means can only be measured by continuous monitors.

Although an occasional exceedance of the objective level is seen from time to time at the Stockton (Billingham) and Darlington St Cuthbert's Way sites, the frequency is low and well within the objective exceedance maximum.

A better measure is to look at the 99.8th percentile of the 1 hour means. This is the level above which there would have been 18 higher values over the year, and is thus a direct comparison with the objective level. All stations have the 99.8th percentile comfortably within the objective level, with those away from roadside locations less than half of the objective level.

The Darlington (St Cuthbert's) Way site is the worst case kerbside site for the whole of the Tees Valley, and shows that while road traffic can cause elevated 1 hour means, concentrations remain well within the objective.

The Stockton (Billingham) site shows the highest percentiles. Although this might be due to low level emissions from local industry, which is based on nitrogen technology, there is now evidence that the adjacent truck depot is having a significant influence. Even so, the 99.8th percentiles remain comfortably below the objective, and the site is not an area of relevant public exposure.

The results from the Middlesbrough (Breckon Hill) and Redcar (Corporation Road) AURN stations confirm that nitrogen oxide emissions from tall stacks along the estuary do not impact greatly on ground level concentrations.

Health effects : Short term exposure to high levels of nitrogen dioxide can cause inflammation of the airways, and enhance the response to allergens in sensitised individuals.

PARTICULATE PM_{10}

Annual mean objective (2005) **maximum 40 µg/m³ (gravimetric)** **no exceedances**

Continuous monitoring stations - all results µg/m³ (gravimetric) as the annual mean

AURN Stations	2009	2008	2007	2006
Gravimetric method	TEOM FDMS	VCM (1.3 Factor)	1.3 Factor	1.3 Factor
Middlesbrough (1993) (Breckon Hill)	18	19 (21)	21	23
Gravimetric method	BAM	BAM		
Stockton (2008) (Eaglescliffe)	16	13 (3 mths data)	-	-
		1.3 Factor	1.3 Factor	1.3 Factor
Stockton (2000 - 2008) (Yarm High Street)	-	28 # (8 mths data)	26	28

 # - Monitoring station moved to Eaglescliffe October 2008. No Q4 results

Local Stations	2009	2008	2007	2006
Gravimetric method	All VCM (1.3 Factor)	All VCM (1.3 Factor)	All 1.3 Factor	All 1.3 Factor
Stockton, Billingham (1998) (Cowpen Depot)	16 (18)	16 (18)	20	21
Darlington (2004) (Cockerton Bridge)	18 (20)	19 (21)	21	22
Darlington (2000) (St Cuthbert's Way)	26 (30)	24 (28)	27	34
Hartlepool (2003) (Stockton Road)	-	-	-	-
Middlesbrough (2000) (MacMillan College)	18 (19)	18 (21)	22	23
Middlesbrough (2003) (Elm Street)	18 (20)	19 (22)	21	24
Redcar (1998) ^ (Corporation Road)	18 (21) #	18 (21)	21 ^	24

 # - less than 6 months data. Data annualised using Stockton (Eaglescliffe) AURN station.

^ - AURN status removed September 2007, local station Q4 results 2007 included.

Note : GRAVIMETRIC METHOD

For 2006 / 7 all monitoring instruments were unmodified TEOM, results adjusted to gravimetric equivalence by guidance factor of 1.3.

For 2009, the AURN station at Middlesbrough was fitted with a TEOM FDMS monitor, providing direct gravimetric equivalence.

For 2009, the AURN station at Stockton Eaglescliffe was fitted with a BAM monitor, providing direct gravimetric equivalence.

For 2008 / 9, the local station unmodified TEOM results were adjusted using the Volatile Correction Model (vcm), giving slightly lower concentrations to the 1.3 factor. The vcm method was not suitable for earlier years.

PARTICULATE PM_{10} continuous monitors

Objective 1 of 2 :Annual mean of 40 µg/m³ (gravimetric) maximum, with no exceedances

Relevant Exposure is where members of the public may be exposed to levels of particulate PM_{10} above 40 µg/m³ (gravimetric) as an annual mean by December 31st 2004.

This includes all locations where members of the public might be regularly exposed, and the building façades of residential properties, schools, hospitals, care homes, etc.

Generally excluded are the building façades of offices or other places of work where members of the public do not have regular access; hotels, unless people live there as their permanent residence, gardens of residential properties; kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is likely to be short term.

Sources

There are a variety of primary sources of particulate PM_{10}, which are very fine particles of less than 10 micron in size. Fine particles are composed of a wide range of materials from a variety of sources including:
Combustion sources (such as road traffic); *secondary particles*, mainly sulphate and nitrate formed by chemical reactions in the atmosphere, and often transported from far across Europe; c*oarse particles*, suspended soils and dusts (eg, from the Sahara), sea salt, biological particles, and particles from construction work.

Results (see opposite)

The results from the fixed AURN and Local monitors show a good degree of consistency on a year by year basis, and are generally well within the objective level, with no exceedances recorded. Overall, 2009 results showed similar levels to 2008, with perhaps a small decline over earlier years. However, this probably reflects the continuing poor weather conditions than an overall downward trend.

The Darlington (St Cuthbert's) Way site is a town centre kerbside location, and clearly shows the influence of slow moving traffic on annual means. There is no public exposure issue present at this type of location, but levels remain well below the objective. The Stockton (Yarm) kerbside site was moved to Eaglescliffe (about 1 kilometre distant) during Q3 2008. Eaglescliffe is an area of relevant public exposure, and the first full year results confirm a substantial reduction in particulate levels.

The Middlesbrough (Breckon Hill and MacMillan College) sites are public exposure locations in areas generally surrounded by high traffic roads. Even so, the annual means are significantly lower than the kerbside site above, indicating that roadside sources quickly fall with distance as long as there is a generally open aspect.

The Middlesbrough (Elm Street), and Redcar monitors generally show that typical urban background levels, even a short distance from congested roads, have levels well below the objective.

The Government had proposed a further annual mean objective of 20 µg/m³ (gravimetric) for year 2010. This proposal, which still applies to Scotland, has now been replaced by a $PM_{2.5}$ objective (see pages 24 – 25). For the record, current monitoring results suggest that the proposal would not have been met in many parts of the Tees Valley without a significant reduction in source emissions of particulate PM_{10}, including natural sources.

Health effects : Exposure to particulate PM_{10} is associated with a range of effects on health, including effects on the respiratory and cardiovascular systems, asthma and mortality. Those members of the public with pre-existing lung and heart disease are particularly at risk.

PARTICULATE PM_{10}

24 hour mean objective (2004) **maximum 50 µg/m³ (gravimetric)**

maximum 35 exceedances / year

Continuous monitoring stations - all results µg/m³ (gravimetric) as the maximum of 24 hour means

(any exceedances are shown in brackets)

Figures shown below the 24 hour maximums are the 90th percentile of the 24 hour means, which provides a direct comparison with the objective level.

AURN Stations		2009	2008	2007	2006
	Gravimetric method	TEOM FDMS	VCM	1.3 Factor	1.3 Factor
Middlesbrough (1993) (Breckon Hill)	90th %ile	59 (3) 33	74 (13) 34	92 (11) 31	100 (10) 38
	Gravimetric method	BAM	BAM	-	-
Stockton (2008) (Eaglescliffe)	90th %ile	57 (3) 27	42 (0) (3 mths) 19	- -	- -
	Gravimetric method	-	1.3 Factor	1.3 Factor	1.3 Factor
Stockton (2000 - 2008) (Yarm High Street)	90th %ile	- -	68 # (14) (8 mths) 42	102 (12) 39	84 (15) 41

 # - Monitoring station moved to Eaglescliffe October 2008. No Q4 results

Local Stations		2009	2008	2007	2006
	Gravimetric method	All VCM	All VCM	All 1.3 Factor	All 1.3 Factor
Stockton, Billingham (1998) (Cowpen Depot)	90th %ile	54 (2) 28	61 (6) 31	70 (3) 30	86 (11) 35
Darlington (2004) (Cockerton Bridge)	90th %ile	60 (3) 29	66 (6) 32	66 (6) 32	76 (3) 33
Darlington (2000) (St Cuthbert's Way)	90th %ile	72 (13) 38	93 (14) 41	64 (6) 42	91 (35) 50
Hartlepool (2003) (Stockton Road)	90th %ile	- -	- -	- -	- -
Middlesbrough (2000) (MacMillan College)	90th %ile	55 (3) 28	106 (12) 34	85 (9) 33	96 (9) 38
Middlesbrough (2001) (Elm Street)	90th %ile	52 (2) 30	67 (15) 35	75 (9) 31	102 (9) 38
Redcar (1998) ^ (Corporation Road)	90th %ile	49 (0) * 27	80 (6) 29	49 (0) ^ 34	84 (10) 41

*** - less than 6 months data**

^ - AURN status removed September 2007, local station Q4 results 2007 included.

Note : GRAVIMETRIC METHOD

For 2006 / 7 all monitoring instruments were unmodified TEOM, results adjusted to gravimetric equivalence by guidance factor of 1.3.

For 2009, the AURN station at Middlesbrough was fitted with a TEOM FDMS monitor, providing direct gravimetric equivalence.

For 2009, the AURN station at Stockton Eaglescliffe was fitted with a BAM monitor, providing direct gravimetric equivalence.

For 2008 / 9, the local station results were adjusted using the Volatile Correction Model (vcm), giving small differences to the 1.3 factor. The vcm method was not suitable for earlier years.

PARTICULATE PM_{10} continuous monitors

Objective 2 of 2 : 24 hour mean of 50 µg/m³ (gravimetric) maximum, with up to 35 exceedances per year

Relevant Exposure is where members of the public may be exposed to levels of particulate PM_{10} above 50 µg/m³ (gravimetric) as a 24 hour mean by December 31st 2004.

This includes all locations where members of the public might be regularly exposed, gardens of residential properties, and the building façades of residential properties, schools, hospitals, care homes, hotels, etc.

Generally excluded are kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.

Sources

There are a variety of primary sources of particulate PM_{10}, which are very fine particles of less than 10 micron in size. Fine particles are composed of a wide range of materials from a variety of sources including:
Combustion sources (such as road traffic); *secondary particles*, mainly sulphate and nitrate formed by chemical reactions in the atmosphere, and often transported from far across Europe; c*oarse particles*, suspended soils and dusts (eg, from the Sahara), sea salt, biological particles, and particles from construction work.

Results (see opposite)

The 24 hour mean results from the fixed AURN and Local monitors show a degree of variation on a year by year basis, reflecting the greater variety of sources and weather conditions. 2009 results confirm this variation, but with lower levels reflecting the poor weather conditions.

The Darlington (St Cuthbert's) Way site is a town centre kerbside location, and clearly shows the influence of slow moving traffic on 24 hour levels, with this type of location normally having the highest levels and number of exceedances. There is no public exposure issue present at this type of location, but levels remain well below the objective. The Stockton (Yarm) kerbside site was moved to Eaglescliffe (about 1 kilometre distant) during Q3 2008. Eaglescliffe is a public exposure location, and first full year results confirm a substantial reduction in particulate levels.

The Middlesbrough (Breckon Hill and MacMillan College) sites are public exposure locations in areas generally surrounded by high traffic roads. Levels tend to be lower with fewer exceedances.

The Middlesbrough (Elm Street), Darlington (Cockerton Bridge) and Stockton (Billingham) monitors generally show that typical urban background levels, even a short distance from congested roads, have levels comfortably below the objective.

The Redcar (Corporation Road) site is a background site with generally low levels, although fugitive emissions from nearby industrial areas may be picked from time to time.

Health effects : Exposure to particulate PM_{10} is associated with a range of effects on health, including effects on the respiratory and cardiovascular systems, asthma and mortality. Those members of the public with pre-existing lung and heart disease are particularly at risk.

PARTICULATE $PM_{2.5}$ New objective, not yet included in regulation

Annual mean objective (2020) **maximum 25 µg/m³ (gravimetric)** **no exceedances**

Target 15% reduction at urban background between 2010 and 2020

Two AURN stations, Middlesbrough Breckon Hill, and Stockton (Eaglescliffe), were installed with new monitors for particulate PM_{10} and $PM_{2.5}$, and became operational in Q4 2008.

The Middlesbrough Breckon Hill site is based on TEOM FDMS monitors for both PM_{10} and $PM_{2.5}$.

The Stockton Yarm site is based on BAM technology for both PM_{10} and $PM_{2.5}$.

AURN Stations		2009	2008	2007	2006
Middlesbrough (Q4 2008) (Breckon Hill)	% PM_{10}	10 57 %	13 (2 mths) 81 %	-	-
Stockton (Q4 2008) (Eaglescliffe)	% PM_{10}	10 64 %	8 (3 mths) 62 %	-	-

Based on the full year 2009 results, it is expected that particulate $PM_{2.5}$ levels at locations with unmodified TEOM PM_{10} monitors, for which results are adjusted to gravimetric equivalence using vcm, should not exceed 65% of the adjusted PM_{10} level.

Taking the worst case annual mean for PM_{10} (see page 20) of 26 µg/m³ (vcm gravimetric) at the Darlington St Cuthbert's Way kerbside location, $PM_{2.5}$ levels in the Tees Valley should not exceed 18 µg/m³ (gravimetric) as an annual mean at any location, well below the objective level. At the other locations, which are representative of public exposure, $PM_{2.5}$ levels are unlikely to exceed 13 µg/m³ (gravimetric).

TEOM - Tapered element oscillating microbalance monitor, providing 1hour averages. Operates at 50 deg C, and may lose volatile particulates. Results are multiplied by a government factor of 1.3 to give an approximate gravimetric equivalence.

FDMS – Filter Dynamics Measurement System is a TEOM modification, providing 1hour averages, which can compensate for volatile particulate loss and provide direct gravimetric equivalence.

BAM - Beta attenuated mass monitor, providing 1hour averages

PARTICULATE $PM_{2.5}$ continuous monitors

Objective : Annual mean of 25 µg/m³ (gravimetric) maximum, with no exceedances

Target 15% reduction at urban background between 2010 and 2020

Relevant Exposure is where members of the public may be exposed to levels of particulate $PM_{2.5}$ above 25 µg/m³ (gravimetric) as an annual mean by December 31st 2020.

This includes all locations where members of the public might be regularly exposed, and the building façades of residential properties, schools, hospitals, care homes, etc.

Generally excluded are the building façades of offices or other places of work where members of the public do not have regular access; hotels, unless people live there as their permanent residence; gardens of residential properties; kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is likely to be short term.

Sources

There are a variety of primary sources of particulate $PM_{2.5}$, which are very fine particles of less than 2.5 micron in size. Fine particles are composed of a wide range of materials from a variety of sources including:
Combustion sources (such as road traffic); *secondary particles*, mainly sulphate and nitrate formed by chemical reactions in the atmosphere, and often transported from far across Europe; c*oarse particles*, suspended soils and dusts (eg, from the Sahara), sea salt, biological particles, and particles from construction work.

Results (see opposite)

The measurement of particulate $PM_{2.5}$ has been the subject of considerable research over recent years. The standard TEOM continuous monitor, which is most common in the UK, has been shown to tend to read low due to its operating temperature of 50 deg C driving off volatile fractions, and this effect was more noticeable at the smaller particle size. An FDMS modification to the TEOM for both PM_{10} and $PM_{2.5}$ has been shown to provide equivalence to the European standard filter measurement system, and the BAM unit also shows equivalence.

The results shown opposite show that the Government target for 2020 is easily met at both sites, which are locations of relevant public exposure. The results also give an indication of what fraction particulate $PM_{2.5}$ may have of the total particulate PM_{10} measured. The FDMS TEOM, and the BAM monitors indicate a $PM_{2.5}$ fraction of around 60%.

It is generally accepted in UK Government and other European reports, that the $PM_{2.5}$ fraction is approximately two thirds (66%) of the PM_{10} total. For the purpose of this report, a worst case factor of 70% will be used, which suggests that Tees Valley levels of $PM_{2.5}$ should not exceed 18 µg/m³ (based on 2009 annual PM_{10} measurements), ie comfortably within the Government target for 2020.

Health effects : Exposure to particulate $PM_{2.5}$ is associated with a range of effects on health, including effects on the respiratory and cardiovascular systems, asthma and mortality. Those members of the public with pre-existing lung and heart disease are particularly at risk.
Particulate $PM_{2.5}$ is thought to have a stronger association with these health effects than PM_{10}.

SULPHUR DIOXIDE

24 hour mean objective (2004) maximum 125 µg/m³ maximum 3 exceedances / year

Continuous monitoring stations - all results µg/m³ as the maximum of 24 hour means

(any exceedances are shown in brackets)

Figures shown below the 24 hour maximums are the 99th percentile of the 24 hour means, which provides a direct comparison with the objective level.

AURN Station		2009	2008	2007	2006
Middlesbrough (1993) (Breckon Hill)	99th %ile	23 17	33 23	31 25	33 25

Local Stations		2009	2008	2007	2006
Redcar (1998) ^ (Corporation Road)	99th %ile	18 * 14	- ^ -	54 ^ 29	28 23
Stockton, Billingham (1998) (Cowpen Depot)	99th %ile	- -	- -	23 20	17 * 16
Hartlepool (2003) (Stockton Road)	99th %ile	- -	- -	17 * 16	19 * 17

*** - less than 6 months data**

^ - AURN status removed September 2007, local station Q4 results 2007 included.

SULPHUR DIOXIDE **continuous monitors**

Objective 1 of 3 :24 hour mean of 125 µg/m³ (47 ppb) maximum, with up to 3 exceedances per year

Relevant Exposure is where members of the public may be exposed to levels of sulphur dioxide above 125 µg/m³ as a 24 hour mean by December 31st 2004.

This includes all locations where members of the public might be regularly exposed, gardens of residential properties, and the building façades of residential properties, schools, hospitals, care homes, hotels etc.

Generally excluded are kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.

Sources

Sulphur dioxide (SO_2) is produced when a material, or fuel, containing sulphur is burned. Globally, much of the SO_2 in the atmosphere comes from natural sources, but in the UK the predominant source is power stations burning fossil fuels, principally coal and heavy oils. Widespread domestic use of coal can also lead to high local concentrations of SO_2.
Within the Tees valley, the main source of SO_2 is industry along the Tees estuary, although emissions are normally from high stacks giving better dispersion away from ground level. In 2003, a EU directive limiting the sulphur content of certain fuel oils took effect.

Results (see opposite)

The 24 hour mean results from all monitors show that levels are consistently well within the objective, with no exceedance at any of the sites. The 99th percentile of 24 hour means is the level at which there have been 3 higher values over the year, and is a direct comparison with the objective level. All stations show 99th percentiles less than one quarter of the objective level, with 2009 results from Middlesbrough and Redcar confirming that trend.

During 2009, two of the three Local stations have not been operational due to maintenance difficulties on these older monitors. The Redcar (Corporation Road) monitor was restarted midway through 2009. A new monitor is planned for Stockton (Billingham). The Hartlepool monitor is now closed.

The highest recorded levels have tended to be at the Redcar (corporation Road) station, which is more on the prevailing wind from industrial emitters than the others. However, levels have fallen significantly over recent years as a result of lower emissions from the main industrial complexes. Other stations have also generally reflected this downward trend.

This objective will continue to be met across the whole of the Tees Valley as long as industrial emissions do not significantly increase. If they do, this will be picked up at Middlesbrough and Redcar.

Health effects : Exposure to sulphur dioxide is associated with restriction of the airways by stimulating nerves in the lining of the nose, throat and airways of the lung. The latter effect is particularly to occur in those suffering from asthma and chronic lung disease.

SULPHUR DIOXIDE

1 hour mean objective (2004) **maximum 350 µg/m³** **maximum 24 exceedances / year**

Continuous monitoring stations - all results µg/m³ as the maximum of 1 hour means

(any exceedances are shown in brackets)

Figures shown below the 1 hour maximums are the 99.7th percentile of the 1 hour means, which provides a direct comparison with the objective level.

AURN Stations		2009	2008	2007	2006
Middlesbrough (1993) (Breckon Hill)	99.7%ile	154 53	184 59	152 66	152 73

Local Stations		2009	2008	2007	2006
Redcar (1998) ^ (Corporation Road)	99.7%ile	64 * 29	- -	149 ^ 82	152 72
Stockton, Billingham (1998) (Cowpen Depot)	99.7%ile	- -	- -	161 54	45 * 37
Hartlepool (2003) (Stockton Road)	99.7%ile	- -	- -	34 * 23	47 * 22

*** - less than 6 months data**

^ - AURN status removed September 2007, local station Q4 results 2007 included.

SULPHUR DIOXIDE **continuous monitors**

Objective 2 of 3 :1 hour mean of 350 µg/m³ (132 ppb) maximum, with up to 24 exceedances per year

Relevant Exposure is where members of the public may be exposed to levels of sulphur dioxide above 350 µg/m³ as a 1 hour mean by December 31st 2004.

This includes all locations where members of the public might be regularly exposed, the gardens of residential properties, any outdoor locations to which the public might reasonably be expected to spend one hour or longer, kerbside sites (eg pavements of busy shopping streets), those parts of car parks, bus stations, and railway stations etc which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or more, and the building façades of residential properties, schools, hospitals, care homes, hotels, etc.

Generally excluded are kerbside sites where the public would not be expected to have regular access.

Sources

Sulphur dioxide (SO_2) is produced when a material, or fuel, containing sulphur is burned. Globally, much of the SO_2 in the atmosphere comes from natural sources, but in the UK the predominant source is power stations burning fossil fuels, principally coal and heavy oils. Widespread domestic use of coal can also lead to high local concentrations of SO_2.
Within the Tees valley, the main source of SO_2 is industry along the Tees estuary, although emissions are normally from high stacks giving better dispersion away from ground level. In 2003, a EU directive limiting the sulphur content of certain fuel oils took effect.

Results (see opposite)

The 1 hour mean results from all monitors show that levels are consistently well within the objective, with no exceedance at any of the sites. The 99.7th percentile of 1 hour means is the level at which there have been 24 higher values over the year, and is a direct comparison with the objective level. All stations show 99.7th percentiles less than one quarter of the objective level, with Middlesbrough Breckon Hill showing a further fall for 2009.

During 2009, two of the three Local stations have not been operational due to maintenance difficulties on these older monitors. The Redcar (Corporation Road) monitor was restarted midway through 2009. A new monitor is planned for Stockton (Billingham). The Hartlepool monitor is now closed.

The highest recorded 1 hour mean used to be at the Redcar (Corporation Road) station, which is more on the prevailing wind from industrial emitters than the others. Levels have fallen significantly over recent years as a result of lower emissions from the main industrial complexes.

This objective will continue to be met across the whole of the Tees Valley as long as industrial emissions do not significantly increase. If they do, this will be picked up at Middlesbrough and Redcar.

Health effects : Exposure to sulphur dioxide is associated with restriction of the airways by stimulating nerves in the lining of the nose, throat and airways of the lung. The latter effect is particularly to occur in those suffering from asthma and chronic lung disease.

SULPHUR DIOXIDE

15 minute mean objective (2005) **maximum 266 µg/m³** **maximum 35 exceedances / year**

Continuous monitoring stations - all results µg/m³ as the maximum of 15 minute means

(any exceedances are shown in brackets)

Figures shown below the 15 minute maximums are the 99.9th percentile of the 15 minute means, providing a direct comparison with the objective level.

AURN Stations		2009	2008	2007	2006
Middlesbrough (1993) (Breckon Hill)	99.9%ile	192 (0) 81	317 (1) 81	200 (0) 95	200 (0) 98

Local Stations		2009	2008	2007	2006
Redcar (1998) ^ (Corporation Road)	99.9%ile	69 48	- -	261 ^ 122	239 106
Stockton, Billingham (1998) (Cowpen Depot)	99.9%ile	- -	- -	196 89	51 * 41
Hartlepool (2003) (Stockton Road)	99.9%ile	- -	- -	38 * 30	77 * 28

*** - less than 6 months data**

^ - AURN status removed September 2007, local station Q4 results 2007 included.

SULPHUR DIOXIDE **continuous monitors**

Objective 3 of 3 : 15 minute mean of 266 µg/m³ (100 ppb) maximum, with up to 35 exceedances per year

Relevant Exposure is where members of the public may be exposed to levels of sulphur dioxide above 266 µg/m³ as a 15 minute mean by December 31st 2005.

This includes all locations where members of the public might reasonably be exposed for a period of 15 minutes or longer.

There are no exclusions.

Sources

Sulphur dioxide (SO_2) is produced when a material, or fuel, containing sulphur is burned. Globally, much of the SO_2 in the atmosphere comes from natural sources, but in the UK the predominant source is power stations burning fossil fuels, principally coal and heavy oils. Widespread domestic use of coal can also lead to high local concentrations of SO_2.
Within the Tees valley, the main source of SO_2 is industry along the Tees estuary, although emissions are normally from high stacks giving better dispersion away from ground level. In 2003, a EU directive limiting the sulphur content of certain fuel oils took effect.

Results (see opposite)

Of the three sulphur dioxide objectives, the 15 minute objective is the more difficult one to achieve, but the results show that significant progress has been achieved in reducing industrial emissions over recent years. The 15 minute mean results now show only a very occasional exceedance of this objective, with highest peak levels historically recorded at the Redcar (Corporation Road) station, which is generally on the prevailing wind from the industrial emitters.

During 2009, two of the three Local stations have not been operational due to maintenance difficulties on these older monitors. The Redcar (Corporation Road) monitor was restarted midway through 2009. A new monitor is planned for Stockton (Billingham). The Hartlepool monitor is now closed.

The 99.9th percentile of 15 minute means is the level at which there have been 35 higher values over the year, and is a direct comparison with the objective level. All stations have shown 99.9th percentiles less than half of the objective level.

It is expected that this difficult objective will continue to be met across the whole of the Tees Valley as long as industrial emissions do not significantly increase. If they do, this will be picked up at Middlesbrough and Redcar.

Health effects : Exposure to sulphur dioxide is associated with restriction of the airways by stimulating nerves in the lining of the nose, throat and airways of the lung. The latter effect is particularly to occur in those suffering from asthma and chronic lung disease.
The effects of sulphur dioxide on sensitive subjects appear almost immediately at the start of exposure, leading to this 15 minute objective, which is specific to the UK.

CARBON MONOXIDE

8 hour running mean objective (2003) **maximum 10 mg/m³** **no exceedances**

Continuous monitoring stations - all results mg/m³ as the maximum of 8 hour running means

AURN Stations	2009	2008	2007	2006
Middlesbrough (1993) (Breckon Hill)	0.9	1.5	1.4	1.4
Stockton (2003 - 2007) # (Yarm High Street)	-	-	1.4 #	1.9

 # - AURN status removed September 2007, no further monitoring.

Local Station	2009	2008	2007	2006
Redcar (1998) **^** (Corporation Road)	1.9 *	-	0.9 ^	1.1
Hartlepool (2003 - 2006) (Stockton Road)	-	-	-	1.1

*** - less than 6 months data**

^ - AURN status removed September 2007, no Q4 results

CARBON MONOXIDE **continuous monitors**

Objective: **8 hour running mean of 10 mg/m³ (8.6 ppm) maximum, with no exceedances**

Relevant Exposure is where members of the public may be exposed to levels of carbon monoxide above 10 mg/m³ as an 8 hour running mean by December 31st 2003.

This includes all locations where members of the public might be regularly exposed, gardens of residential properties, and the building façades of residential properties, schools, hospitals, care homes, hotels etc.

Generally excluded are kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.

Sources

Carbon monoxide (CO) is a colourless, odourless, poisonous gas produced by incomplete, or inefficient, combustion of fuel. It is predominantly produced by road transport, in particular petrol-engine vehicles.
Within the Tees Valley, road transport is the main source at ground level. Industrial emissions along the Tees estuary are significant, but are normally emitted through tall stacks, which give dispersion away from ground level.

Results (see opposite)

Monitoring of carbon monoxide has now stopped at two locations due to the consistently low concentrations even at kerbside locations (eg Stockton Yarm), and this is in keeping with the nationwide reduction of carbon monoxide monitoring sites. The Middlesbrough Breckon Hill AURN station, an urban background location, continues to monitor and, along with Redcar (Corporation Road) that restarted midway through 2009, provide the markers for the rest of the Tees Valley.

The Middlesbrough monitor shows no change over recent years, with concentrations well below the objective level.

It is safe to say that this objective will be easily met across the whole of the Tees Valley.

Health effects : This gas prevents the normal transport of oxygen by the blood. This can lead to a significant reduction in the supply of oxygen to the heart, particularly in people suffering from heart disease.

BENZENE

Running annual mean objective (2003)	**maximum 16.25 µg/m³**	**no exceedances**
Annual mean objective (2010)	**maximum 5.00 µg/m³**	**no exceedances**

Non-continuous monitoring stations - all results µg/m³ as the annual mean

National Network	2009	2008	2007	2006
Middlesbrough (Feb 2002) (Breckon Hill)	0.98	1.15	1.16	1.60
Stockton (2008) (Eaglescliffe)	0.67	0.51 (3 mths data only)	-	-
Stockton (2002 - 2008) (Yarm High Street kerbside site)	-	1.46 # (9 mths data only)	1.81 ^	2.00 ≠

**** - excluding high two week reading in August, annual mean was 1.70 µg/m³**

≠ - 1.75 µg/m³ is the estimated 2010 level using 2003 technical guidance adjustment factors for roadside locations, page 3-6

^ - 1.52 µg/m³ is the estimated 2010 level using 2003 technical guidance adjustment factors for roadside locations, page 3-6

- 1.38 µg/m³ is the estimated 2010 level using 2003 technical guidance adjustment factors for roadside locations, page 3-6

The continuous hydrocarbon monitor at Redcar Corporation Road ceased operation in 2004.

BENZENE **continuous and non-continuous monitors**

Objective 1 of 2 :Running annual mean of 16.25 µg/m³ (5 ppb) maximum, with no exceedances

Objective 2 of 2 : Annual mean of 5.00 µg/m³ (1.54 ppb) maximum, with no exceedances

Relevant Exposure is where members of the public may be exposed to levels of benzene above 16.25 µg/m³ as a running annual mean by December 31st 2003, and 5.00 µg/m³ as an annual mean by December 31st 2010.

This includes all locations where members of the public might be regularly exposed, and the building façades of residential properties, schools, hospitals, care homes, etc.

Generally excluded are the building façades of offices or other places of work where members of the public do not have regular access; hotels, unless people live there as their permanent residence, gardens of residential properties; kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is likely to be short term.

Sources

Benzene is a volatile organic compound (VOC) which is a minor constituent of petrol. The main sources of benzene in the atmosphere in Europe are the distribution and combustion of petrol, with combustion being the single biggest source (70%).
Within the Tees Valley, another significant source is industry, on both sides of the Tees estuary. These are sometimes fugitive emissions that can lead to quite high concentrations, even if only for a short period. Action is being taken by the Environment Agency to reduce all emissions from industrial sources.

Results (see opposite)

Monitoring of Benzene is now restricted to national network pumped diffusion tube sites at Middlesbrough and Stockton. Results from both show a continuing downward trend in benzene concentrations to well below objective levels.

The Middlesbrough site is a public exposure location, and now shows steady low levels, with little sign of the industrial emissions that had been detected earlier in the decade and before.

The Stockton Eaglescliffe site is also a public exposure location, and in its first full year shows a lower level than Middlesbrough. This probably reflects its isolation from industrial sources nearer the coast.

The historical data from the Stockton (Yarm) diffusion tube location, which was a kerbside location, clearly shows the impact that slow moving, heavy traffic can have on benzene concentrations. Although this was not a public exposure location, the first objective of 16.25 µg/m³ was easily met, and the second objective of 5.00 µg/m³ for 2010 was also comfortably met.

The Local continuous hydrocarbon monitoring station that used to be at Redcar (Corporation Road), was on a prevailing wind direction from the main industrial emitters industry for up to 70% of the year, and had historically shown relatively high concentrations. These fell significantly over the years as a result of reduced industrial emissions, with the first objective level of 16.25 µg/m³ easily met. The second objective level of 5.00 µg/m³ (for 2010) was not met prior to year 2000, but with the fall in industrial emission levels, this objective was consistently being met, and, based on Middlesbrough results, will continue to be the case as long as industrial emissions are kept under close control.

Health effects : Benzene is a recognised genotoxic human carcinogen, which means that no absolute safe level can be specified for ambient air concentrations of benzene. The first objective level of 16.25 µg/m³ as a running annual mean is considered to represent an exceedingly small risk to health.
The second objective level of 5.00 µg/m³ is set to keep exposure to benzene as low as practicable.

1,3-BUTADIENE

Running annual mean objective (2003) **maximum 2.25 µg/m³** **no exceedances**

Non-continuous monitoring stations - all results µg/m³ as the annual mean

National Network	2009	2008	2007	2006
Middlesbrough (2003 - 2007) (Breckon Hill)	-	-	0.14 *	0.09

* - Station closed September 2007, 8 months data only.

The continuous hydrocarbon monitor at Redcar Corporation Road ceased operation in 2004.

1,3-BUTADIENE continuous monitors

Objective : Running annual mean of 2.25 µg/m³ (1 ppb) maximum, with no exceedances

Relevant Exposure is where members of the public may be exposed to levels of 1,3-butadiene above 2.25 µg/m³ as a running annual mean by December 31st 2003.

This includes all locations where members of the public might be regularly exposed, and the building façades of residential properties, schools, hospitals, care homes etc.

Generally excluded are the building façades of offices or other places of work where members of the public do not have regular access; hotels, unless people live there as their permanent residence, gardens of residential properties; kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is likely to be short term.

Sources

1,3-butadiene, like benzene, is a VOC emitted into the atmosphere principally from fuel combustion of petrol and diesel vehicles. 1,3-butadiene is also an important chemical in certain industrial processes, particularly the manufacture of synthetic rubber.
The main source of 1,3-butadiene emissions in the Tees Valley is from industry. These are sometimes fugitive emissions that can lead to quite high concentrations, even if only for a short period. Action is being taken by the Environment Agency to reduce all emissions from industrial sources.

Results (see opposite)

The Automatic Hydrocarbon Network continuous monitoring station at Middlesbrough (Breckon Hill), closed by the Government in December 2000, consistently picked up industrial emissions on a north-easterly wind direction, ie from the industrial sources. This wind direction is only around 15% of the year, and running annual means have been well within the objective level of 2.25 µg/m³, and showed some decline. Results from the diffusion system installed in 2003 (annual mean only) suggest that 1,3-butadiene concentrations have fallen close to the limit of detection.
Following a review by Defra of the 1,3-butadiene monitoring network, the diffusion tube monitor has been closed from September 2007.

The Local continuous hydrocarbon monitoring station at Redcar (Corporation Road) was more on a prevailing wind direction from the industrial sources (for up to 70% of the year), and always showed a higher running annual mean than that at Middlesbrough. However, concentrations fell significantly over the last decade as a result of reduced industrial emissions, to well within the objective level. This is expected to continue to be the case as long as industrial emissions are kept well under control.
This unit was not in use over the period 2005 to 2008 due to operational difficulties, and has now been closed.

Although there is now no 1-3-butadiene monitoring in the Tees Valley, concentrations are expected to continue to be well below the objective level as long as industrial emissions are kept firmly under control.

Health effects : Exposure to 1,3-butadiene is associated with the induction of cancers in the lymphoid system and blood-forming tissues, lymphomas and leukaemia. 1,3-butadiene is a genotoxic carcinogen in humans, for which no absolutely safe level can be defined. The objective level of 2.25 µg/m³ as a running annual mean is considered to represent an exceedingly small risk to health.

LEAD

Annual mean objective (2004)	**maximum 0.5 µg/m³**	**no exceedances**
Annual mean objective (2008)	**maximum 0.25 µg/m³**	**no exceedances**

All results are µg/m³ as the annual mean

Stockton Council Area	2009	2008	2007	2006	2005	2004	2003	2002
Redmarshall (rural)	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Eaglescliffe (industry boundary)	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Seal Sands (industry boundary)	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Note : All readings now below the limit of detection

Sites closed 2007

Redcar & Cleveland Council Area	2009	2008	2007	2006	2005	2004	2003	2002
Redcar Corporation Road (downstream from steel works)	0.009	0.009	-	-	-	-	-	-
Redcar Normanby Flatts Lane Upstream from steel works)	0.007	0.005	-	-	-	-	-	-

Note : Corporation Road started June 2008, Flatts Lane started September 2008

for comparison, national network results from other parts of the UK are as follows:

National Network	2009	2008	2007	2006	2005	2004	2003	2002
London (Cromwell Road)	0.01	0.01	0.01	0.03	0.02	0.02	0.03	0.03
Leeds (multi-element site) (closed August 2007)	-	-	0.02	0.02	0.01	0.02	0.04	0.03
Newcastle (Elswick) (closed August 2007)	-	-	0.01	0.01	0.01	0.02	0.01	0.02
Manchester	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
Walsall Centre (lead industry site)	0.02	0.02	0.03	0.02	0.03	0.05	0.04	0.05
Windermere / Cockley Beck	-	-	-	-	<0.01	<0.01	<0.01	<0.01

rural site – Cockley Beck started April 2003, closed December 2004

LEAD **non-continuous monitors**

Objective 1 : **Annual mean of 0.5 µg/m³ maximum, with no exceedances**

Objective 2 : **Annual mean of 0.25 µg/m³ maximum, with no exceedances**

Relevant Exposure is where members of the public may be exposed to levels of lead above 0.5 µg/m³ as an annual mean by December 31st 2004, and an annual mean of 0.25 µg/m³ as an annual mean by December 31st 2008.

This includes all locations where members of the public might be regularly exposed, and the building façades of residential properties, schools, hospitals, nursing homes, libraries, etc.

Generally excluded are the building façades of offices or other places of work where members of the public do not have regular access; hotels, unless people live there as their permanent residence; gardens of residential properties; kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is likely to be short term.

Sources

A major source of lead at ground level was from petrol-engine vehicle exhausts, but as a result of the introduction of lead-free petrol, this source is no longer significant.

In recent years industry, in particular secondary non-ferrous metal smelters, have become the most significant contributors to emissions of lead.

There are no lead-based industries located in the Tees Valley area.

Results (see opposite)

Stockton Council have carried out lead monitoring at three locations as part of a heavy metal monitoring programme. Results going back to 1997, and earlier, clearly show that the objectives are easily met, and with all readings below the limit of detection, the monitoring programme was stopped during 2007. There are no lead-based industries in any of the Tees Valley Council areas, and the Stockton results are reflective of lead levels across the region.

The new national network for heavy metals now includes lead monitoring upwind and downwind of the Redcar steel works. Results confirm that lead-in-air concentrations are very low in the Tees Valley, and indeed have fallen to very low levels across the UK, even close to lead industry sites.

Health effects : Exposure to lead is associated with toxic biochemical effects in humans which can cause problems in the synthesis of haemoglobin, effects on the kidneys, gastrointestinal tract, joints and reproductive system, and acute or chronic damage to the nervous system.
The possible effects of lead on the brain development in children, and hence their intellectual development, is the greatest cause for concern.

OZONE

8 hour running mean *provisional* objective (2005)

maximum 100 µg/m³ maximum 10 day exceedances / year

Continuous monitoring stations - all results µg/m³ as the maximum of 8 hour running means

(any day exceedances are shown in brackets)

AURN Station	2009	2008	2007	2006
Middlesbrough (1993) (Breckon Hill)	104 (1)	121 (11)	128 (4)	178 (22)

Local Stations	2009	2008	2007	2006
Redcar (1998) ^ (Corporation Road)	116 (3) *	120 (45)	127 (15) ^	140 (21)
Stockton (2009) (Eaglescliffe)	107 (2)	-	-	-
Stockton (1996 - 2008) (Cowpen Depot)	-	142 (38)	143 (17)	165 (29)
Stockton (2001 - 2008) (Yarm High Street)	-	96 # (0) (8 mths only)	110 (2)	130 (19)

*** - less than 6 months data**

^ - AURN status removed September 2007, local station Q4 results 2007 included.

 # - Monitoring station moved to Eaglescliffe October 2008. No Q4 results

OZONE continuous monitors

Provisional objective : 8 hour running mean of 100 µg/m³ (50 ppb) maximum, with up to 10 day exceedances per year

Relevant Exposure is where members of the public may be exposed to levels of ozone above 100 µg/m³ as an 8 hour running mean by December 31st 2005.

This includes all locations where members of the public might be regularly exposed, gardens of residential properties, and the building façades of residential properties, schools, hospitals, care homes etc.

Generally excluded are kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.

Sources

Ozone is a secondary air pollutant. It is not emitted by any process, but is formed as a result of complex chemical reactions on other air pollutants, particularly in the presence of strong sunlight. The source pollutants, such as nitrogen dioxide and hydrocarbons, are emitted from traffic and industry, and as the chemical reaction process can take some time, the source pollutants can originate a considerable distance away, eg mainland Europe. It is recognised, therefore, that local or even national action may not be sufficient to reduce ozone levels. The government has therefore only set a target for ozone at this time, and ozone is not included in the national Air Quality Review and Assessment process.
Ozone levels tend to peak during sunny summer months, and are often highest in rural areas as a result from air pollution elsewhere.

Results (see opposite)

The results from the fixed AURN and Local monitors show a good degree of consistency on a year by year basis, and tend to be highest at all the locations when the weather is fine and sunny. For example, 2006 showed a dramatic upturn as fine weather spread across the country, but 2007 reflected the return of poorer summer weather. 2008 results for maximum 8 hour running means also shows a generally poor summer, but the number of day exceedances was very high due a nationwide ozone episode in May. 2009 results are very low due to the poor summer weather, and no large-scale ozone episode.

The Redcar (Corporation Road) site normally shows the highest number of days when the target level of 100 µg/m³ is exceeded, and usually exceeds the provisional objective maximum number of exceedance days. This is a coastal influence, with ozone produced offshore as a result of local and / or continental air pollution, being carried on-shore by sea breezes. Nitrogen oxide levels are lower on the coast, which means that there is less scavenging of ozone to form nitrogen dioxide. The Redcar results for 2009 did not start until July, and do not reflect the normal picture. On the other hand, the Stockton (Yarm) local station had high levels of nitrogen oxides from traffic, and there is a strong reaction with ozone, leading to lower ozone concentrations and exceedance days, but relatively high nitrogen dioxide levels. 2008 was a clear example of this. Middlesbrough and Eaglescliffe better reflect the main urban areas.
In general, the results indicate that there will be exceedances in many parts of the Tees Valley when there is a warm and sunny summer period.

Ozone is not yet a prescribed air pollutant under the UK air quality strategy, and is unlikely to be for some time. Ozone is not included in air quality review and assessment procedures.

Health effects : Exposure to high concentrations of ozone is associated with slight irritation to the eyes or nose. Very high levels of exposure (to over 1000 µg/m³, or 10 times the target level) over several hours can cause damage to the airway lining followed by inflammatory reaction.
At levels of ozone above 200 µg/m³ as an 8 hour concentration, effects in healthy individuals has been clearly demonstrated.

Polycyclic Aromatic Hydrocarbons (PAHs)

Annual mean *provisional* objective (2010) **maximum 0.25 ng/m³ (B*a*P #)** **no exceedances**

Non-continuous monitoring station - all results ng/m³ (B*a*P #) as the maximum of annual means

National Network	2009	2008	2007	2006	2005	2004	2003	2002
Middlesbrough (2007) (Breckon Hill –digital sampler)	0.39	1.1	0.3 (Q4)	-	-	-	-	-
Middlesbrough (1992 - 2007) (Longlands College – Anderson sampler)	-	-	0.35	0.28	0.18	0.14	0.24	0.21

For comparison, the new national digital sampler network results from industrial towns, Port Talbot, Scunthorpe and Royston, are shown below, along with Newcastle Centre, and the rural Yorkshire area, High Muffles:

National Network	2009	2008	2007	2006	2005	2004	2003	2002
Port Talbot Margam (Q4 2007)	0.39	0.6	0.4 (Q4)	-	-	-	-	-
(upwind Port Talbot Coke Ovens)								
Swansea (Q4 2007)	0.24	0.3	0.3 (Q4)					
(downwind Port Talbot Coke Ovens)								
Scunthorpe Santon (Q4 2007)	2.4	6.1	1.7 (Q4)	-	-	-	-	-
(upwind Scunthorpe Coke Ovens)								
Scunthorpe Town (2007)	1.8	3.2	1.2 (Q4)	-	-	-	-	-
(downwind Scunthorpe Coke Ovens)								
Royston (Q4 2007)	1.0	2.7	1.2 (Q4)	-	-	-	-	-
(upwind Monkton Coke Ovens)								
South Hiendley (Q4 2007)	0.9	1.3	0.9 (Q4)					
(downwind Monkton Coke Ovens)								
Newcastle Centre (July 2007)	0.14	0.27	0.2 (H2)	-	-	-	-	-
High Muffles (1997)	0.09 (8mths)	0.21	0.1 (Q4)	-	-	-	-	-

notes:

A nanogram (ng) is one billionth of a gram (10^{-9})

\# A range of PAH species are measured. Annual means are expressed as concentrations of Benzo(a)Pyrene (B*a*P) as a marker for the total mixture of PAHs.

Polycyclic Aromatic Hydrocarbons (PAHs) **non-continuous monitors**

Provisional objective : Annual mean of 0.25 ng/m³ (BaP) maximum, with no exceedances

Relevant Exposure is where members of the public may be exposed to levels of PAH above 0.25 ng/m³ as an annual mean by December 31st 2010.

This includes all locations where members of the public might be regularly exposed, and the building façades of residential properties, schools, hospitals, care homes etc.

Generally excluded are the building facades of offices or other places of work where members of the public do not have regular access; hotels, unless people live there as their permanent residence; gardens of residential properties; kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is likely to be short term.

Sources

Polycyclic aromatic hydrocarbons (PAHs) are a large group of organic compounds with two or more benzene rings within their molecular structure. Those compounds with two or three benzene rings are normally present in vapour phase, while heavier compounds with five or more benzene rings are mainly in particulate phase. The EU working group on PAHs has proposed benzo(a)pyrene (B*a*P) as a marker for PAHs, and it is this compound on which PAH measurement is focused.
The main sources of BaP in the UK are domestic coal and wood burning, fires (eg accidental fires, bonfires, forest fires etc) and industrial processes such as coke production, of particular relevance to the Tees Valley. Road transport is the largest source for total PAHs, but this source is dominated by species thought to be less hazardous than BaP.
The decline in domestic and industrial coal burning, new controls over agricultural burning, and upgrading of incinerators to high temperature technology, has led to a fall in emissions of B*a*P over the last decade. Emissions are expected to fall further as a result of reductions in domestic coal burning, improved industrial abatement and lower vehicle emissions.

Results (see opposite)

Although monitoring results since 1995 from the Middlesbrough (Longlands Road) TOMPS site have shown an erratic but overall decline in PAH levels, and concentrations in 2004 / 2005 fell below the provisional objective level, monitored levels in 2006 and 2007 rose above the objective level. The monitoring equipment was not directional, and the likely source(s) associated with the increase were not identified. This site was closed at the end of 2007.
The Longlands TOMPS monitor was in an elevated location, which was not a public exposure location.

The new PAH network monitor installed at Middlesbrough Breckon Hill AURN station in Q4 2007 is a public exposure location. The monitor is based on a more accurate technology than the TOMPS monitor above. Early results suggest that the objective level is at risk of being exceeded.
The Environment Agency advises that the two coke ovens associated with the steel complex along the south side of the Tees estuary is the main source of PAHs. The Breckon Hill monitor is generally upwind of the coke ovens, and further monitoring downwind is required.

Other national results also show variable year-on-year results, but the main industrial towns with coke ovens nearby clearly show the highest concentrations, again well above the objective level.

PAHs are not a prescribed air pollutant under the UK air quality strategy.

Health effects : Exposure to polycyclic aromatic hydrocarbons is associated with an increased incidence of tumours of the lung, skin, and other sites, with lung cancer most obviously linked to exposure through inhaled air. The objective level of 0.25 ng/m³ as an annual average is considered to represent a risk to health so small as to be undetectable.

Cadmium, Arsenic, Nickel, Mercury **non-continuous monitors**

No UK air quality objectives have yet been set for these metals, but EU targets are indicated

Stockton Council Area all measurements in nanogram/m³ as the annual mean
Sites closed 2007

	cadmium	2009	2008	2007	2006	2005	2004	EU target
	Redmarshall	-	-	-	0.1 *	0.7	0.9	5 ng/m^3
	Eaglescliffe	-	-	-	0.3	0.6	2.3	
	Seal Sands	-	-	-	-	0.9	0.7	

	arsenic	2009	2008	2007	2006	2005	2004	EU target
	Redmarshall	-	-	-	-	0.8	0.7	6 ng/m^3
	Eaglescliffe	-	-	0.5 *	0.8	1.0	1.1	
	Seal Sands	-	-	-	0.2 *	3.0	1.2	

	nickel	2009	2008	2007	2006	2005	2004	EU target
	Redmarshall	-	-	0.1 *	0.7 *	2.1	3.1	20 ng/m^3
	Eaglescliffe	-	-	0.1 *	0.1 *	6.7	4.8	
	Seal Sands	-	-	0.1 *	0.3 *	7.6	4.6	

	Mercury (particulate)	2009	2008	2007	2006	2005	2004	Draft EU target
	Redmarshall	-	-	-	0.1 *	1.5	0.2	50 ng/m3 for Mercury (vapour). No target set for Mercury (particulate)
	Eaglescliffe	-	-	-	0.6 *	0.5	0.4	
	Seal Sands	-	-	-		1.1	0.2	

* less than 6 months data

Redcar & Cleveland Council Area all measurements in nanogram/m³ as the annual mean
Corporation Road site opened June 2008, Flatts Lane site opened September 2008

	cadmium	2009	2008	EU target
	Redcar Corporation Road (downwind)	0.21	0.19	5 ng/m^3
	Redcar Flatts Lane (upwind)	0.10	0.11 *	

	arsenic	2009	2008	EU target
	Redcar Corporation Road (downwind)	0.53	0.40	6 ng/m^3
	Redcar Flatts Lane (upwind)	0.34	0.21 *	

	nickel	2009	2008	EU target
	Redcar Corporation Road (downwind)	1.0	0.92	20 ng/m^3
	Redcar Flatts Lane (upwind)	0.55	0.42 *	

	Mercury (particulate)	2009	2008	Draft EU target
	Redcar Corporation Road (downwind)	0.01	0.03	No EU target set for Mercury (particulate). Draft EU target for Mercury (vapour) is 50 ng/m3 Mercury (vapour) not monitored at Redcar sites
	Redcar Flatts Lane (upwind)	0.01	0.01 *	

* less than 6 months data

National Networks 2009
Annual average concentrations of twelve heavy metals are monitored at twenty-four multi-element sites, two of which are Redcar shown above. A further selection of results around steel works is as follows, note that Mercury (vapour) is not monitored at these locations:

Heavy Metal network	all measurements in nanogram/m³ as the annual mean			
	cadmium	**arsenic**	**nickel**	**Mercury (particulate)**
Scunthorpe Santon (downwind)	0.21	0.94	1.27	0.02
Scunthorpe Town (upwind)	0.20	0.83	0.84	0.02
Sheffield Brinsworth (downwind)	0.36	1.02	9.81	0.05
Sheffield Centre (upwind)	0.16	0.61	1.69	0.02

Note : A nanogram (ng) is one billionth of a gram (10^{-9})

Cadmium, Arsenic, Nickel, Mercury

No UK air quality objectives have yet been set for these pollutants, but they are likely to be based on EU targets (see below) as an annual mean, with no exceedances. Public exposure will be as defined for PAHs.

Sources

Cadmium (Cd) is produced as an inevitable by-product of zinc, and sometimes lead, refining, but once collected is relatively easy to recycle. It is mainly used in high performance nickel/cadmium batteries, but is also a good corrosion resistance coating. Other uses are as pigments, stabilisers for PVC, in alloys, and electronic compounds. UK emissions are associated with lead-zinc smelting and battery recycling plants, iron and steel manufacturing, electricity and waste combustion. Cigarette smoking can be a significant source. However, for the non-smoking population, the major exposure pathway is through food. EU Cadmium target is 5 ng/m^3.

Arsenic (As) is a metalloid with a complex chemistry, which can form a number of inorganic and organic compounds. In its inorganic form, it is widely distributed in rocks, soils and sediments, but it is also widely found in oxidised forms. The principal use of arsenic (as arsenic trioxide) is in wood preserving products, but it is also to be found in agricultural chemicals such as insecticides, herbicides, algaecides and growth promoters. On a global scale, releases to air are from natural sources such as volcanic eruptions and forest fires. On a local scale, emissions are likely to arise from coal burning, industrial waste disposal, and the application of agricultural chemicals containing arsenic, and the burning of wood with arsenic-containing preservatives. Cigarette smoking can be a significant source. However, for the non-smoking population, the major exposure pathway is through food and water. EU Arsenic target is 6 ng/m^3.

Nickel (Ni) is a metal which has many similarities to the other ferromagnetic metals, iron and cobalt. It is mainly used in the production of stainless steels and other alloys because it imparts heat and corrosion resistance, as well as hardness and strength. Nickel alloys and plating are commonly found in vehicles, tools, electrical and household goods, jewellery and coinage. The main sources of nickel in air, besides nickel production and plating plants, are from the combustion of coal and oil for heat and power generation, and the incineration of wastes and sewage sludge. Cigarette smoking can be a significant source. However, for the non-smoking population, the major exposure pathway is through food. EU Nickel target is 20 ng/m^3.

Mercury Hg (v) is a global pollutant with complex chemical and physical properties. It occurs naturally in the atmosphere from degassing of the earth's crust, emissions from volcanoes, and evaporation from natural bodies of water. World-wide mining of the metal leads to indirect discharges to atmosphere. Mercury has widespread use in industrial processes and in products such as batteries, lamps and thermometers. It is widely used in dentistry as an amalgam for fillings, and by the pharmaceutical industry. Mercury is mainly present in the atmosphere in a relatively unreactive gaseous form, but with a long atmospheric lifetime (of the order of 1 year), but methylated forms can form naturally which are highly toxic. UK emissions are associated with chlorine manufacture using mercury cells, non-ferrous metal production, coal combustion, and crematoria. The main pathway for mercury to humans is through the food chain, and not inhalation. Draft EU Mercury (vapour) target is 50 ng/m^3, there is no target for mercury (particulate).

Results (see opposite)

Stockton Council has monitored heavy metal concentrations in air since 1991 at three locations, but with low results and the impending closure of the nearby Chrome industrial facility, monitoring was stopped during 2007. Redcar is now part of the new national heavy metal network, and monitors upwind and downwind of the steel works.

Early results show that levels for the four elements compare favourably with results from other steel related industrial areas, and that concentrations are well below EU targets.

Cadmium, arsenic, nickel and mercury are not yet air pollutants that are included in the UK air quality strategy

Health effects :

Cadmium is bio-persistent and derives its toxicity from its chemical similarity to zinc, which is an essential micronutrient. Long-term exposure can cause renal misfunction. High levels are associated with lung disorders and bone defects.

Arsenic toxicity depends on its chemical form. It may be beneficial in small doses, but is generally considered to be carcinogenic to the lung and skin.

Nickel compounds generally exhibit a low acute toxicity. Nickel and its water-soluble salts are potent skin sensitisers, and are restricted for jewellery use where there may be direct contact with the skin.

Mercury is a toxic substance with no known function in human biochemistry or physiology. Inorganic poisoning can cause tremors, and spontaneous abortion. Mercury methyl compounds cause damage to the brain and central nervous system.

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TREND GRAPHS AND ANALYSIS

nitrogen dioxide annual mean

nitrogen dioxide 1 hour mean

particulate PM_{10} annual mean

particulate PM_{10} 24 hour mean

sulphur dioxide 1 hour mean

sulphur dioxide 15 minute mean

carbon monoxide 8 hour running mean

benzene running annual mean

1,3-butadiene running annual mean

ozone 8 hour running mean and day exceedance

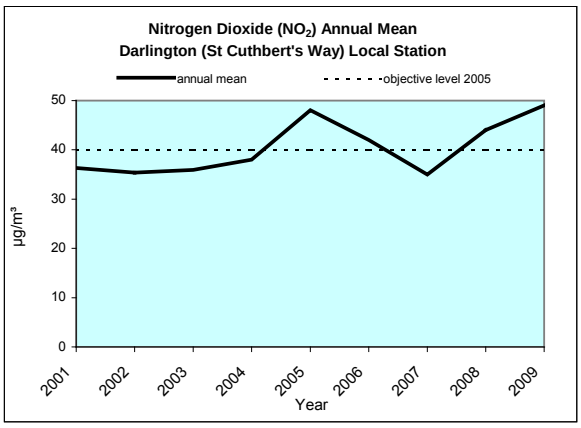
polycyclic aromatic hydrocarbons (PAHs) annual mean

NITROGEN DIOXIDE

annual mean trend – kerbside and roadside sites

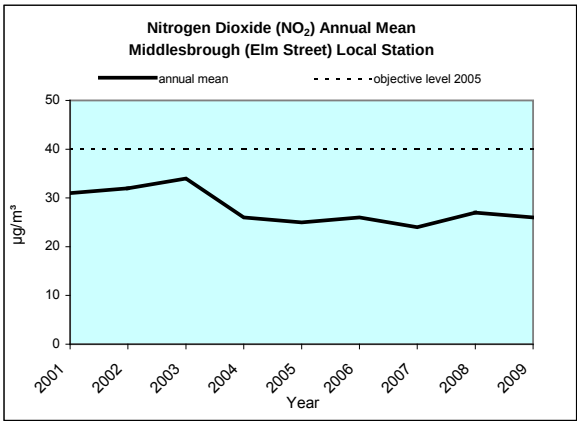
Darlington (St Cuthbert's Way), Middlesbrough (Elm Street), Darlington (Cockerton Bridge) Local Stations, Stockton (Eaglescliffe & Yarm) AURN Stations and Hartlepool (Stockton Road) Local Station

DARLINGTON (St Cuthbert's Way) Local Station
(urban kerbside site)

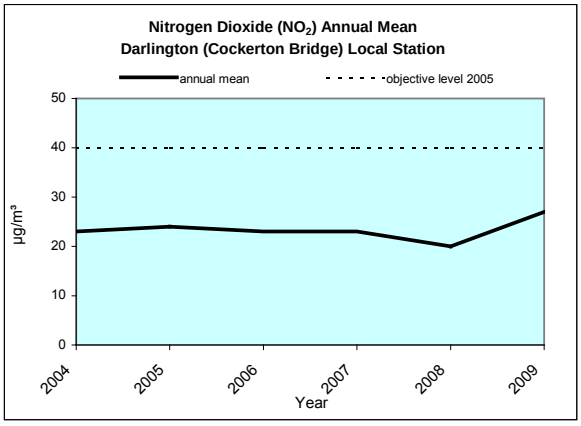


note: 2004 and 2005 data 3 months only, annualised using Yarm AURN data

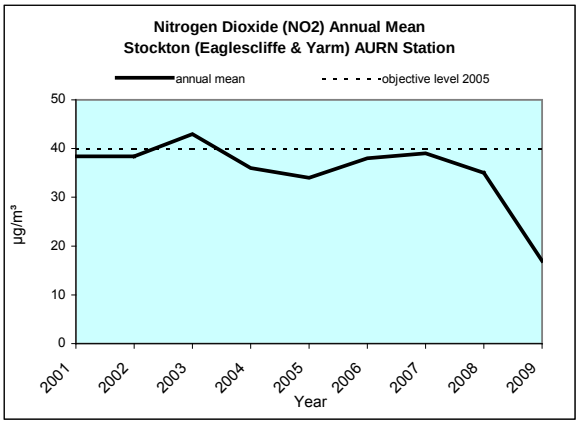
MIDDLESBROUGH (Elm Street) Local Station
(urban roadside site)



DARLINGTON (Cockerton Bridge) Local Station
(urban roadside site)

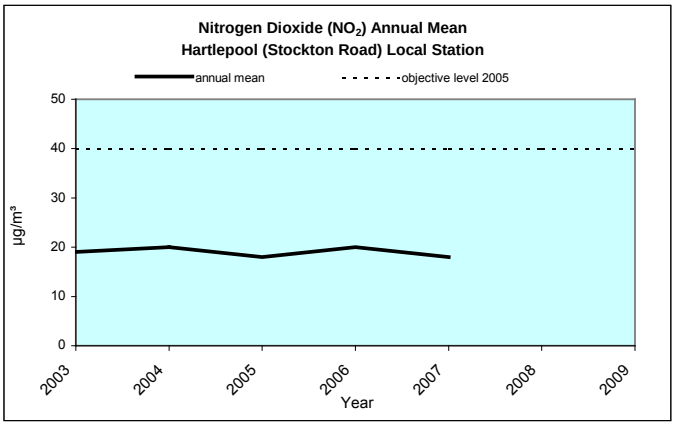


STOCKTON (Eaglescliffe and Yarm) AURN Stations
(roadside / kerbside site classification)



Eaglescliffe from 2009

HARTLEPOOL (Stockton Road) Local Station
(urban roadside site)



NITROGEN DIOXIDE ANNUAL MEAN POLLUTION TREND – kerbside and roadside sites

(continuous chemiluminescent analyser measurement)

1. The nitrogen dioxide objective for the annual mean (2005) is a maximum of 40 µg/m³, with no exceedances.

2. The two kerbside sites, Darlington (St Cuthbert's Way), and the now closed Stockton (Yarm High Street), clearly demonstrate the impact of slow moving heavy traffic, with nitrogen dioxide levels hovering around the objective level. There are, however, no public exposure issues in the vicinity of either station.

3. The roadside sites in Middlesbrough, Darlington, Hartlepool, and Eaglescliffe (from 2009), are set back several metres from the kerbside, and this reflects in significantly lower annual means, comfortably below the objective level. Note that the Middlesbrough (Elm Street) site is in an area of slow moving traffic and tends to have higher annual means than say the Hartlepool (Stockton Road) site, which is in an area with significantly higher average traffic speeds.

4. The two Darlington sites show around 10% increases for 2009 over 2008, which is not seen elsewhere. Analysis of monthly results suggests that this was due to higher levels being recorded during the first quarter, and is weather related.

5. Of the roadside sites, Eaglescliffe is an area of relevant public exposure and along with the other roadside locations, is representative of the worst-case roadside location within the Tees Valley where public exposure issues may exist. This provides further evidence that Air Quality Management Areas are not required.

6. There is no obvious downward trend at most locations, with any reduction in vehicle emissions being offset by increases in traffic flow. This reflects the national trend.

Conclusion

Road traffic is the main source of nitrogen dioxide pollution at ground level, but this normally quickly disperses within a relatively short distance of the kerbside. There is no clear sign of nitrogen dioxide levels from traffic falling, with emission improvements generally being offset by traffic flow increases, and annual variations reflecting weather conditions.

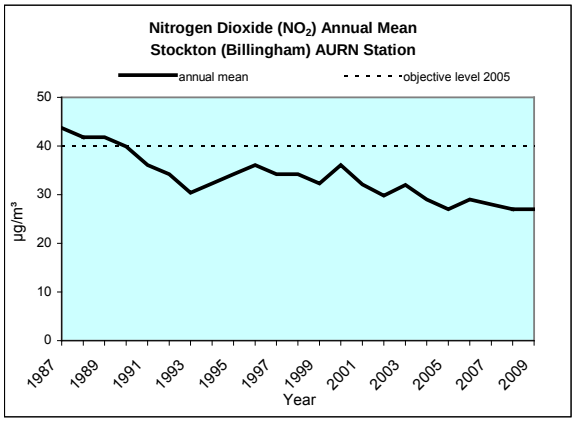
The annual mean objective of 40 µg/m³ maximum with no exceedances will continue to be met across the Tees Valley area in all areas where there is relevant public exposure.

NITROGEN DIOXIDE

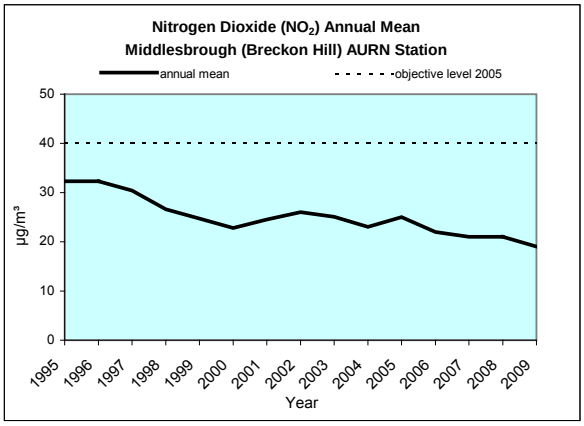
annual mean trend – industrial and urban background sites

Stockton (Billingham) and Middlesbrough (Breckon Hill) AURN Stations,
Redcar (Corporation Road) and Middlesbrough (MacMillan College) Local Stations

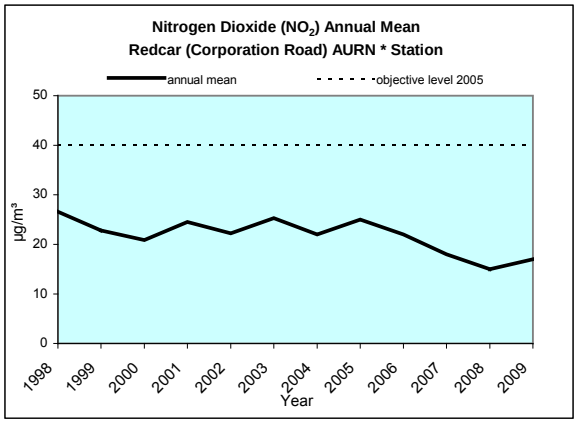
STOCKTON (Billingham) AURN Station
(urban-industrial site classification)



MIDDLESBROUGH (Breckon Hill) AURN Station
(urban-industrial site classification)

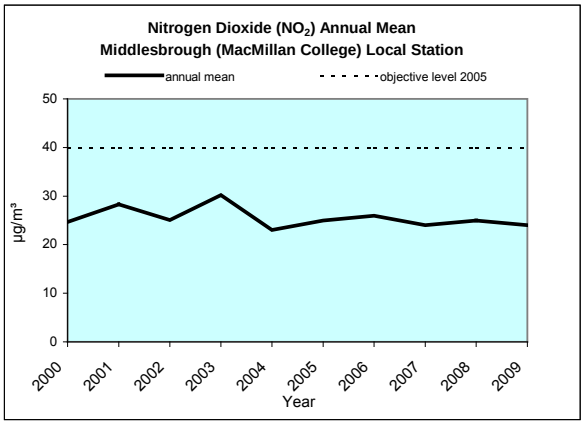


REDCAR (Corporation Road) AURN * Station
(suburban site classification)



note * Local station from October 2007

MIDDLESBROUGH (MacMillan College) Local Station
(urban background site)



NITROGEN DIOXIDE ANNUAL MEAN POLLUTION TREND – industrial and urban background sites

(continuous chemiluminescent analyser measurement)

1. The nitrogen dioxide objective for the annual mean (2005) is a maximum of 40 µg/m³, with no exceedances.

2. There is no obvious downward trend at most locations, with any reduction in vehicle emissions being offset by increases in traffic flow.

3. The Stockton (Billingham) site has been operating the longest in the Tees valley (since 1987) and is close to the Billingham chemical complex, which specialises in nitrogen-based chemistry such as ammonia, nitric acid and fertiliser production. Nitrogen compound emissions have significantly reduced over the years, and this is reflected in the downward trend. However, this monitoring site is also a storage depot for Council vehicles, and indications are that vehicle emissions are now keeping annual means higher than would otherwise be expected. There are no public exposure issues in the immediate vicinity.

4. The Middlesbrough (Breckon Hill) site is an urban industrial background site within school grounds, a public exposure location. There is no obvious impact from industry, but the site is in a residential area bounded by busy town centre roads. An overall downward trend can be seen, and this probably reflects traffic diverting onto the A66 by-pass road. Annual means remain comfortably within the objective level.

5. The Redcar (Corporation Road) site is within college grounds, and is a public exposure suburban location. Traffic in the vicinity is generally light, and there is no obvious impact from the large chemical and steel industrial complexes, which are 3 – 4 kilometres away on a prevailing wind direction. Monitored levels are typical background levels in a built-up area, and are well within the objective level.

6. The Middlesbrough (MacMillan College) site is a public exposure urban background location. It is within 300 metres of the main trunk road interchange (A19 north-south, and A66 east-west) with generally free flowing, but high traffic flows. Results show good pollution dispersion over this distance, with annual means comfortably within the objective level.

Conclusion

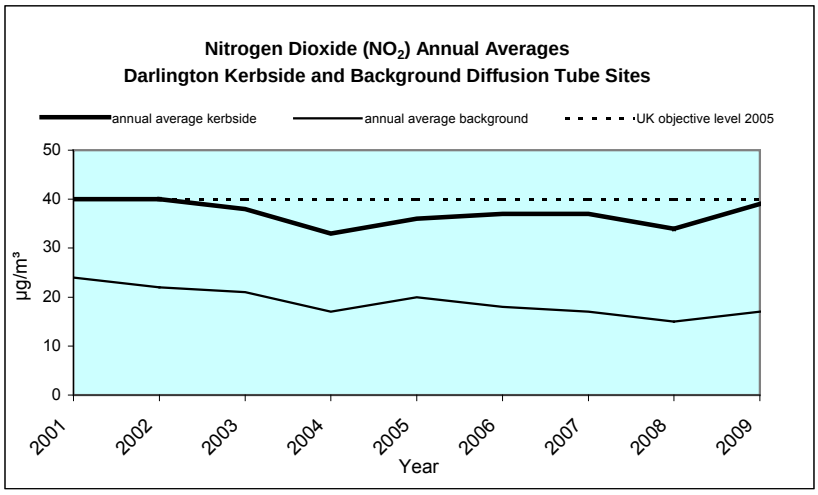
The annual mean objective of 40 µg/m³ maximum with no exceedances will continue to be met across the Tees Valley area in all areas where there is relevant public exposure.

NITROGEN DIOXIDE

annual mean trend

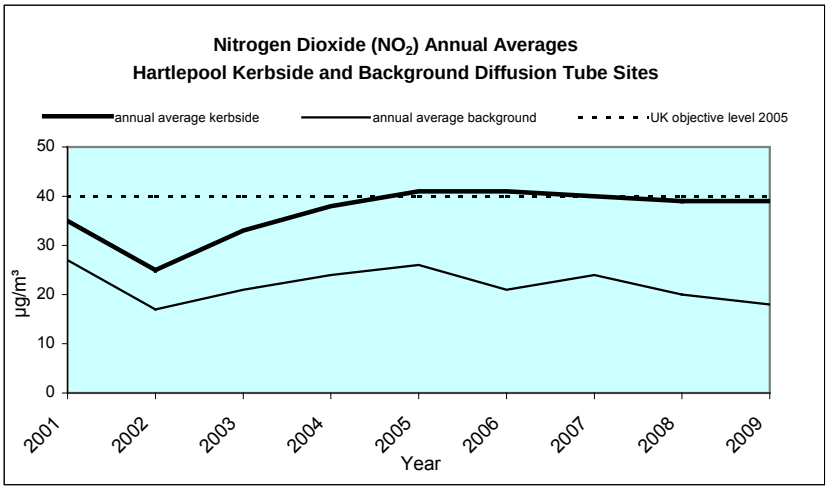
Darlington, Hartlepool and Stockton diffusion tube sites

All results adjusted for overall bias

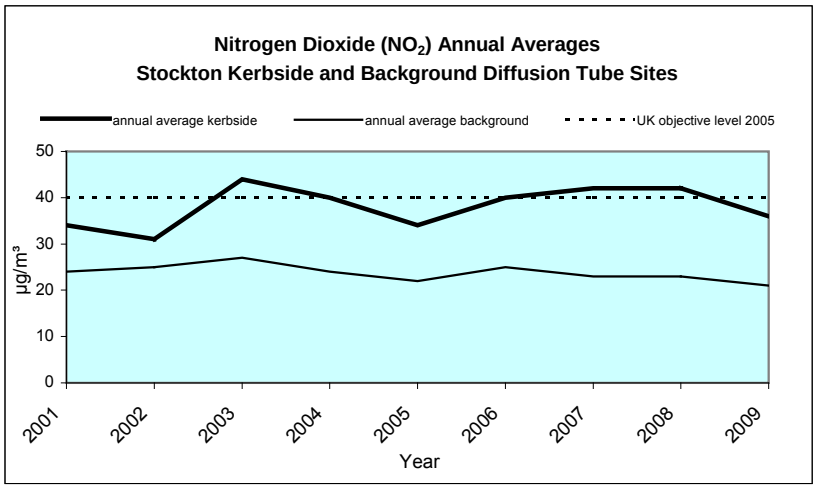


DARLINGTON

HARTLEPOOL



note: 2009 data 2 months only



STOCKTON

NITROGEN DIOXIDE ANNUAL MEAN POLLUTION TREND

(non-continuous diffusion tube measurement)

1. The nitrogen dioxide objective for the annual mean (2005) is a maximum of 40 µg/m³, with no exceedances.

2. Diffusion tubes are inherently less accurate than continuous monitors, but are a cost-effective way to measure annual averages of nitrogen dioxide over a wider area. There is evidence that diffusion tubes tend to read up to 20% higher than continuous monitors at the kerbside sites.

3. The graphs shown opposite are based on averages of similar locations of diffusion tubes covering kerbside and background sites in the three Council areas still using diffusion tubes. All results have been adjusted for diffusion tube bias.

4. Diffusion tube bias factors are only available from 2001, so earlier diffusion tube results 1996 – 2000 are not shown.

5. There has been no significant downward trend, with any reduction in vehicle emissions being offset by increases in traffic flow. Darlington tubes showed an increase for 2009. This was also seen at the two continuous monitors and reflects weather conditions during the first quarter.

6. Kerbside sites show levels of pollution at, or approaching, the objective level. In view of the inaccuracy of the tubes, it is unlikely that the sites exceed the objective level, but in any event there are no public exposure issues at this type of location. These diffusion tube sites were included in a road modelling study completed in July 2005, and submitted with the 2006 Updating and Screening Report. The study confirmed that kerbside diffusion tubes read significantly high.

7. The background sites show much lower levels, well within the objective level.

8. The results broadly confirm results and conclusions from the Tees Valley continuous monitors.

Conclusion

Road traffic is the main source of nitrogen dioxide pollution at ground level, but this normally quickly disperses within a relatively short distance of the roadside. There is no clear sign of nitrogen dioxide levels from traffic falling, with emission improvements being offset by traffic flow increases.

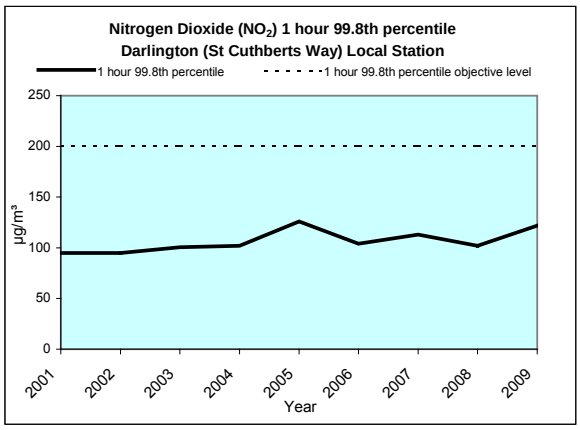
The annual mean objective of 40 µg/m³ maximum with no exceedances will continue to be met across the Tees Valley area in all areas where there is relevant public exposure.

NITROGEN DIOXIDE

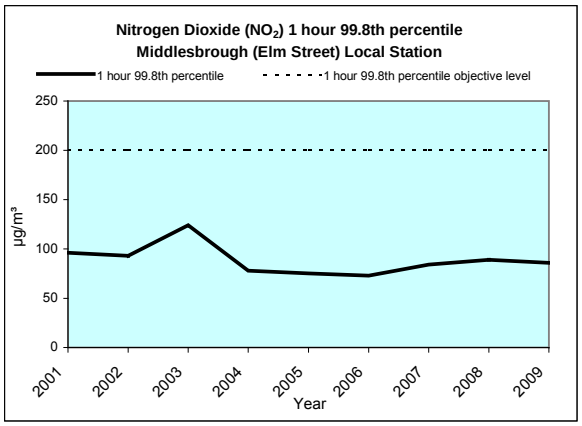
1 hour 99.8th percentile trend – kerbside and roadside sites

Darlington (St Cuthbert's Way), Middlesbrough (Elm Street), Darlington (Cockerton Bridge) Local Stations, Stockton (Eaglescliffe & Yarm) AURN Stations and Hartlepool (Stockton Road) Local Station

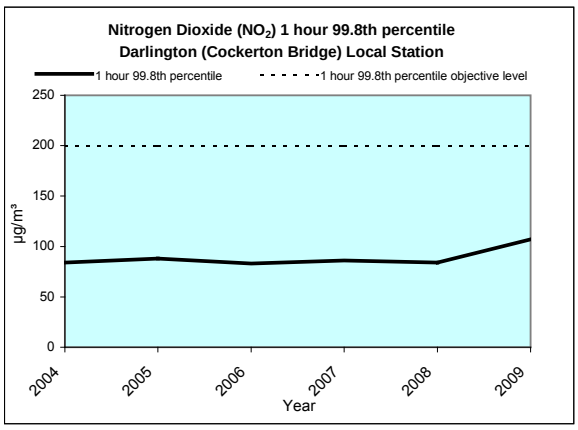
DARLINGTON (St Cuthbert's Way) Local Station
(urban kerbside site)



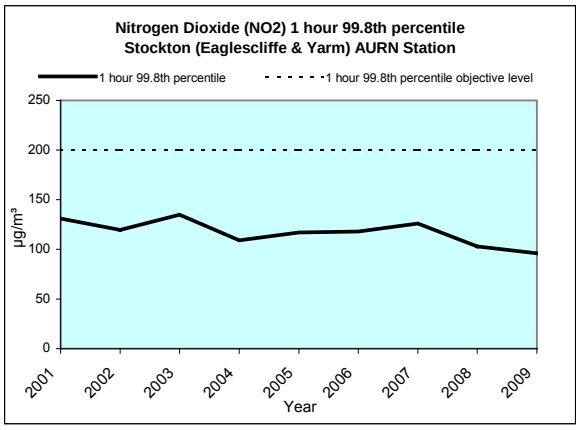
MIDDLESBROUGH (Elm Street) Local Station
(urban roadside site)



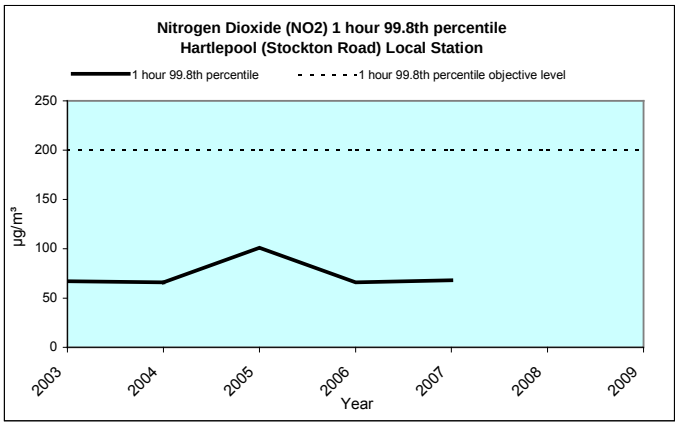
DARLINGTON (Cockerton Bridge) Local Station
(urban roadside site)



STOCKTON (Eaglescliffe and Yarm) AURN Stations
(roadside / kerbside site classification)



Hartlepool (Stockton Road) Local Station
(urban roadside site)



NITROGEN DIOXIDE 1 HOUR 99.8th PERCENTILE POLLUTION TREND – kerbside and roadside sites

(continuous chemiluminescent analyser measurement)

1. The nitrogen dioxide objective for 1 hour means (2005) is a maximum of 200µg/m³ with no more than 18 exceedances in any one year. This equates to the 99.8th percentile of 1 hour mean readings over the year, and is the measure of how well this objective is being met.

2. The two kerbside sites, Darlington (St Cuthbert's Way) and the now closed Stockton (Yarm High Street) show that slow moving heavy traffic does not necessarily lead to a high incidence of peak 1 hour concentrations. This is only likely to happen if pollution dispersion is severely restricted, such as can happen along roads with 'canyon' type characteristics caused by tall buildings close to either side of the road. These are not found within the Tees Valley.

3. The difference between 1 hour kerbside concentrations and 1 hour roadside concentrations is much less than for the annual means shown earlier. Even at the kerbside sites, concentrations are well below the objective.

Conclusion

Road traffic is the main source of nitrogen dioxide pollution at ground level, but hourly means do not build up to the objective level under normal dispersion conditions.

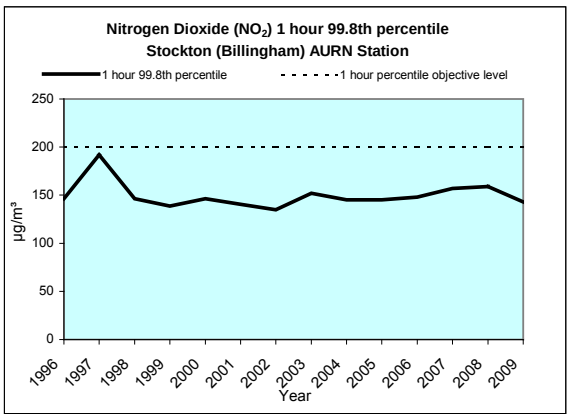
The 1 hour mean objective of 200 µg/m³ maximum with no more than 18 exceedances / year (99.8th percentile) will continue to be met in all parts of the Tees Valley area.

NITROGEN DIOXIDE

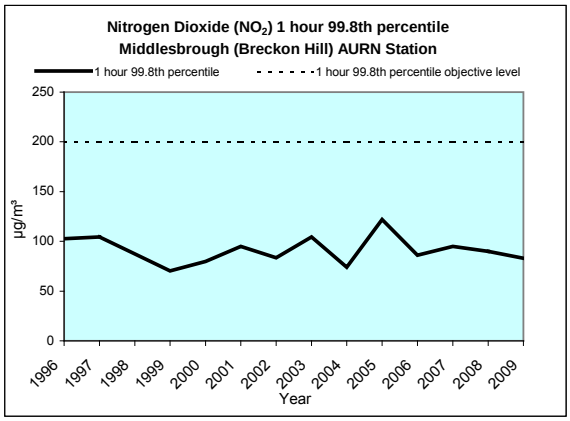
1 hour 99.8th percentile trend – industrial and urban background sites

Stockton (Billingham), Middlesbrough (Breckon Hill) and Redcar (Corporation Road) AURN Stations, and Middlesbrough (MacMillan College) Local Station

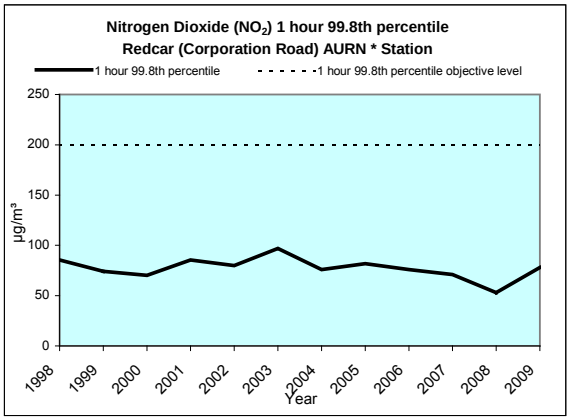
STOCKTON (Billingham) AURN Station
(urban-industrial site classification)



MIDDLESBROUGH (Breckon Hill) AURN Station
(urban-industrial site classification)

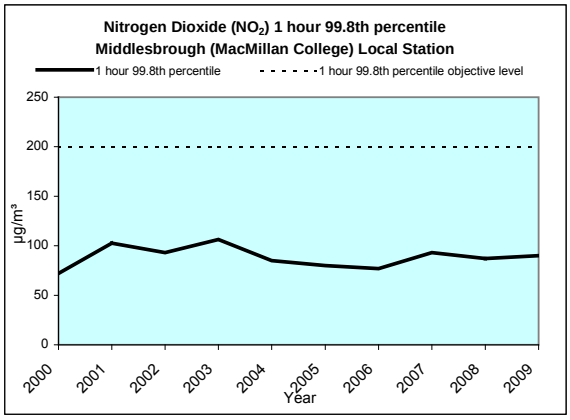


REDCAR (Corporation Road) AURN * Station
(suburban site classification)



note * Local station from October 2007

MIDDLESBROUGH (MacMillan College) Local Station
(urban background site)



NITROGEN DIOXIDE 1 HOUR 99.8th PERCENTILE POLLUTION TREND – industrial and urban background sites

(continuous chemiluminescent analyser measurement)

1. The nitrogen dioxide objective for 1 hour means (2005) is a maximum of 200µg/m³ with no more than 18 exceedances in any one year. This equates to the 99.8th percentile of 1 hour mean readings over the year, and is the measure of how well this objective is being met.

2. All of the sites show a degree of variation year on year probably due to weather variations, but are broadly constant with no clear downward trend.

3. Highest levels are recorded at the Stockton (Billingham), which is close to the Billingham chemical complex specialising in nitrogen-based chemistry such as ammonia, nitric acid and fertiliser production. Nitrogen compound emissions have significantly reduced over the years, but a reduction in the 1 hour 99.8th percentile is not as pronounced as with the annual mean trend. The monitoring site is also a storage depot for Council vehicles, and indications are that vehicle emissions during the key morning and afternoon logistic periods are contributing to more frequent and higher 1 hour levels than would otherwise be expected.

4. The two urban background sites in Middlesbrough (Breckon Hill and MacMillan College) and the suburban background site in Redcar (Corporation Road) show similar levels of 1 hour 99.8th percentiles, well within the objective. There is no obvious impact on pollution levels from the large chemical and steel industrial complexes along the Tees estuary.

Conclusion

Road traffic is the main source of nitrogen dioxide pollution at ground level, but hourly means do not build up to the objective level under normal dispersion conditions.

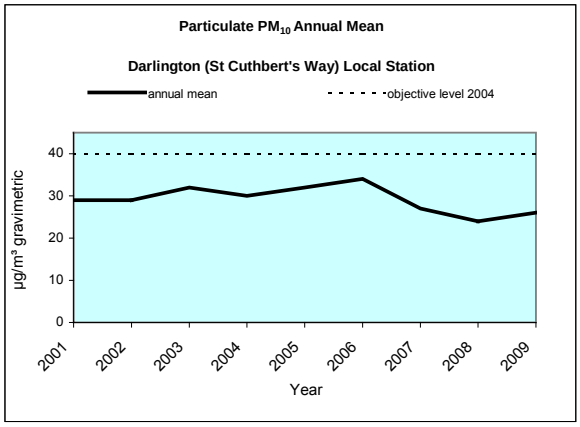
The 1 hour mean objective of 200 µg/m³ maximum with no more than 18 exceedances / year (99.8th percentile) will continue to be met in all parts of the Tees Valley area.

PARTICULATE PM_{10}

annual mean trend – kerbside and roadside sites

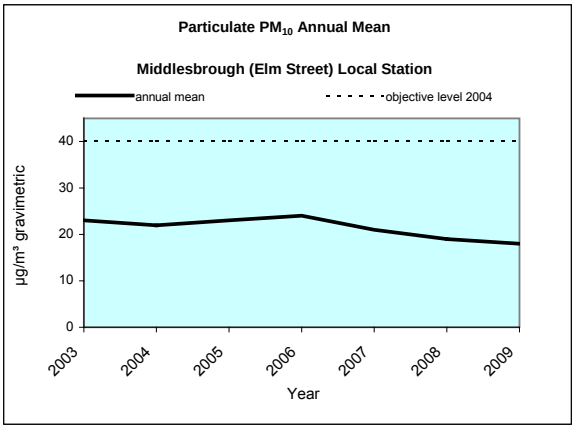
Darlington (St Cuthbert's Way), Middlesbrough (Elm Street), Darlington (Cockerton Bridge) Local Stations, Stockton (Eaglescliffe and Yarm) AURN Stations and Hartlepool (Stockton Road) Local Station

DARLINGTON (St Cuthbert's Way) Local Station
(urban kerbside site)

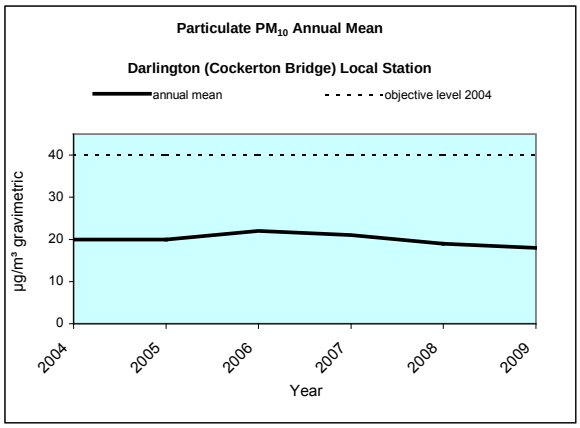


note: 2004 and 2005 data 3 months only, annualised using Yarm AURN data

MIDDLESBROUGH (Elm Street) Local Station
(urban roadside site)

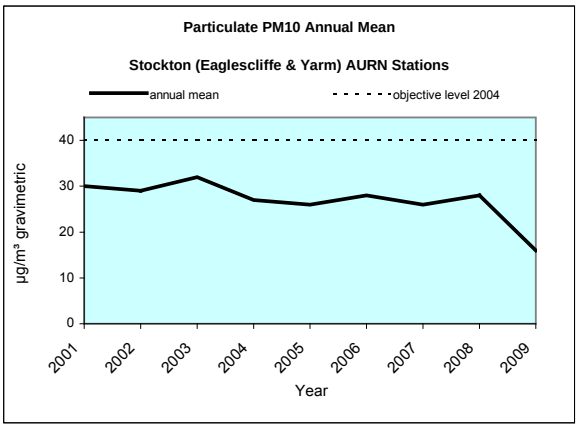


DARLINGTON (Cockerton Bridge) Local Station
(urban roadside site)



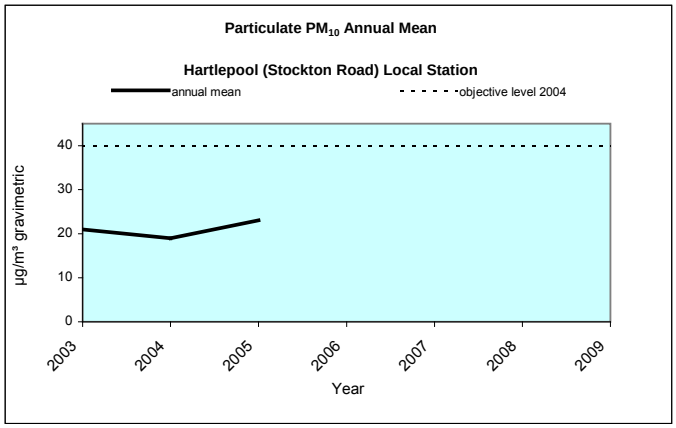
note: 2004 data 4 months only, annualised using Yarm AURN data

STOCKTON (Eaglescliffe and Yarm) AURN Stations
(roadside / kerbside site classification)



site closed, transferred to Eaglescliffe October 2008
2009 data is for Eaglescliffe using a BAM monitor

HARTLEPOOL (Stockton Road) Local Station
(urban roadside site)



note: 2005 data 5 months only, annualised using Yarm AURN data, no 2006 / 07 / 08 / 09 data

PARTICULATE PM_{10} ANNUAL MEAN POLLUTION TREND – kerbside and roadside sites

(Continuous tapered element oscillating microbalance (TEOM) measurement, results adjusted to gravimetric values)

1. The 2004 particulate PM_{10} objective for the annual mean is a maximum of 40 µg/m³ (gravimetric), with no exceedances. The proposal for a 2010 objective of 20 µg/m³ (gravimetric), with no exceedances, has been replaced by a particulate $PM_{2.5}$ objective in the 2008 air quality strategy revision for England.

2. The two kerbside sites, Darlington (St Cuthbert's Way) and the now closed Stockton (Yarm High Street), show particulate PM_{10} annual means consistently higher than at the roadside monitoring sites, indicating that traffic particulates disperse with distance under normal conditions.

3. 2009 results again reflect poor summer weather, with few of the high pressure episodes which allow particulate build-up as in 2003 and 2006.

4. Annual means are comfortably below the 2004 objective of 40 µg/m³ (gravimetric).

5. The new Eaglescliffe roadside location (2009) is an area of relevant public exposure with the annual mean comfortably within the objective level. The Middlesbrough (Elm Street), Darlington (Cockerton Bridge) and Hartlepool (Stockton Road) roadside sites are set back from the road towards the building line, but they are indicative of worst case public exposure locations. Results show that there normal good dispersion away from the kerbside, with annual means well within the objective level.

Conclusion

Road traffic is a major source of particulate PM_{10} pollution at ground level, but there is a wider range of particulate PM_{10} pollution sources that will have an impact away from roadside.

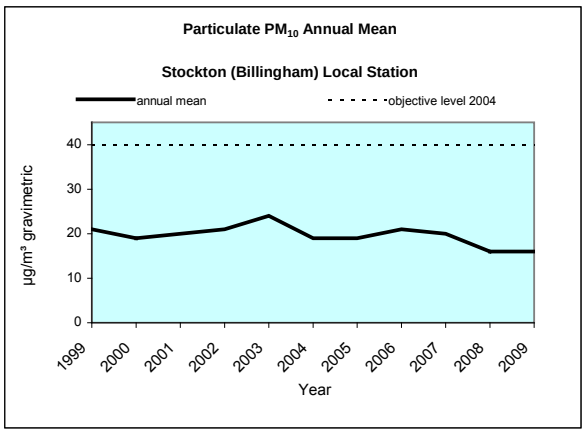
The 2004 annual mean objective of 40 µg/m³ (gravimetric) maximum with no exceedances will continue to be met across the Tees Valley.

PARTICULATE PM_{10}

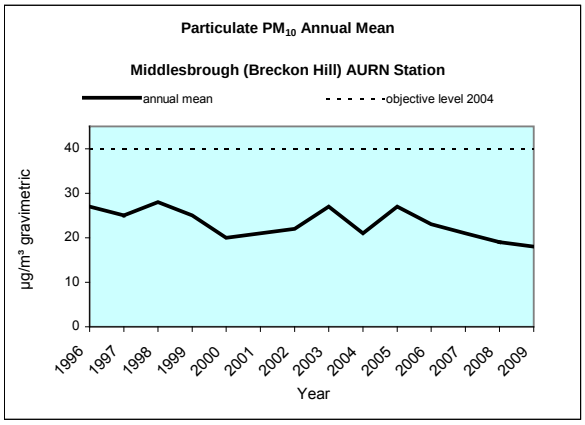
annual mean trend – industrial and urban background sites

Stockton (Billingham) and Middlesbrough (Breckon Hill) AURN Stations,
Middlesbrough (MacMillan College) Local Station and Redcar (Corporation Road) Local / AURN Station

STOCKTON (Billingham) Local Station
(urban-industrial site)

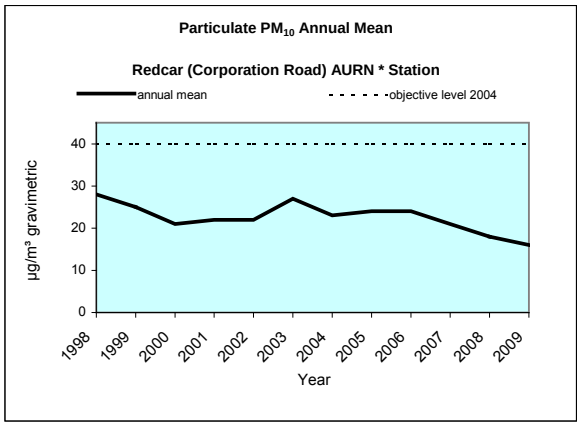


MIDDLESBROUGH (Breckon Hill) AURN Station
(urban-industrial site classification)



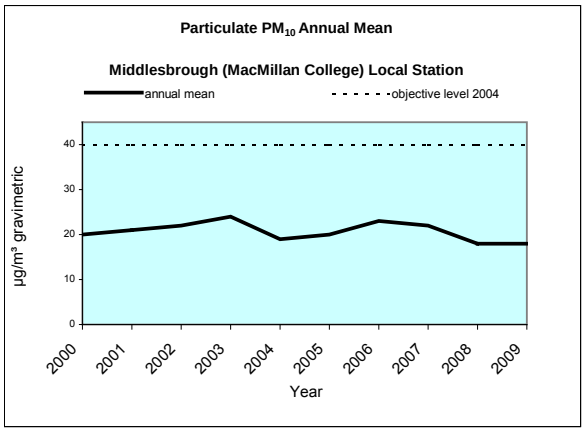
2009 data is from a new TEOM FDMS monitor

REDCAR (Corporation Road) AURN * Station
(suburban site classification)



note: * Local station from October 2007

MIDDLESBROUGH (MacMillan College) Local Station
(urban background site)



PARTICULATE PM_{10} ANNUAL MEAN POLLUTION TREND – industrial and urban background sites

(Continuous tapered element oscillating microbalance (TEOM) measurement, results adjusted to gravimetric values)

1. The 2004 particulate PM_{10} objective for the annual mean is a maximum of 40 µg/m³ (gravimetric), with no exceedances. The proposal for a 2010 objective of 20 µg/m³ (gravimetric), with no exceedances, has been replaced by a particulate $PM_{2.5}$ objective in the 2008 air quality strategy revision for England.

2. The Stockton (Billingham) site is more consistently at the low end of the range of annual means measured in the Tees Valley. It is sufficiently far inland to be unaffected by coastal sources, and does not seem to be significantly affected by the local industrial complex, or the short-term movements of vehicles on the site.

3. The Middlesbrough (Breckon Hill) site is an urban industrial background site within school grounds, a public exposure location. The trend line is more erratic, suggesting that the site is exposed to other sources of particulate pollution other than traffic, ie industry, local construction (as in 2005) etc.

4. The Redcar (Corporation Road) site is within college grounds, and is a public exposure suburban location. Traffic in the vicinity is generally light, and is unlikely to be the most significant source of particulate pollution. There is likely to be some impact from the large chemical and steel industrial complexes, which are 3 – 4 kilometres away on a prevailing wind direction, but another potential source of particulate PM_{10} at this location is from coastal sources such as sand and salt.

5. The Middlesbrough (MacMillan College) site is a public exposure urban background location. It is within 300 metres of the main trunk road interchange (A19 north-south, and A66 east-west) with high, but generally free flowing, traffic flows.

6. 2009 results again reflect poor summer weather, with few of the high pressure episodes which allow particulate build-up, as seen in the 2003 and 2006 results. This build up of particulate pollution is more pronounced at the 24 hour mean level results, which follow.

7. All four stations show that the 2004 annual mean objective is readily met.

Conclusion

Road traffic is a major source of particulate PM_{10} pollution at ground level, but there is a wider range of particulate PM_{10} pollution sources that have an impact away from roadside.

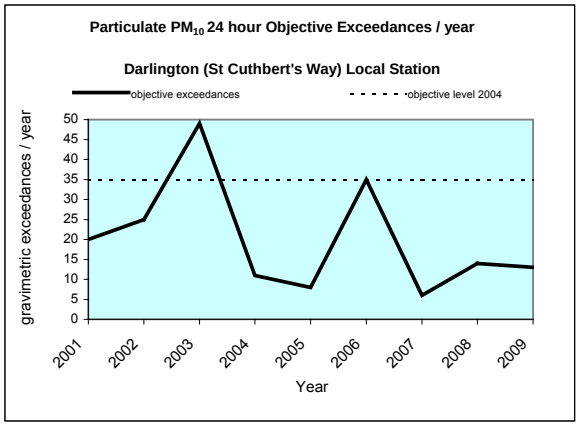
The 2004 annual mean objective of 40 µg/m³ (gravimetric) maximum with no exceedances will continue to be met across the Tees Valley.

PARTICULATE PM_{10}

24 hour exceedance trend – kerbside and roadside sites

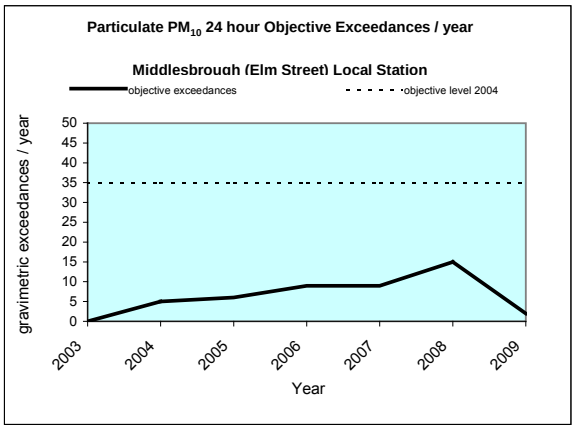
Darlington (St Cuthbert's Way), Middlesbrough (Elm Street), Darlington (Cockerton Bridge) Local Stations, Stockton (Eaglescliffe and Yarm) AURN Stations and Hartlepool (Stockton Road) Local Station

DARLINGTON (St Cuthbert's Way) Local Station
(urban roadside site)

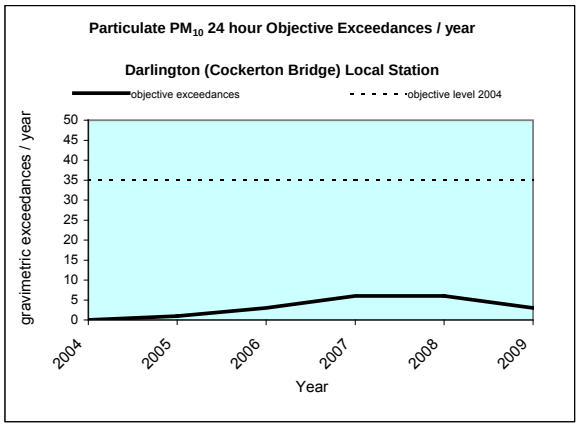


note: 2004 and 2005 data 3 months only

MIDDLESBROUGH (Elm Street) Local Station
(urban roadside site)

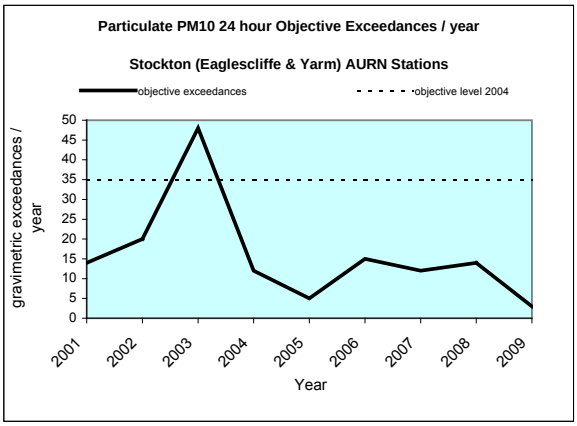


DARLINGTON (Cockerton Bridge) Local Station
(urban roadside site)



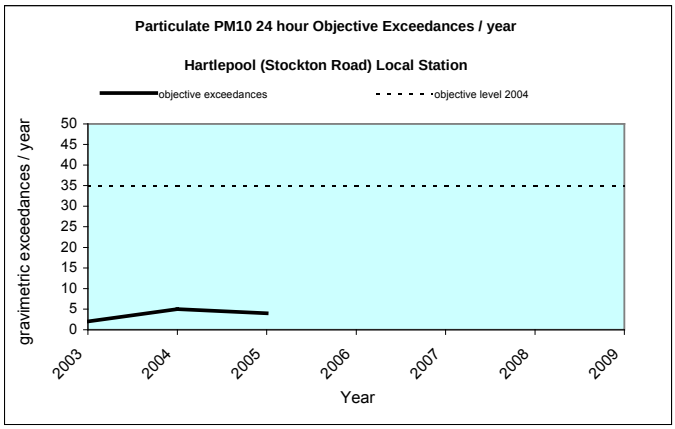
note: 2004 data 4 months only

STOCKTON (Eaglescliffe and Yarm) AURN Stations
(roadside / kerbside site classification)



site closed, transferred to Eaglescliffe October 2008
2009 data is for Eaglescliffe using a BAM monitor

HARTLEPOOL (Stockton Road) Local Station
(urban roadside site)



note: 2005 data 5 months only, no 2006 / 07 / 08 / 09 data

PARTICULATE PM_{10} 24 HOUR MEAN POLLUTION EXCEEDANCE TREND – kerbside and roadside sites

(Continuous tapered element oscillating microbalance (TEOM) measurement, results adjusted to gravimetric values)

1. The 2004 particulate PM_{10} objective for 24 hour means is a maximum of 50 µg/m³ (gravimetric) with no more than 35 exceedances in any one year.

2. The two kerbside sites, Darlington (St Cuthbert's Way) and the now closed Stockton (Yarm High Street), show the number of particulate PM_{10} 24 hour mean exceedances consistently higher than at the roadside monitoring sites. This is particularly so at times of poor atmospheric dispersion such as seen in 2003 and 2006. The Yarm kerbside site was moved for 2009 a short distance to Eaglescliffe roadside site, which is representative of public exposure. Exceedances dropped dramatically demonstrating concentrations fall away with distance from kerbside where there is good dispersion.

3. The Middlesbrough (Elm Street) site is a town centre site, set back from the road on the building line. It is a possible public exposure location. Traffic is slow moving, but results show normal good dispersion away from the kerbside, with the number of exceedances well within the objective level.

4. The Darlington (Cockerton Bridge) and Hartlepool (Stockton Road) sites are set slightly further back from the road than Elm Street above. Both sites are well within the 35 exceedance objective.

Conclusion

Road traffic is the main source of particulate PM_{10} pollution at ground level, but there is a wider range of particulate PM_{10} pollution sources that will have an impact away from roadside.

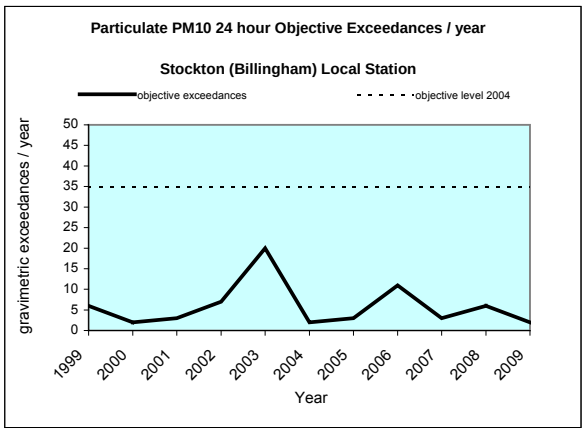
The 2004 objective of maximum 35 exceedances of the 24 hour mean will continue to be met across the Tees Valley where there is relevant public exposure.

PARTICULATE PM_{10}

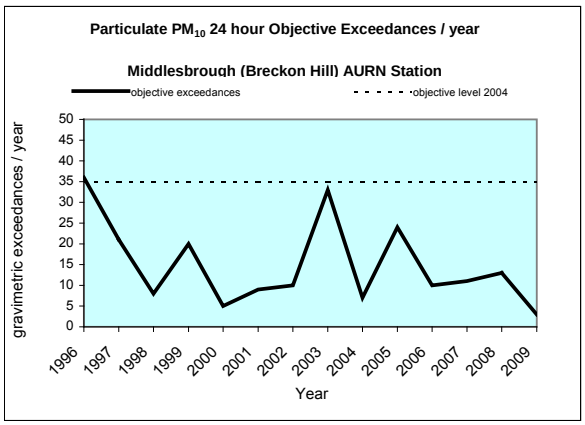
24 hour exceedance trend – industrial and urban background sites

Stockton (Billingham) and Middlesbrough (Breckon Hill) AURN Stations,
Middlesbrough (MacMillan College) Local Station and Redcar (Corporation Road) Local / AURN Station

STOCKTON (Billingham) Local Station
(urban-industrial site)

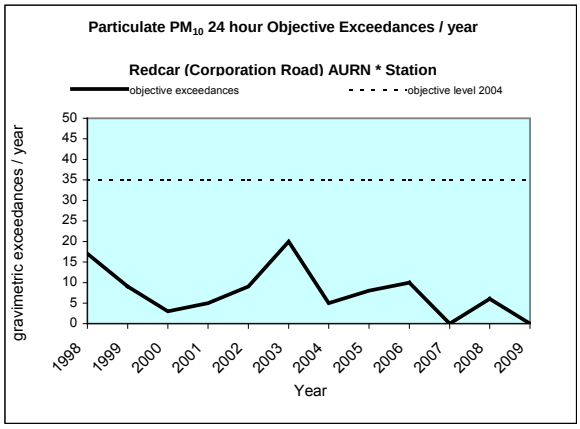


MIDDLESBROUGH (Breckon Hill) AURN Station
(urban-industrial site classification)



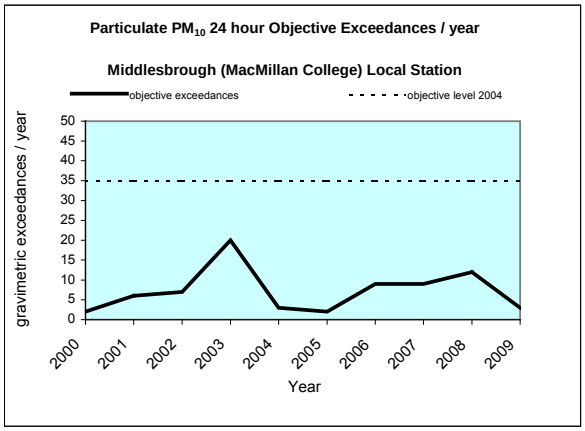
2009 data is from a new TEOM FDMS monitor

REDCAR (Corporation Road) AURN * Station
(suburban site classification)



note * Local station from October 2007

MIDDLESBROUGH (MacMillan College) Local Station
(urban background site)



PARTICULATE PM_{10} 24 HOUR MEAN POLLUTION EXCEEDANCE TREND – industrial and urban background sites

(Continuous tapered element oscillating microbalance (TEOM) measurement, results adjusted to gravimetric values)

1. The 2004 particulate PM_{10} objective for 24 hour means is a maximum of 50 µg/m³ (gravimetric) with no more than 35 exceedances in any one year. The proposal for a 2010 objective of 50 µg/m³ (gravimetric), with no more than 7 exceedances in any one year, has been withdrawn in the 2008 air quality strategy revision for England.

2. The Stockton (Billingham) site is at the low end of the range of 24 hour mean exceedances measured in the Tees Valley, but clearly shows small peaks in years with periods of poor dispersion, such as 2003 and 2006. It is sufficiently far inland to be unaffected by coastal sources, and does not seem to be significantly affected by the local industrial complex, or the short term movements of vehicles on the site. The objective level of exceedance for 2004 is normally easily met.

3. The Middlesbrough (Breckon Hill) site is an urban industrial background site within school grounds, a target group location. The trend line is more erratic, suggesting that the site is exposed to other sources of particulate pollution other than traffic, ie industry, poor dispersion (as in 2003), construction (as in 2005) etc.
   The number of objective exceedances is normally well below the 2004 objective level of 35.

4. The Redcar (Corporation Road) site is within college grounds, and is a public exposure suburban location. Traffic in the vicinity is generally light, and is unlikely to be the most significant source of particulate pollution. There maybe some impact from the large chemical and steel industrial complexes which are 3 – 4 kilometres away on a prevailing wind direction, but another potential source of particulate PM_{10} at this location is from coastal sources such as sand and salt. The years of poor dispersion, 2003 and 2006, are prominent.
   The number of objective exceedances is normally well below the 2004 objective level of 35.

5. The Middlesbrough (MacMillan College) site is a public exposure urban background location. It is within 300 metres of the main trunk road interchange (A19 north-south, and A66 east-west) with high, but generally free flowing, traffic flows. Although traffic source pollution is well dispersed under normal conditions, the years of poor dispersion, 2003 and 2006, are prominent.
   The objective level for 2004 of 35 exceedances maximum is comfortably met.

Conclusion

While road traffic is the main source of particulate PM_{10} pollution at ground level, there is a wider range of particulate PM10 pollution sources that will have an impact away from roadside, in particular long periods of poor dispersion.

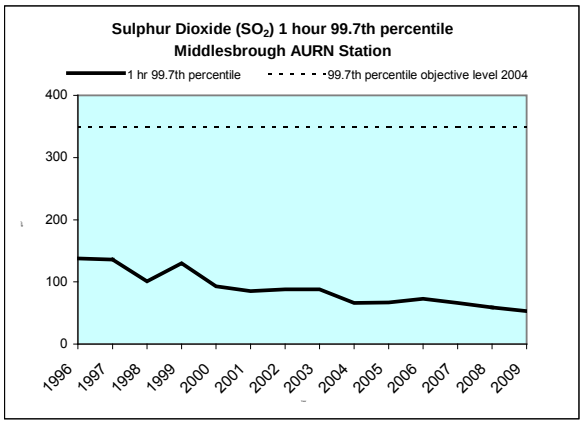
The 2004 objective of maximum 35 exceedances of the 24 hour mean will continue to be met across the Tees Valley where there is relevant public exposure.

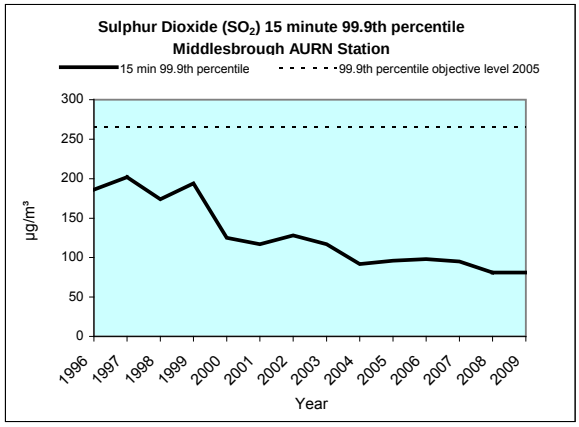
SULPHUR DIOXIDE

1 hour 99.7th percentile and 15 minute 99.9th percentile trends
Middlesbrough and Redcar * AURN Stations and Stockton (Billingham) Local Station

MIDDLESBROUGH (Breckon Hill) AURN Station

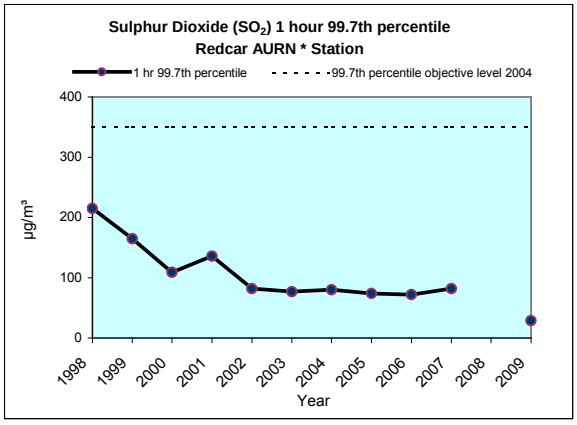
(urban-industrial site classification)

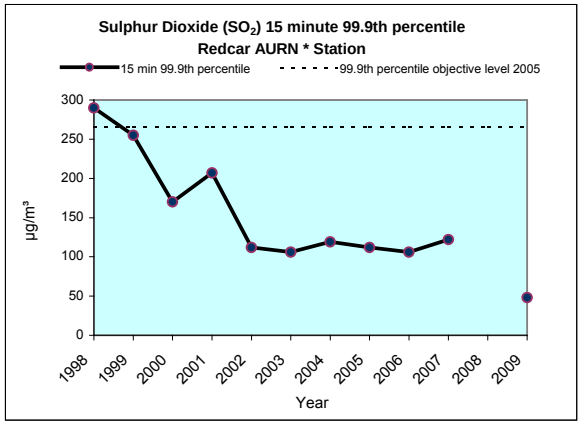




REDCAR (Corporation Road) AURN * Station

(suburban site classification)

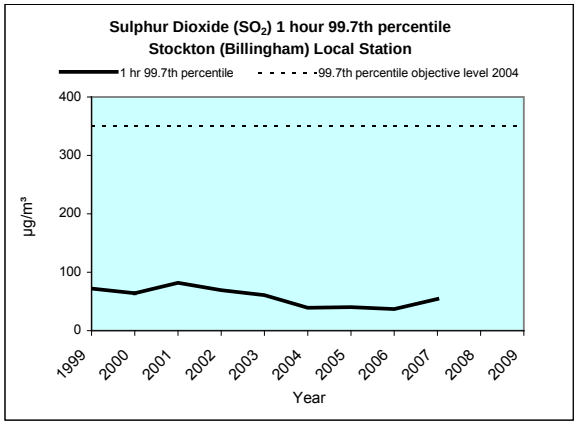


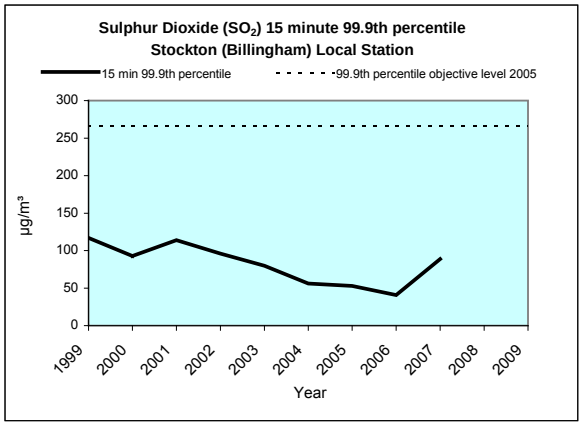


note: * Local station from October 2007, no 2008 data, restart July 2009

STOCKTON (Billingham) Local Station

(urban-industrial site)





note: No 2008 or 2009 data

SULPHUR DIOXIDE 24 HOUR MEAN 99th PERCENTILE, 1 HOUR MEAN 99.7th PERCENTILE, and 15 MINUTE 99.9th PERCENTILE POLLUTION TREND

(Continuous ultra-violet fluorescence (UVF) analyser)

1. The 2004 sulphur dioxide objective for 24 hour means is a maximum of 125 µg/m³ with no more than 3 exceedances in any one year. This equates to the 99th percentile of 24 hour readings over the year.
   This objective is easily met across the Tees Valley, with little variation year on year, and is not shown opposite.

2. The 2004 sulphur dioxide objective for 1 hour means is a maximum of 350 µg/m³ with no more than 24 exceedances in any one year. This equates to the 99.7th percentile of 1 hour readings over the year, and the trend at each monitoring location is shown opposite on the left.
   This objective is also easily met at the monitoring sites, with a clear downward trend at the Redcar site, and to a lesser extent at the Middlesbrough and Billingham sites. Levels have stabilised over the last few years. Sulphur dioxide pollution in the Tees Valley is almost entirely due to industrial emissions, but these have shown significant reductions over recent years, partly due to the increased availability of natural gas, and partly due to restrictions on the level of sulphur content of other fuels. This reduction in pollution levels has been more pronounced at the Redcar site, which is generally downwind of the major chemical and steel industrial complexes along the Tees estuary.

3. The 2005 sulphur dioxide objective for 15 minute means is a maximum of 266 µg/m³ with no more than 35 exceedances in any one year. This equates to the 99.9th percentile of 15 minute readings over the year, and the trend at each monitoring location is shown opposite on the right.
   This objective is the most demanding of the three sulphur dioxide objectives, but is now comfortably met at the monitoring sites. The downward trend at all three stations has now stabilised at less than half of the objective level.

Conclusion

Industrial emissions are the main source of sulphur dioxide pollution at ground level, normally from plume grounding as a result of adverse weather conditions and / or stack design factors.

Industrial emission levels have fallen by over 30 percent in the last five years, and this is reflected in the monitored levels.

All three sulphur dioxide objectives are expected to continue to be met in all parts of the Tees Valley, and will continue to be met as long as industrial emissions do not significantly increase. The 15 minute objective is the most susceptible to any future changes in the sulphur content of fuels used by industry.

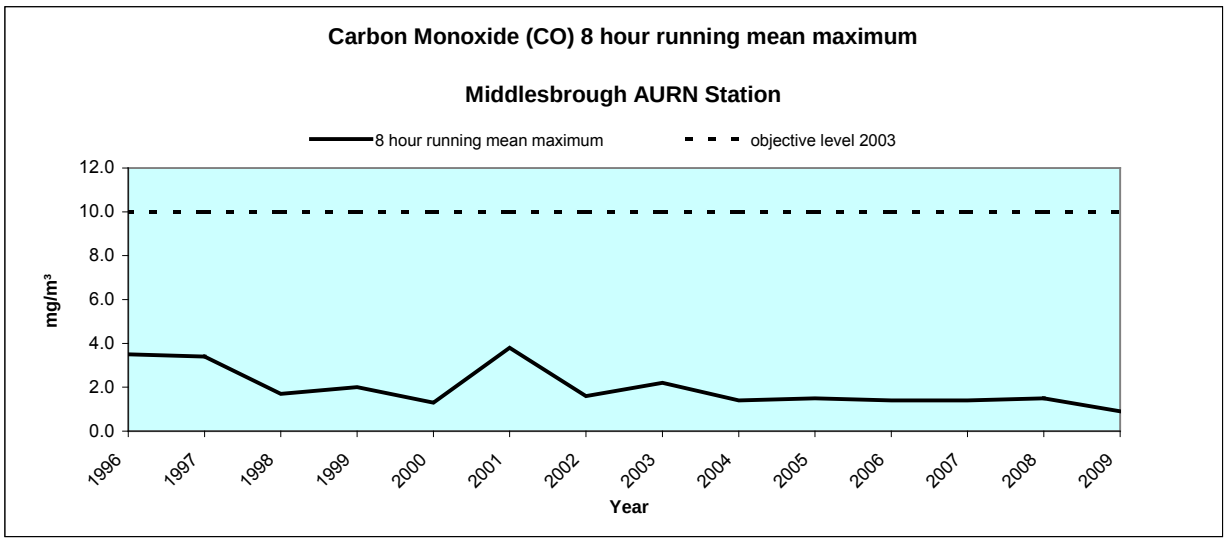
CARBON MONOXIDE

8 hour running mean trend

Middlesbrough (Breckon Hill), Redcar (Corporation Road),
and Stockton Yarm (High Street) AURN Stations

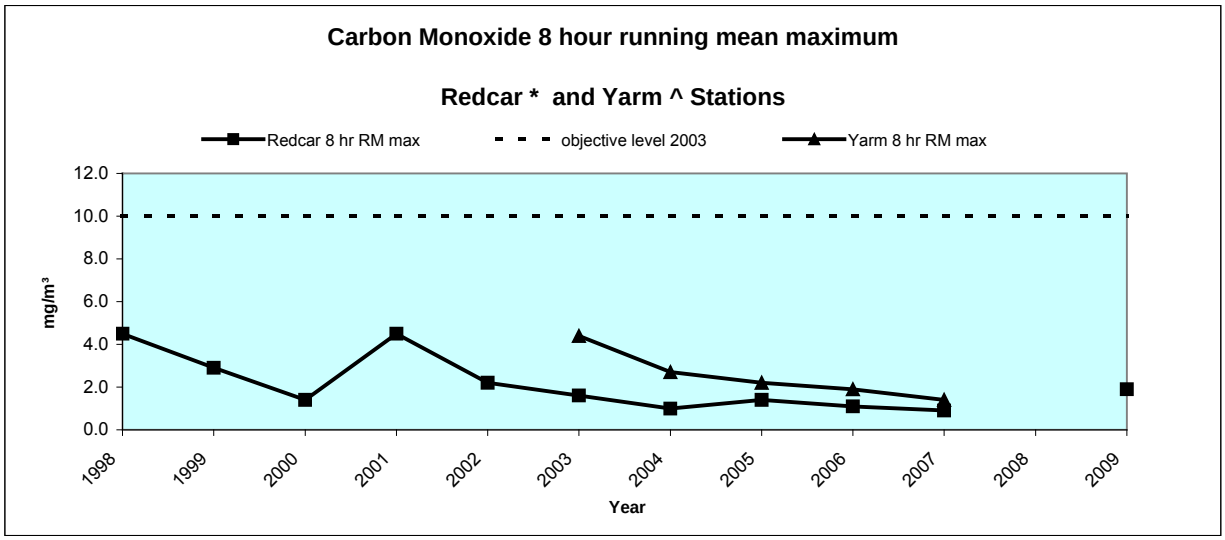
MIDDLESBROUGH (Breckon Hill) AURN Station

(urban-industrial site classification)



REDCAR (Corporation Road) and Yarm (High Street) AURN * Stations

(suburban and roadside site classifications)



*** Carbon Monoxide monitoring at Redcar AURN station discontinued October 2007, resumed as Local station 2009**

^ Carbon Monoxide monitoring at Stoacton Yarm High Street AURN station discontinued October 2007

CARBON MONOXIDE 8 HOUR RUNNING MEAN POLLUTION TREND

(continuous gas correlation analyser)

1. The 2003 carbon monoxide objective for the 8 hour running mean is a maximum of 10 mg/m³ with no exceedances.

2. This objective is easily met at the monitoring sites. The Redcar (Corporation Road) site has shown slightly higher levels than at the Middlesbrough (Breckon Hill) site, and this is due to the Redcar site being generally downwind of industrial emissions from the major chemical and steel industrial complexes along the Tees estuary. However, both have now stabilised at low levels.

3. The more recent, but now closed, AURN monitoring station at Stockton (Yarm High Street), has provided a measure of emissions from congested slow moving traffic. Results show carbon monoxide levels consistently higher than those recorded at Middlesbrough and Redcar, but the 8 hour running means remain well below the objective level.

4. It is noted that carbon monoxide monitoring at the Stockton Yarm AURN site was discontinued in 2007 as part of the AURN network review. Although the Redcar Corporation Road AURN site lost AURN status in the same review, the site continues for the time being as a Local station.

5. This reduction in carbon monoxide monitoring reflects reduced monitoring across the UK in view of the very low levels recorded at all stations.

Conclusion

Traffic emissions are the main source of carbon monoxide pollution at ground level, but industrial emissions can impact from time to time, although it is not clear whether this results from plume grounding from tall stacks, or from lower level fugitive emissions.

The 8 hour running mean objective of 10 mg/m³ with no exceedances will continue to be met across the Tees Valley.

BENZENE

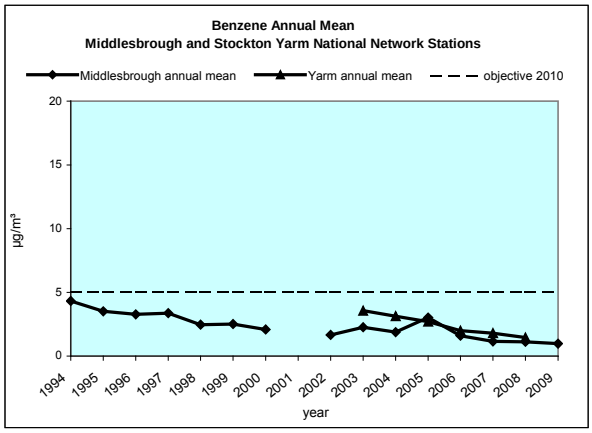
annual mean and running annual mean trends

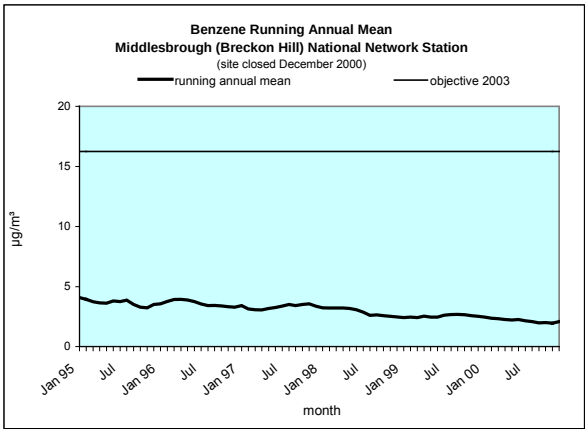
,

Middlesbrough and Stockton Eaglescliffe / Yarm National Network Stations
Redcar (Corporation Road) Local Station

BENZENE - Middlesbrough (Breckon Hill) and Yarm National Network Stations

(urban - industrial and roadside site classifications)

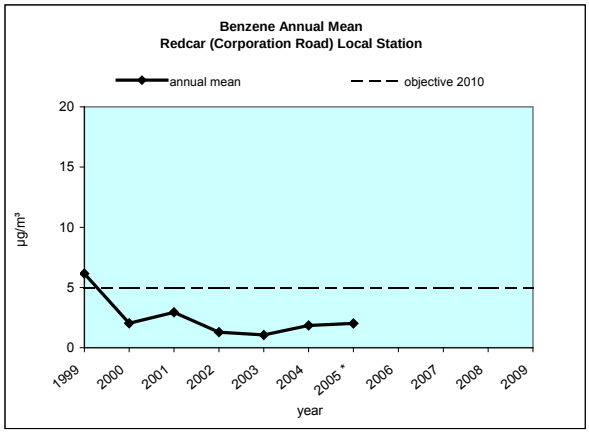


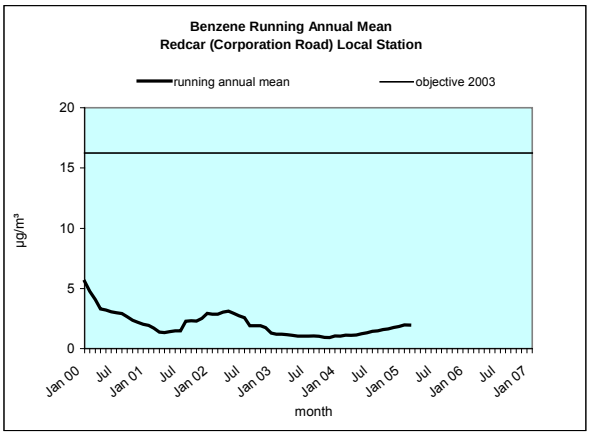


note 1 Middlesbrough AURN continuous monitor closed December 2000. Replaced with a national network Benzene pumped diffusion type system from February 2002.
note 2 No Middlesbrough annual mean data for 2001. No Middlesbrough running annual mean data for 2001 onwards.
note 3 Yarm national network Benzene pumped diffusion tube type system installed July 2002. Transferred to Eaglescliffe October 2008
note 4 Eaglescliffe value for 2009 is 0.67 µg/m^3, below that of Middlesbrough 2009 at 0.98 µg/m3

BENZENE - Redcar (Corporation Road) Local Station

(suburban site)





note 1 Redcar continuous monitor not operational March 2005 - December 2007
Hydrocarbon monitor closed January 2008

note 1 Redcar continuous monitor not operational March 2005 - December 2007
Hydrocarbon monitor closed January 2008

BENZENE ANNUAL MEAN AND RUNNING ANNUAL MEAN POLLUTION TREND
(Continuous gas chromatography analyser or non-continuous pumped diffusion tube measurement)

1. The 2003 benzene objective for the annual running mean is a maximum of 16.25 µg/m³ with no exceedances. The 2010 benzene objective for the annual mean is a maximum of 5 µg/m³ with no exceedances.

2. The Middlesbrough (Breckon Hill) monitoring station, a public exposure location, was a continuous national network hydrocarbon monitoring station to the end of 2000, and was replaced by a national network pumped diffusion tube system for benzene early in 2002. There was no measurement for 2001. The diffusion tube system only provides an annual mean, although in practice there is little difference between the annual mean and the running annual mean.
   The Redcar (Corporation Road) Local monitoring station was a continuous hydrocarbon monitoring station and provides both an annual mean and running annual mean. The station has been closed since early 2005.
   The Stockton Yarm site is also a national network pumped diffusion tube system, and started in 2003 as a kerbside site.
   In September 2008, the Yarm diffusion tube was transferred to Eaglescliffe, 1 kilometre away. This is a public exposure location.

3. All stations show that there has been a steady decline in monitored levels of benzene over the last decade, but levels have now stabilised at low levels. This fall is mainly due to significant reductions in industrial emissions from the chemical and steel industrial complexes along the Tees estuary. The Redcar site, being generally downwind of the industrial complexes, had shown historical levels higher than those at Middlesbrough, but by 2005 they were similar. This is almost certainly due to a greater impact from traffic emissions of benzene at Middlesbrough (see 5 below). However, the sharp increase in annual mean at Middlesbrough for 2005 was due to a fugitive emission in a two-week period during August, thought to be ship tank cleaning. As the Redcar station was not operational, it has not been possible to verify this, but results since 2005 show a return to normal.

4. The pumped diffusion tube system at Stockton Yarm (transferred to Eaglescliffe end 2008) has provided a measure of emissions from congested slow moving traffic, and while historical results have shown a significantly higher annual mean than those measured at Middlesbrough or Redcar, they reached very similar levels, demonstrating how successful benzene abatement measures to vehicles have been. The 2009 Eaglescliffe roadside concentration was less than that at Middlesbrough.

5. The 2003 and 2010 benzene objectives are now readily met,

Conclusion

Industrial emissions of benzene within the Tees Valley have fallen significantly over recent years and this is reflected in a steady decline in monitored levels. There is now some evidence that traffic emissions may now be the major source of ground level benzene, although fugitive emissions from industry can still give very high short-term levels. The benzene abatement measures for vehicles, such as changes in the benzene content of petrol and the installation of catalytic converters, are contributing to lower traffic related emissions of benzene.

The running annual mean objective of 16.25 µg/m³ with no exceedances for 2003 will continue to be easily met across the Tees Valley. The annual mean objective of 5 µg/m³ with no exceedances for 2010 will continue to be met across the Tees Valley as long as industrial emissions are kept under tight control.

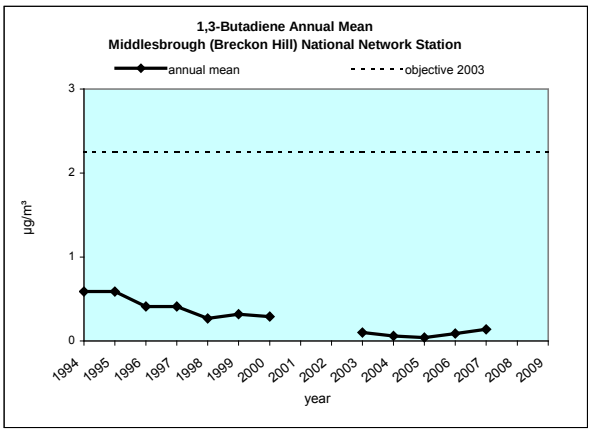
1,3-BUTADIENE

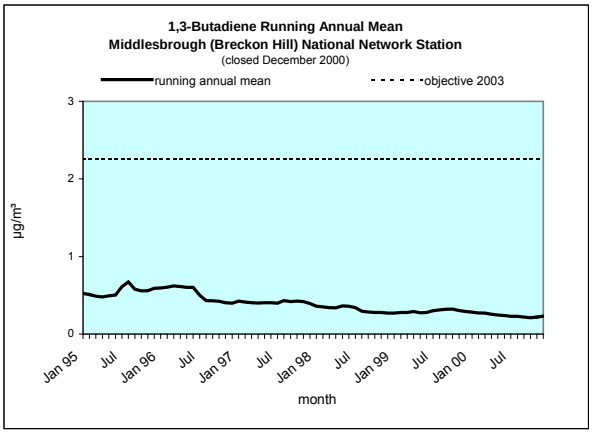
annual mean and running annual mean trends

Redcar (Corporation Road) Local Station and Middlesbrough (Breckon Hill) National Network Station

1,3-BUTADIENE - Middlesbrough (Breckon Hill) National Network Station

(urban - industrial site classification)



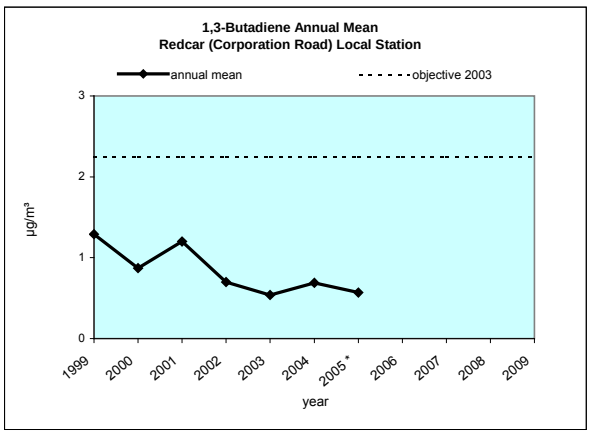


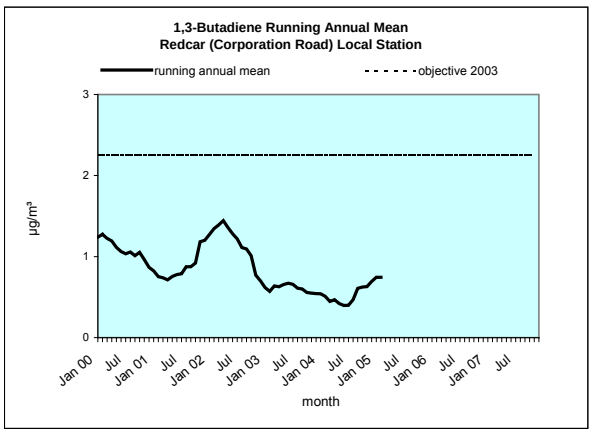
note 1 AURN continuous monitor closed December 2000. Replaced with a 1,3-Butadiene diffusion type system from March 2003 until September 2007.

note 2 No annual mean data for 2001 and 2002. No running annual mean data for 2001 onwards.

1,3-BUTADIENE - Redcar (Corporation Road) Local Station

(suburban site)





note 1 Redcar continuous monitor not operational March 2005 - December 2007
Hydrocarbon monitor closed January 2008

1,3-BUTADIENE ANNUAL MEAN AND RUNNING ANNUAL MEAN POLLUTION TREND

(Continuous gas chromatography analyser or non-continuous diffusion tube measurement)

1. The 2003 1,3-butadiene objective for the annual running mean is a maximum of 2.25 µg/m³ with no exceedances.

2. The Middlesbrough monitoring station was a continuous national network hydrocarbon monitoring station to the end of 2000, and was replaced by a diffusion tube system for 1,3-butadiene early in 2003. There was no measurement for 2001 or 2002. The diffusion tube system only provides an annual mean, although in practice there is little difference between the annual mean and the running annual mean.
   The Redcar Local monitoring station was a continuous hydrocarbon monitoring station and provided both an annual mean and running annual mean. The station has been closed since early 2005.

3. Both stations showed that there has been a decline in monitored levels of 1,3-butadiene over recent years. This is due to significant reductions in industrial emissions from the chemical industrial complexes along the Tees estuary. The Redcar site, being generally downwind of the industrial complexes, has shown historical levels higher than those at Middlesbrough, and this is likely to remain the case, since industrial emissions are the main potential source of 1,3-butadiene in the area.

4. The Middlesbrough Breckon Hill diffusion tube monitor was discontinued in September 2007 following a review of UK monitoring requirements for hydrocarbons, and there is now no monitoring of 1-3,butadiene in the Tees Valley.

Conclusion

Industrial emissions of 1,3-butadiene within the Tees Valley have fallen significantly over recent years and this is reflected in the overall decline in monitored levels.

The running annual mean objective of 2.25 µg/m³ with no exceedances for 2003 will continue to be met across the Tees Valley as long as industrial emissions are kept under tight control.

There is a case for restarting 1,3-butadiene monitoring in the Redcar area if a cost-effective and reliable monitoring system can be found.

OZONE

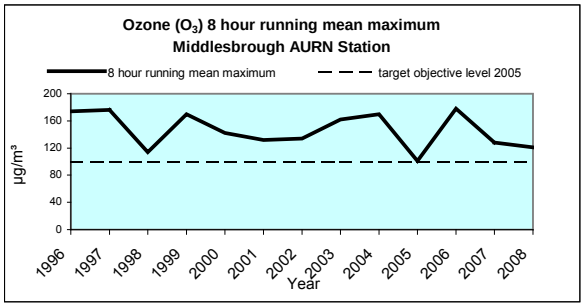
8 hour running mean and day exceedance trends

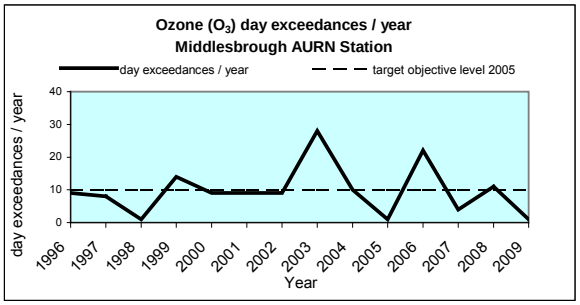
Middlesbrough (Breckon Hill) AURN Station

and Redcar (Corporation Road), Stockton (Yarm / Eaglescliffe), Stockton (Billingham) Local Stations

MIDDLESBROUGH (Breckon Hill) AURN Station

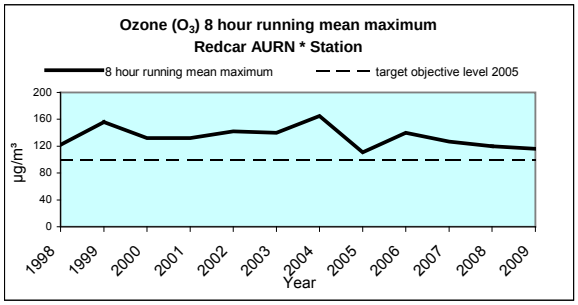
(urban-industrial site classification)

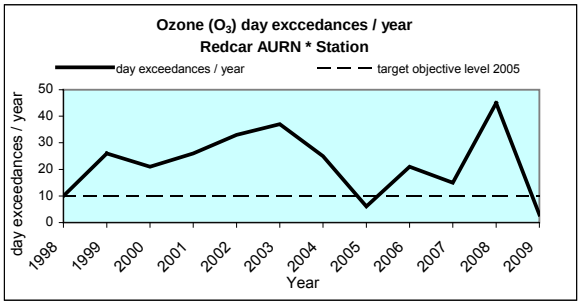




REDCAR (Corporation Road) AURN * Station

(suburban site classification)

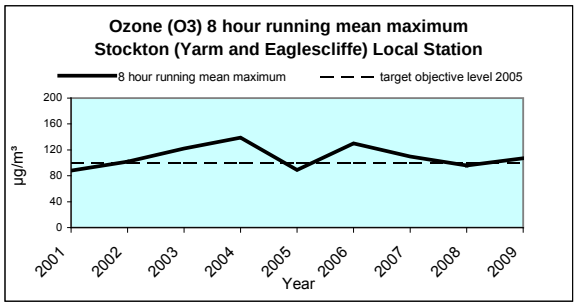


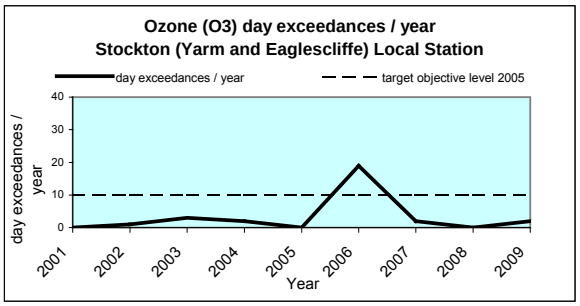


note * Local station from October 2007

STOCKTON (Yarm High Street and Eaglescliffe) Local Station

(kerbside site)

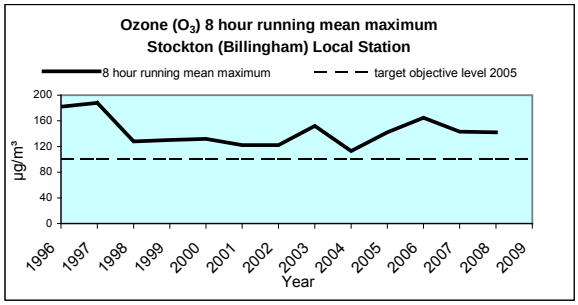


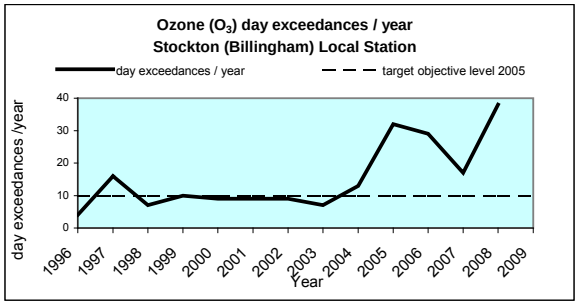


Eaglescliffe data 2009

STOCKTON (Billingham) Local Station

(urban-industrial site)





ozone monitor closed January 2009

OZONE 8 HOUR RUNNING MEAN POLLUTION TREND
(continuous analyser)

1. Ozone is not currently a prescribed pollutant for air quality assessment, but has a target objective of 100 µg/m³ for the 8 hour running mean, with no more than 10 day exceedances in any one year.

2. Ozone is a secondary pollutant. It is not emitted by any process, but is formed as a result of complex chemical reactions on other air pollutants, particularly in the presence of strong sunlight. The source pollutants, such as nitrogen dioxide and hydrocarbons, are emitted from traffic and industry, and as the chemical reaction process can take some time, the source pollutants can originate a considerable distance away, eg mainland Europe. Ozone levels tend to peak during sunny summer months, and are often highest in rural areas as a result of air pollution from elsewhere. It is recognised by the Government that local or even national action may not be sufficient to reduce ozone levels.

3. The Middlesbrough (Breckon Hill), Redcar (Corporation Road), and Stockton (Billingham) monitoring stations all show similar levels of maximum 8 hour running means each year (left graph), above the objective level of 100 µg/m³. The roadside site at Stockton (Eaglescliffe and Yarm) shows lower maximum 8 hour running means, but these are still around the objective level. The longer periods of sunnier weather in 2006 are reflected in higher monitored levels at all four stations, with a marked downturn since 2007 as a result of the poor summer weather over the last three years.

4. The number of days on which there is an exceedance (right graph) show a marked difference, with the coastal Redcar site normally showing day exceedances significantly above the objective maximum of 10 days. The Middlesbrough and Stockton (Billingham) sites normally show exceedance days around the objective maximum. The kerbside site at Stockton (Yarm) shows very few day exceedances due to the ozone scavenging effect from high levels of nitric oxide emitted from cars being oxidised to form nitrogen dioxide. The increase in day exceedances in 2008, most pronounced in Redcar, was due to a nationwide ozone episode in May which has been shown to be due to import of pollution from the continent on easterly winds. 2009 shows a significant downturn in exceedances with no ozone episodes over the year.

5. The reason for the high level of ozone exceedances at Redcar may also be associated with hydrocarbon emissions from the industrial complexes along the Tees estuary. During summer fine weather periods, it is thought that pollutants are taken out to sea on night time off-shore breezes, but are then returned to the coastal region as higher levels of ozone by day time on-shore breezes. There are also lower levels of ozone scavenging pollutants along the coastal region.

6. The proposed objective for ozone is unlikely to be met in many parts of the Tees Valley, particularly when there is a warm and sunny summer period. Ozone episodes across the UK are often associated with transboundary pollutants from the continent on south-easterly winds.

Conclusion

Industrial emissions of hydrocarbons within the Tees Valley and / or pollution from the continent are likely to result in high day exceedances of ozone along the coastal region, and to a lesser extent inland.

The proposed 8 hour running mean objective of 100 µg/m³ with up to 10 day exceedances for 2005 will not be met across significant areas of the Tees Valley. However, the Government view is that this target objective is unlikely to enter regulation in the near future.

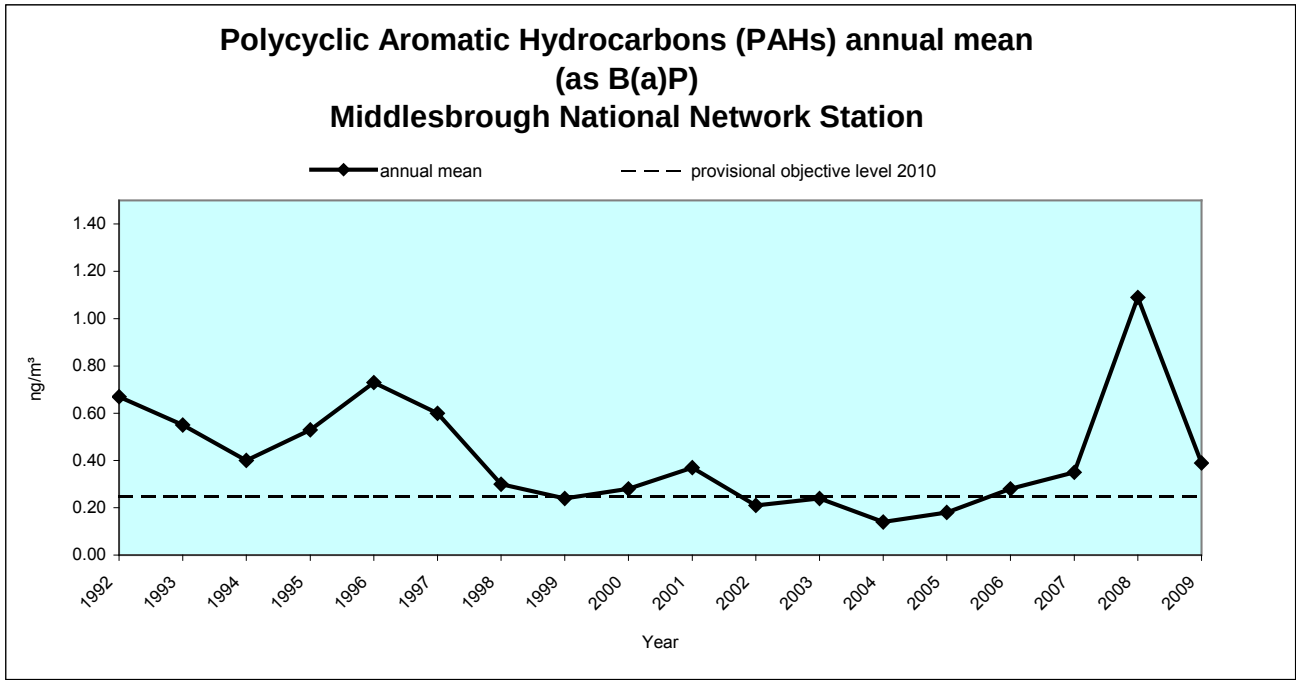
A better understanding is required of ozone formation in the Tees Valley, and the influence of ozone pollution from continental sources.

POLYCYCLIC AROMATIC HYDROCARBONS (PAHs)
annual mean trend

MIDDLESBROUGH Breckon Hill (was Longlands College to 2007) Station

(non-continuous urban background site)

note : New national network digital monitor at a Breckon Hill target group location from January 2008



POLYCYCLIC AROMATIC HYDROCARBONS (PAHs) ANNUAL MEAN POLLUTION TREND

(Non-continuous analyser)

1. PAHs are not yet a prescribed pollutant for air quality assessment under the new UK air quality strategy (2008). PAH has a 2010 objective of 0.25 ng/m³ as an annual mean (BaP) with no exceedances. A nanogram (ng) is one billionth of a gram (10^{-9}).

2. Polycyclic aromatic hydrocarbons are a large group of organic compounds with two or more benzene rings within their molecular structure. Those compounds with two or three benzene rings are normally in vapour phase, while heavier compounds with five or more benzene rings are mainly in particulate phase. The EU working group on PAHs has proposed benzo(a)pyrene (BaP) as a marker for PAH, and it is this compound on which PAH measurement is focused.

3. The main sources in the UK are domestic coal and wood burning, fires (eg accidental fies, bonfires, forest fires etc), and industrial processes such as coke production, which is of particular relevance to the Tees Valley. Road transport is the largest source of total PAHs, but the source is dominated by species of PAH thought to be less hazardous than BaP. The decline in domestic and industrial coal burning, new controls over agricultural burning, and upgrading of incinerators to high temperature technology, has led to a substantial decline in overall emissions of PAHs.

4. Monitoring of PAHs has been carried at Middlesbrough Longlands College since 1992, as part of a UK national network for micro pollutants. The station shows a significant overall decline in PAH over the period, but while concentrations fell below the objective level in 2004 /5, there was a steady increase to above the objective level in 2006 / 7.

5. The Middlesbrough Longlands College site was on the roof of the College building, and was part of the TOMPS monitoring network originally installed to monitor micropollutant concentrations in the atmosphere, rather than at public exposure locations required for air quality management. The monitor was removed at the end of 2007 as part of a national review of PAH monitoring.
   A new monitor for PAH was installed at the Middlesbrough Breckon Hill AURN station during 2007 as part of a new UK PAH monitoring network. This monitor will provide ground level concentrations of PAH, and is a public exposure location. The new monitor is considered more accurate than the earlier TOMPS unit.

6. 2008 and 2009 results from the new monitor show a dramatic increase in PAH concentrations to well above the objective level. This step change in measured values has also been seen elsewhere in the UK, and is the subject of investigation by Defra.

7. Comparison with other industrial and major conurbation sites on the national network (see page 42) show that Middlesbrough measurements are above city centre areas such as Manchester, Newcastle and Leeds, but below industrial areas such as Scunthorpe and Royston. This suggests that industrial emissions are the significant source factor within the Tees Valley. The Environment Agency has confirmed that the two coke ovens associated with the steel complex are the main source of PAHs.

Conclusion

Industrial emissions of PAHs within the Tees Valley appeared to have fallen over recent years and this is reflected in a steady decline in monitored levels to below the objective level by 2004. The step change in concentrations in 2008 and 2009, following the installation of ground level monitoring using the more accurate digital sampler, is of concern. Although 2009 results are substantially lower, they remain above the objective level, and this is at an upwind site from the major industrial sources.

The proposed annual mean objective of 0.25 ng/m³ (BaP) with no exceedances for 2010 looks less likely to be met in the region of the main chemical and steel complexes along the Tees estuary, without further reductions in emission levels.

Additional monitoring closer to, and downwind of, the coke ovens is required to better quantify the scale and influence of industrial emissions.

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APPENDICES

Appendix 1 - monitoring data ratification and validation

Appendix 1

MONITORING DATA RATIFICATION AND VALIDATION

Continuous Monitors

The monitoring results from the four AURN fixed continuous monitoring stations are ratified and validated centrally through agencies appointed by Defra.

The remaining Local fixed continuous monitoring stations, and the jointly owned mobile continuous monitoring station, are modern installations, operated under a comprehensive service contract with the suppliers Casella or Enviro-Technology. Operators of the sites have received supplier training. Monitoring results are collected, ratified and validated by the appropriate Council.

Each Council is committed to achieving accuracy, precision, data capture, traceability and long term consistency to ensure that data is representative of ambient air quality. They each have a documented quality assurance and control programme, which includes an established schedule of regular site calibrations, validation of data, and documentation of all procedures. Details are summarised as follows:

Calibration	Daily 'automatic' calibration with frequent (usually fortnightly) manual checks. Calibration gas obtained from approved gas standard suppliers.
Equipment	Comprehensive service agreement with the supplier.
Data capture	Site operators are experienced and trained personnel, monitoring data capture on a daily basis where possible to ensure that faults are detected and corrected quickly.
Data Processing	Appropriate zero and span calibration factors are applied automatically on-site, with regular manual checks.
Ratification	Data is screened, where possible on a daily basis, to check for unusual measurements. Suspicious data is investigated fully, and if found to be faulty, is deleted from the records. Particular attention is paid to possible environmental changes in the vicinity of the analyser. Data is recorded monthly and compared with earlier results. Data is collated quarterly with that from other monitors within the Tees Valley, including AURN stations, as a further check on accuracy. All data is published annually by the Tees Valley Environmental Protection Group.

Nitrogen Dioxide Diffusion Tubes

The Tees Valley nitrogen dioxide diffusion tube programmes are operated through approved laboratories with formal accreditation to BS standards, and which participate in the WASP programme. The tube preparations are all based on 50% TEA in acetone, and the tubes are installed to a defined monthly exposure schedule. Particular attention is paid to proper installation of the tubes at the site, and reliable exposure duration.
Stockton-on-Tees Council carries out triple tube co-location studies with continuous monitors, and the data obtained has been used to correct results for diffusion tube bias for Stockton-on-Tees and Hartlepool Councils. For Darlington Council, overall bias adjustment factors from the relevant laboratory are used, as published by Air Quality Consultants Ltd on behalf of Defra.

REFERENCES

Reference 1 The Air Quality Strategy 2008

available to download on the DEFRA web-site, reference 2

Reference 2 Department for Environment, Food & Rural Affairs (DEFRA)

web-site for Air Quality www.defra.gov.uk/environment/airquality/index.htm

Reference 3 The UK National Air Quality Information Archive

web-site (for monitoring results) www.airquality.co.uk/index.php

Reference 4 Local Air Quality Management Technical Guidance LAQM TG08

(available to download on the DEFRA web-site, reference 2)

REVIEW and ASSESSMENT SUBMISSIONS

These are held in the main reference library of each Council. All submissions have been approved by Defra.

Review & Assessment 2000 Stage 1

A Tees Valley study

Review & Assessment 2000 Stage 3

Separate reports for Darlington, Hartlepool, Middlesbrough, Redcar & Cleveland and Stockton-on-Tees Councils.

Review & Assessment Updating Report 2003

Separate reports for Darlington, Hartlepool, Middlesbrough, Redcar & Cleveland and Stockton-on-Tees Councils.

Progress Report 2004

A single report for Darlington, Hartlepool, Middlesbrough, Redcar & Cleveland and Stockton-on-Tees Councils.

Progress Report 2005

A single report for Darlington, Hartlepool, Middlesbrough, Redcar & Cleveland and Stockton-on-Tees Councils.

Review & Assessment Updating Report 2006

Separate reports for Darlington, Hartlepool, Middlesbrough, Redcar & Cleveland and Stockton-on-Tees Councils.

Progress Report 2007

A single report for Darlington, Hartlepool, Middlesbrough, Redcar & Cleveland and Stockton-on-Tees Councils.

Progress Report 2008

A single report for Darlington, Hartlepool, Middlesbrough, Redcar & Cleveland and Stockton-on-Tees Councils.

Review & Assessment Updating Report 2009

Separate reports for Darlington, Hartlepool, Middlesbrough, Redcar & Cleveland and Stockton-on-Tees Councils. New web-based reporting system

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