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Executive summary

The Clean Air for Europe (CAFE) Directive and 4th Daughter Directive establish a coherent framework under which the limit values or target values regulating ambient air pollutants are set within Europe. Under *Article 5* of the CAFE Directive and *Article 4* of the 4th daughter Directive, a requirement is placed upon Member States to undertake an investigation of ambient air quality at least every 5 years in order to establish estimates for the overall distribution and levels of pollutants and to identify monitoring requirements in line with the guidance provided by the Directives. In accordance with *Article 5* paragraph 2 of the CAFE Directive, this document provides the first such review of pollutant levels and distribution since the original preliminary assessment was conducted in 2003. The review is based on the high quality monitoring data from the established network of fixed automatic monitoring stations as defined by the original assessment.

This review has utilised relevant measurements from Gibraltar's high quality, fixed monitoring network and these measurements have been compared with appropriate Upper and Lower Assessment Thresholds (UAT and LAT) and Long Term Objectives (LTO) presented in the relevant Directives. Exceedance of these values dictates the requirement for fixed monitoring. The results of the assessment are summarised in Table E1 below.

Table E1 Summary of established monitoring requirements

Pollutant	Assessment threshold status	Need fixed continuous monitoring	Comments / Recommendations
NO_2	>UAT	Yes	Current monitoring satisfies Directive requirements
PM_{10}	>UAT	Yes	Current monitoring satisfies Directive requirements
$PM_{2.5}$	LAT-UAT	Yes	Current monitoring satisfies Directive requirements
SO_2	<LAT	No	Recommend retention of monitoring as useful indicator of shipping emissions. Will demonstrate AQ impact of new, cleaner power station at Lathbury Barracks.
CO	<LAT	No	Recommend retention of monitoring as useful indicator of traffic emissions (NO_X, NO_2 and PM_{10}, $PM_{2.5}$)
Benzene	LAT-UAT	Yes	Current monitoring satisfies Directive requirements
O_3	>LTO	Yes	Current monitoring satisfies Directive requirements
Arsenic	ND*	No	Recommend retention of monitoring for comparison against 2012 Target Value in conjunction with nickel monitoring.
Cadmium	<LAT	No	Recommend retention of monitoring for comparison against 2012 Target Value in conjunction with nickel monitoring..
Lead	<LAT	No	Recommend retention of monitoring for comparison against 2012 Target Value in conjunction with nickel monitoring..
Nickel	>UAT	Yes	Current monitoring satisfies Directive requirements
BaP	<LAT	No	Recommend retention of monitoring for comparison against 2012 Target Value

*** Not Determined – not enough data**

This assessment shows that the current network of ambient air pollution monitoring stations in Gibraltar is compliant with the criteria specified in the CAFE and 4th Daughter Directive going forward.

We recommend the continuation of fixed monitoring for pollutants currently in place for local Government policy support, abatement strategy assessment and for scientific justification and analysis, although we emphasize these are not required for formal compliance with the Directives in all cases.

Table of contents

1 Introduction

EU Council Directive 96/62/EC, (commonly known as The Framework Directive[1]), and subsequent 'Daughter Directives'[2][3][4] have established a coherent framework under which the limit values or target values regulating specified ambient air pollutants are set within Europe. More recently these Directives (excepting the fourth daughter Directive) have been revised and consolidated into a single Directive, known as the Clean Air for Europe or 'CAFE' Directive[5].

Under *Article 5* of Framework Directive, a requirement had been placed upon Member States to undertake a preliminary investigation of ambient air quality prior to the implementation of subsequent Daughter Directives setting limit values referred to in *Article 4* of the Framework Directive. This was undertaken in 2003[6] to inform upon the commissioning of the Gibraltar Air Quality Network by establishing estimates for the overall distribution and levels of pollutants and to identify monitoring requirements in line with the guidance provided by the daughter Directives.

In accordance with *Article 5* paragraph 2 of the CAFE Directive, this document provides the first review of pollutant levels and distribution since the original preliminary assessment was conducted in 2003 and is based on the high quality monitoring data from the established network of fixed automatic monitoring stations as defined by the original assessment.

1.1 Scope of this report

The preliminary assessment undertaken prior to the establishment of the Gibraltar Air Quality Network shaped the network in terms of monitoring locations, numbers of monitors and the pollutants monitored.

In light of the measurements resulting from the Gibraltar Air Quality Network as it was originally defined, this document makes recommendations on the current and future composition of the monitoring network to ensure that the Gibraltar Environmental Agency and Government of Gibraltar can remain confident in the quality and compliance of the network. The review is focused on assessing the network relative to the requirements for minimum compliance with the Directives.

In some cases there may no longer be a formal requirement to maintain fixed monitoring based recent measured concentrations from the existing network. However, there may still be valid scientific and policy support reasons to retain the measurements, for example to preserve a long-term data record, demonstrate continuing improvements in air quality (related to monitoring the success of implemented measures as part of a TEN application) or to provide defensible and robust support for policy decisions/ source apportionment analysis.

1.2 General approach

Our approach to the assessment of air quality regulated by the CAFE and 4th daughter Directives has been to utilise relevant measurements from Gibraltar's high quality, fixed monitoring network that was not available to support the original preliminary assessment. A data capture threshold of 75% has been applied in the calculation of relevant metrics to ensure that values have been used that are representative of the entire year.

These measurements (i.e. the number of hours, number of days or annual mean exceeding) have been compared with appropriate Upper and Lower Assessment Thresholds (UAT and LAT) and Long-

1 The Framework Directive – Council Directive 96/62/EC of 27 September 1996 on ambient air quality and assessment.
21st Daughter Directive - Council Directive 1999/30/EC relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air
3 2nd Daughter Directive - Council Directive 2000/69/EC relating to limit values for benzene and carbon monoxide in ambient air.
4 3rd Daughter Directive –Council Directive 2002/3/EC relating to ozone in ambient air.
5 Council Directive 2008/50/EC on ambient air quality and cleaner air for Europe ('CAFE' Directive)
6 Bush, T. et al. (2003) Preliminary Assessment of air quality in Gibraltar (report: netcen/ED50212/Issue1 to the Gibraltar Environmental Agency)

term Objectives (LTO) presented in the relevant Directives to determine an assessment threshold status for each pollutant. The LAT and UAT for pollutants covered by the CAFE Directive are based on the LV for the respective pollutant with the exception of ozone, for which monitoring is assessed against the LTO. The LAT and UAT for pollutants covered by the 4th Daughter Directive are based on the Target Value (TV) for the respective pollutant. The pollutants assessed in this review are presented in Table 1-1, below.

Table 1-1 Pollutant assessment thresholds and criteria

Pollutant	Metric	LAT	UAT	Directive reference for assessment threshold/criteria
NO_2	Hourly *	100 µg m^{-3}	140 µg m^{-3}	CAFE Directive (Annex II)
	Annual	26 µg m^{-3}	32 µg m^{-3}	CAFE Directive (Annex II)
PM_{10}	Daily **	25 µg m^{-3}	35 µg m^{-3}	CAFE Directive (Annex II)
	Annual	20 µg m^{-3}	28 µg m^{-3}	CAFE Directive (Annex II)
$PM_{2.5}$	Annual	12 µg m^{-3}	17 µg m^{-3}	CAFE Directive (Annex II)
SO_2	Daily	50 µg m^{-3}	75 µg m^{-3}	CAFE Directive (Annex II)
CO	Daily max 8-hr	5 µg m^{-3}	7 µg m^{-3}	CAFE Directive (Annex II)
Benzene	Annual	2 µg m^{-3}	3.5 µg m^{-3}	CAFE Directive (Annex II)
Ozone	Daily max 8-hr	LTO: 120 µg m^{-3}		CAFE Directive (Annex VII, Section C)
Arsenic	Annual	2.4 ng m^{-3}	3.6 ng m^{-3}	4th daughter Directive (Annex II)
Cadmium	Annual	2 ng m^{-3}	3 ng m^{-3}	4th daughter Directive (Annex II)
Lead	Annual	0.25 µg m^{-3}	0.35 µg m^{-3}	CAFE Directive (Annex II)
Nickel	Annual	10 ng m^{-3}	14 ng m^{-3}	4th daughter Directive (Annex II)
BaP	Annual	0.4 ng m^{-3}	0.6 ng m^{-3}	4th daughter Directive (Annex II)

* 18 exceedances permissible
** 35 exceedances permissible

1.2.1 Fixed continuous monitoring requirement

The need for fixed continuous monitoring is determined by the assessment status for each pollutant. Guidance on the number of fixed monitoring stations required for minimum compliance is provided in the relevant Directive(s) and incorporates reference to the population of the zones and agglomerations being assessed.

Pollutants classified as above the UAT for 3 or more of the 5 years of the assessment period require fixed continuous monitoring.

Pollutants classified as above the LAT but below the UAT for 3 or more years of the 5 years of the assessment period require fixed continuous monitoring. There is a minimum requirement for fixed continuous monitoring but this can be supplemented with alternative information such as modelling in order to reduce the monitoring burden as long as the minimum monitoring requirements are met. Gibraltar's size and population determine that even in cases where a pollutant is classified as above the UAT, there is only the minimum requirement for fixed continuous monitoring. In effect, the implications for monitoring requirement of being classified as above the UAT and between the LAT and UAT are the same – i.e. the minimum monitoring specified by the Directive is required and so there is no advantage to being able to use supplementary forms of assessment such as modelling.

Where pollutants are classified as below the LAT for 3 or more years of the assessment period, there is no formal requirement according to the Directives to have fixed continuous monitoring, although there may be compelling reasons for this other than the legislative requirement (as discussed in Section 4).

1.3 Gibraltar air quality monitoring network

1.3.1 Fixed continuous monitoring

Three fixed automatic monitoring stations exist within the network and are illustrated in Figure 1-1. These are:

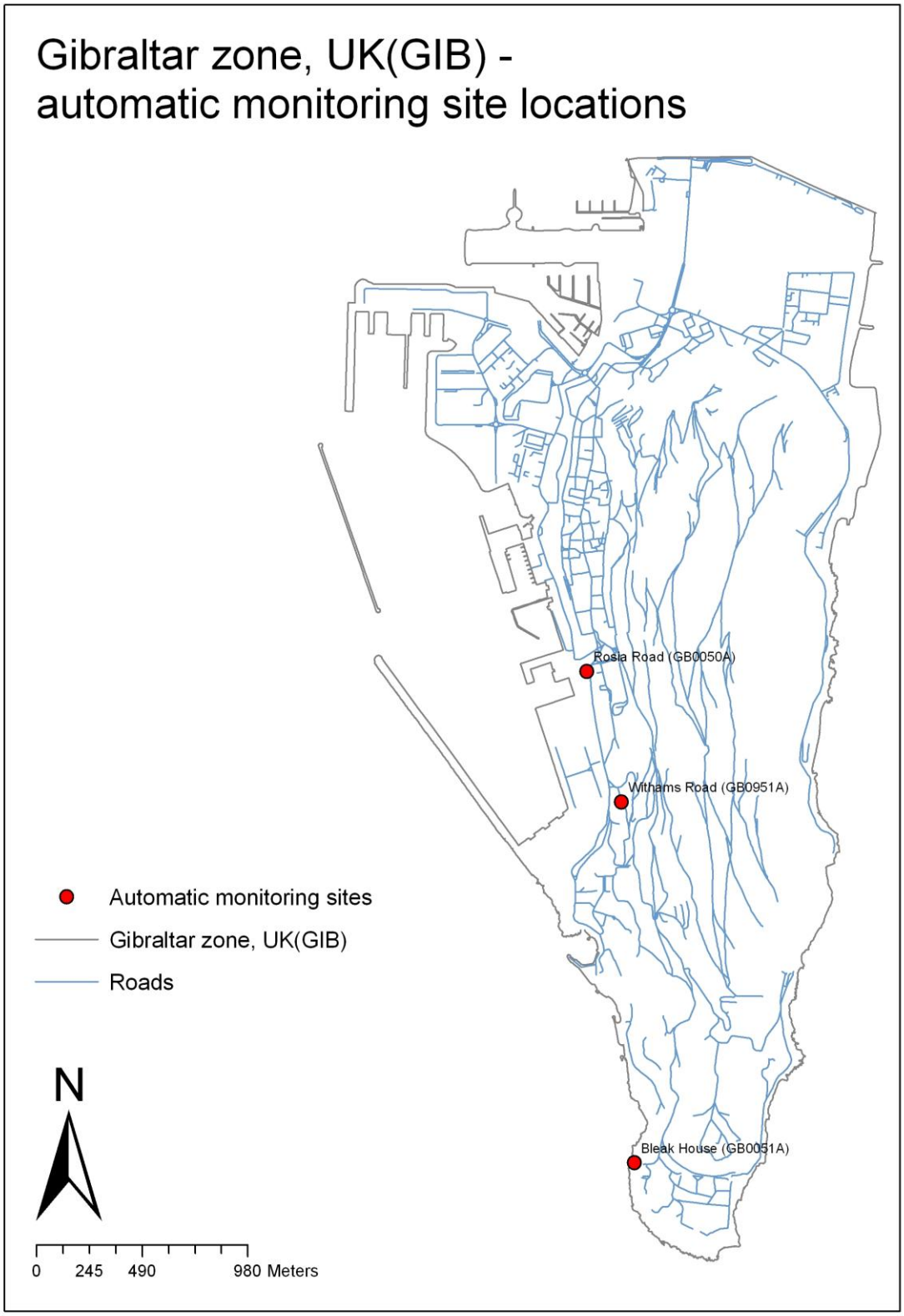
1. Rosia Road (GB0050A)
2. Bleak House (GB0051A)
3. Witham's Road (GB0951A)

Rosia Road is the principal monitoring station and is located in a roadside environment. Here a full suite of CAFE and 4th Daughter Directive pollutants are measured - NO_X, NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO, benzene, arsenic (As), cadmium (Cd), lead (Pb), nickel (Ni) and Benzo[a]Pyrene (BaP).

Bleak House is an urban background monitoring location and measures PM_{10}, ozone, NO_X and NO_2.

Witham's Road measures only NO_X and NO_2 and was established in 2008 following successively high indicative monitoring results (by diffusive sampler) and a modelling assessment that suggested this location was a pollution hotspot driven by emissions from the OESCO and MOD power stations. Though Witham's Road is officially classed as a roadside site under criteria specified in the Directives (i.e. it is within 5 metres of the kerb), the traffic count on this small road is exceptionally low and is not thought to contribute significantly to measured concentrations.

Figure 1-1 Map of fixed automatic monitoring locations in Gibraltar



1.3.2 Indicative monitoring by diffusive sampler

In addition to the fixed automatic monitoring sites in Gibraltar established to satisfy Directive requirements as identified in the original preliminary assessment, an indicative passive sampler monitoring campaign to measure NO_2 and benzene, toluene, ethyl-benzene and xylene (BTEX) by Palmes diffusion tube has been established in Gibraltar. Though less accurate than automatic monitoring (hence its *indicative* status), these samplers are distributed more widely across Gibraltar and provide better spatial representation of concentrations.

Data from these diffusive samplers were used to support the original preliminary assessment. For the purposes of this update, the passive sampler data has not been included in the analysis. The only pollutants that this passive sampler data could inform upon are NO_2 and benzene, both of which have been identified as requiring fixed monitoring in the future based on the existing automatic data so inclusion of the diffusion tube data would not affect the result.

2 CAFE Pollutants

2.1 Nitrogen dioxide

The comparatively small spatial extent of Gibraltar (approximately 6.25 km^2) means that there are no defined vegetation or ecosystem protection areas relevant to the Directives. This means that pollutants and metrics associated with the protection of vegetation and ecosystems (e.g. NO_X and winter mean SO_2) are also not relevant for the compliance of Gibraltar's monitoring network.

The hourly LAT for NO_2 is defined as 50% of the hourly Limit Value (LV) (i.e. 100 $\mu g\ m^{-3}$). The hourly UAT for NO_2 is defined as 70% of the hourly LV (i.e. 140 $\mu g\ m^{-3}$). The Directive states 18 permissible exceedances for these metrics. Calculated exceedances for LAT and UAT for NO_2 in Gibraltar are presented in Table 2-1.

Table 2-1 Calculated exceedances of hourly LAT and UAT for NO_2 in Gibraltar (2005-2009)

Year	Rosia Road			Bleak House			Witham's Road			Assessment Threshold status
	Data capture %	Hours above LAT	Hours above UAT	Data capture %	Hours above LAT	Hours above UAT	Data capture %	Hours above LAT	Hours above UAT	
2005	82.1	122	12	83.5	6	0				BETWEEN LAT and UAT
2006	98.3	105	4	97.4	19	0				BETWEEN LAT and UAT
2007	98.1	159	4	98.5	9	1				BETWEEN LAT and UAT
2008	91.5	102	0	89.1	8	0	62.1	264	2	BETWEEN LAT and UAT
2009	98.4	295	3	96.1	10	0	99.3	722	19	ABOVE UAT

The annual LAT for NO_2 is defined as 65% of the annual LV (i.e. 26 $\mu g\ m^{-3}$). The annual UAT for NO_2 is defined as 80% of the annual LV (32 $\mu g\ m^{-3}$). Calculated annual means for NO_2 in Gibraltar are presented in Table 2-2.

Table 2-2 Calculated exceedances of annual LAT and UAT for NO_2 in Gibraltar (2005-2009)

Year	Rosia Road		Bleak House		Witham's Road		Assessment Threshold status
	Data capture %	Annual mean ($\mu g\ m^{-3}$)	Data capture %	Annual mean ($\mu g\ m^{-3}$)	Data capture %	Annual mean ($\mu g\ m^{-3}$)	
2005	82.1	42	83.5	24			ABOVE UAT
2006	98.3	42	97.4	24			ABOVE UAT
2007	98.1	44	98.5	25			ABOVE UAT
2008	91.5	45	89.1	26	62.1	53	ABOVE UAT
2009	98.4	48	96.1	26	99.3	57	ABOVE UAT

All 3 monitoring sites have data captures in excess of the 75% threshold for each year except for Witham's Road which commenced operation part way into 2008 resulting in low data capture for that year. The assessment threshold status for the hourly metric indicates that levels are between the LAT and UAT. In effect this results in the same burden of fixed monitoring as an exceedance of the UAT because the minimum fixed monitoring required is one site in the Gibraltar zone.

Annual average concentrations measured at Rosia Road are shown to exceed the UAT for 3 or more years out the 5 years 2005-2009. This triggers a formal requirement to measure levels of NO_2 at a

minimum of one location within Gibraltar under the CAFE Directive. Continued operation of the NO_2 monitor at Rosia Road is therefore recommended

Owing to the shorter data-series for the Witham's Road station formal exceedance of the LAT or UAT is not possible. However, given the levels measured (both hourly and annual means) in the part year measured in 2008 and full year for 2009, exceedance of the LAT is likely. Continued operation of this station for monitoring concentrations at this important hotspot location is recommended.

Concentrations at Bleak House are below the LAT for both hourly and annual mean metrics. Even so this background location provides important baseline information on the background pollutant levels and is especially important in this respect for calibrating air quality dispersion models and quantification of transboundary pollution and road traffic/power station source increments. Continued operation of the NO_2 monitor at Bleak House is therefore recommended.

2.2 Particulate matter

2.2.1 PM_{10}

The daily LAT for PM_{10} is defined as 50% of the daily LV (i.e. 25 μg m^{-3}). The daily UAT for PM_{10} is defined as 70% of the daily LV (i.e. 35 μg m^{-3}). The Directive states 35 permissible exceedances for these metrics. Calculated exceedances for LAT and UAT for PM_{10} in Gibraltar are presented in Table 2-3.

Table 2-3 Calculated exceedances of daily LAT and UAT for PM_{10} in Gibraltar (2005-2009)

Year	Rosia Road			Bleak House			Assessment Threshold status
	Data capture %	Days above LAT	Days above UAT	Data capture %	Days aboveLAT	Days above UAT	
2005	90.1	295	157				ABOVE UAT
2006	97.8	326	220				ABOVE UAT
2007	99.2	334	255				ABOVE UAT
2008	90.7	285	195	48.4	129	57	ABOVE UAT
2009	97.5	326	210	94.8	190	63	ABOVE UAT

PM_{10} is measured at both the Rosia Road and (since 2008) the Bleak House monitoring stations. Data capture at Bleak House in the first year of operation was less than 75% due to the partial year of monitoring. Data capture for all other years at both sites were above 75%. The 35 permissible daily exceedances of both the LAT and UAT were exceeded at Rosia Road on 3 or more years of the 5 years 2005-2009, thus triggering a formal requirement to measure levels of PM_{10} at a minimum of one location within Gibraltar under the CAFE Directive.

The annual LAT for PM_{10} is defined as 50% of the annual LV (i.e. 20 μg m^{-3}). The annual UAT for PM_{10} is defined as 70% of the annual LV (28 μg m^{-3}). Calculated annual means for PM_{10} in Gibraltar are presented in Table 2-4.

Table 2-4 Calculated exceedances of annual LAT and UAT for PM_{10} in Gibraltar (2005-2009)

Year	Rosia Road		Bleak House		Assessment Threshold status
	Data capture %	Annual mean (μg m^{-3})	Data capture %	Annual mean (μg m^{-3})	
2005	90.1	36			ABOVE UAT
2006	97.8	40			ABOVE UAT
2007	99.2	45			ABOVE UAT
2008	90.7	41	48.4	34	ABOVE UAT
2009	97.5	38	94.8	27	ABOVE UAT

Likewise for the annual mean metric, concentrations are observed to exceed the UAT for all years with valid data capture rates, thus reinforcing the need to measure PM_{10} in at least one location within Gibraltar. Continued operation of the PM_{10} monitor at Rosia Road is therefore recommended.

The magnitude of the number of days exceeding the UAT at both the urban roadside site (Rosia Road) and the background site (Bleak House) indicates that levels of PM_{10} are heavily influenced by regional and transboundary sources. Continued operation of the PM_{10} monitor at Bleak House is therefore recommended.

2.2.2 $PM_{2.5}$

The annual LAT for $PM_{2.5}$ is defined as 50% of the annual LV (i.e.12 $\mu g\ m^{-3}$). The annual UAT for $PM_{2.5}$ is defined as 70% of the annual LV (17 $\mu g\ m^{-3}$). Calculated annual means for $PM_{2.5}$ in Gibraltar are presented in Table 2-5.

Table 2-5 Calculated exceedances of annual LAT and UAT for $PM_{2.5}$ in Gibraltar (2005-2009)

Year	Rosia Road		Assessment Threshold status
	Data capture %	Annual mean ($\mu g\ m^{-3}$)	
2005	89.6	17	BETWEEN UAT and LAT
2006	95.9	19	ABOVE UAT
2007	98.9	18	ABOVE UAT
2008	97.0	16	BETWEEN UAT and LAT
2009	98.9	16	BETWEEN UAT and LAT

Rosia Road is the only monitoring site in the Gibraltar air quality network that measures $PM_{2.5}$. Annual mean concentrations presented in Table 3-3 indicate that the UAT for $PM_{2.5}$ was exceeded in fewer than 3 of the 5 years 2005-2009. Data capture rates were consistently above 75% over this period. This triggers a formal requirement to measure levels of $PM_{2.5}$ at a minimum of one location within Gibraltar under the CAFE Directive. Continued operation of the $PM_{2.5}$ monitor at Rosia Road is therefore recommended.

2.3 Sulphur dioxide

As for NO_X, there is no requirement for Gibraltar to monitor SO_2 for protection of vegetation as there are no appropriate areas defined within Gibraltar.

The LAT for SO_2 is defined as 40% of the daily LV (i.e. 50 $\mu g\ m^{-3}$). The UAT for SO_2 is defined as 60% of the daily LV (i.e. 75 $\mu g\ m^{-3}$). The Directive states 3 permissible exceedances for these metrics. Calculated exceedances for LAT and UAT for SO_2 in Gibraltar are presented in Table 2-6.

Table 2-6 Calculated exceedances of annual LAT and UAT for SO_2 in Gibraltar (2005-2009)

Year	Data capture %	LAT	UAT	Assessment Threshold status
2005	88.7	1	0	BELOW LAT
2006	97.1	0	0	BELOW LAT
2007	98.0	0	0	BELOW LAT
2008	96.7	0	0	BELOW LAT
2009	98.4	3	0	BELOW LAT

Rosia Road is the sole monitoring site for fixed automatic measurements of SO_2. Table 2-6 indicates that there have been fewer than 3 exceedances of the LAT from the automatic data 2005-2009. Of the few exceedances of the LAT that have been observed these are within the permissible bounds set by

the Directive. As a result, there is no formal requirement to continue to measure SO_2 at Rosia Road. However, we recommend that this is continued in the medium term, at least until it has been demonstrated that the new power station due to commence operation in 2014 does not significantly contribute to ambient concentrations – this is required to demonstrate that the measures associated with the Gibraltar AQ Action Plan are effective as part of a possible time extension.

2.4 Carbon monoxide

The LAT and UAT for CO are based on a maximum daily running 8-hour mean concentration with the LAT being 50% of the LV (i.e. 5 mg m^{-3}) and the UAT being 70% of the LV (i.e. 7 mg m^{-3}).

Table 2-7 Calculated exceedances of LAT and UAT for CO in Gibraltar (2005-2009)

Year	Data capture %	Annual mean (mg m^{-3})	Maximum daily 8-hr mean (mg m^{-3})	Assessment threshold status
2005	89.2	0.5	2.7	BELOW LAT
2006	97.6	0.6	3.1	BELOW LAT
2007	95.2	0.5	2.2	BELOW LAT
2008	98.1	0.5	2.4	BELOW LAT
2009	98.8	0.5	1.9	BELOW LAT

The relevant metrics are shown for years 2005-2009 in Table 2-7 and shows data capture was good for all years. It is evident is that the measured maximum daily running 8-hour mean concentration is below the LAT in all years thus indicating no mandatory requirement to continue fixed automatic monitoring of CO concentrations within Gibraltar. At these levels, looking forward, emissions inventories are deemed sufficient by the Directive for compliance monitoring of likely levels of CO in ambient air.

2.5 Benzene

The LAT and UAT for benzene are based on the annual mean concentration with the LAT being 40% of the LV (i.e. 2 μg m^{-3}) and the UAT being 70% of the LV (i.e. 3.5 μg m^{-3}).

Table 2-8 Calculated exceedances of LAT and UAT for benzene in Gibraltar (2005-2009)

Year	Data capture %	Annual mean (μg m^{-3})	Assessment threshold status
2005	87%	2.33	BETWEEN LAT and UAT
2006	98%	2.75	BETWEEN LAT and UAT
2007	98%	2.28	BETWEEN LAT and UAT
2008	92%	1.75	BELOW LAT
2009	96%	1.87	BELOW LAT

The measured annual mean concentrations are shown for 2005-2009 in Table 2-8. Data capture was good for all years. The LAT is observed to have been exceeded in 3 out of the 5 years 2005-2007. Even though levels from 2008 onward are below the LAT, the concentrations 2005-2007 trigger a formal requirement for one fixed monitoring station for benzene in Gibraltar. Therefore we recommend continued monitoring of benzene at Rosia Road.

2.6 Ozone

Since it's entry into force, ozone has been regulated by the CAFE Directive. Unlike other pollutants there is no specific LAT or UAT for ozone. Instead the need for fixed monitoring is dictated by a single threshold (LTO) for two metrics, evaluated over 5 years, as stated in Article 9.1 of the Directive. The LTOs (defined in Annex VII, Section C of the Directive) are:

- for human health: 120 μg m^{-3} as the maximum daily 8-hour mean ozone concentration

- for vegetation protection: AOT40 (May to July) of 6000 μg m^{-3}.h

Table 2-9 Calculated exceedances of Long Term Objective (protection of health) for ozone in Gibraltar (2005-2009)

Year	Data capture %	Annual mean (μg m^{-3})	Maximum daily 8-hr mean (μg m^{-3})	Assessment threshold status
2005	89.4	68	140	ABOVE LTO
2006	98.7	62	159	ABOVE LTO
2007	90.4	62	140	ABOVE LTO
2008	98.6	60	134	ABOVE LTO
2009	96.2	62	144	ABOVE LTO

The measured maximum daily 8-hour mean concentrations are presented in Table 2-9 for Bleak House for 2005-2009. As this shows, data capture was good for all years and in the 5 years of operation the measured concentrations were all in excess of the LTO for protection of human health.

Table 2-10 Calculated exceedances of Long Term Objective (protection of vegetation) for ozone in Gibraltar (2005-2009)

Year	Data capture %	AOT40 (μg m^{-3}.h)	Assessment threshold status
2005	89.4	16132	ABOVE LTO
2006	98.7	18759	ABOVE LTO
2007	90.4	7863	ABOVE LTO
2008	98.6	9742	ABOVE LTO
2009	96.2	9294	ABOVE LTO

The LTO for protection of vegetation as shown in Table 2-10 was also exceeded for the 5 years of operation. Exceedance of these LTOs results in the continuing need for fixed measurements of ozone, thus triggering a formal requirement for one fixed monitoring station for ozone in Gibraltar. Therefore we recommended continued monitoring of ozone at Bleak House.

2.7 Lead

The LAT and UAT for lead are based on an annual mean concentration, with the LAT being 50% of the LV (i.e. 0.25 μg m^{-3}) and the UAT being 70% of the LV (i.e. 0.35 μg m^{-3}).

Table 2-11 Calculated exceedances of LAT and UAT for Pb in Gibraltar (2005-2009)

Year	Data capture %	Annual mean (μg m^{-3})	Assessment threshold status
2005	100%	0.02	BELOW LAT
2006	100%	0.01	BELOW LAT
2007	100%	0.01	BELOW LAT
2008	100%	0.01	BELOW LAT
2009	100%	0.01	BELOW LAT

The relevant metrics are shown for 2005-2009 in Table 2-11. As this shows, data capture was good for all 5 years of operation. The measured concentrations are consistently below the LAT, indicating no mandatory requirement to continue fixed monitoring of lead concentrations in the future.

3 4th Daughter Directive Pollutants

The fourth Daughter Directive[7] specifies LATs and UATs for heavy metals (arsenic, cadmium and nickel) and polycyclic aromatic hydrocarbons (PAH, specifically Benzo[a]Pyrene, BaP). As for CAFE pollutants these thresholds allow Member States to determine monitoring requirements for these pollutants by zone.

Fixed monitoring was established at Rosia Road for these pollutants in 2005 to determine local levels, no measurements having been made in Gibraltar prior to this date.

3.1 Arsenic

The LAT and UAT for arsenic (As) are based on an annual mean concentration with the LAT being 40% of the TV (i.e. 2.4 ng m^{-3}) and the UAT being 60% of the TV (i.e. 3.6 ng m^{-3}).

Table 3-1 Calculated exceedances of LAT and UAT for As in Gibraltar (2005-2009)

Year	Data capture %	Annual mean (ng m^{-3})	Assessment threshold status
2005	-----	-----	-----
2006	58%	1.05	BELOW LAT
2007	100%	1.02	BELOW LAT
2008	100%	1.28	BELOW LAT
2009	67%	0.90	BELOW LAT

The relevant metrics are shown for 2005-2009 in Table 3-1. As this shows, the site operation commenced in 2006 and data capture was low in this year due to the partial year of operation and in 2009. The measured concentrations are consistently below the LAT. However, owing to the low data capture rate in 2006 and generally short operational time-series, it is not possible to unambiguously characterise the concentrations as below the LAT; 3 or more years below the LAT out of the five would be required for this. On this basis, it is recommended that monitoring of Arsenic levels at Rosia Road continues at least until levels can formally be demonstrated to be below the LAT based on guidance provided by the Directive.

3.2 Cadmium

The LAT and UAT for cadmium (Cd) are based on an annual mean concentration with the LAT being 40% of the TV (i.e. 2 ng m^{-3}) and the UAT being 60% of the TV (i.e. 3 ng m^{-3}).

Table 3-2 Calculated exceedances of LAT and UAT for Cd in Gibraltar (2005-2009)

Year	Data capture %	Annual mean (ng m^{-3})	Assessment threshold status
2005	-----	-----	-----
2006	58%	0.24	BELOW LAT
2007	100%	0.28	BELOW LAT
2008	100%	0.20	BELOW LAT
2009	100%	0.33	BELOW LAT

The relevant metrics are shown for 2005 to 2009 in Table 3-2. As this shows, the site operation commenced in 2006 and data capture was good for all years except 2006 where it was marginally lower than 75% due to the partial year of operation. The measured concentrations are shown to be

[7] 4th Daughter Directive –Council Directive 2004/107/EC relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air

below the LAT for 3 out of the 5 years of operating, indicating no mandatory requirement to continue fixed monitoring of BaP concentrations in the future.

3.3 Nickel

The LAT and UAT for nickel (Ni) are based on an annual mean concentration with the LAT being 50% of the TV (i.e.10 ng m^{-3}) and the UAT being 70% of the TV (i.e.14 ng m^{-3}).

Table 3-3 Calculated exceedances of LAT and UAT for Ni in Gibraltar (2005-2009)

Year	Data capture %	Annual mean (ng m^{-3})	Assessment threshold status
2005	100%	17.6	ABOVE UAT
2006	100%	15.8	ABOVE UAT
2007	100%	17.1	ABOVE UAT
2008	100%	20.4	ABOVE UAT
2009	92%	12.1	BETWEEN LAT and UAT

The relevant metrics are shown for 2005-2009 in Table 3-3. As this shows, data capture was good for all 5 years of operation. The measured concentrations are consistently above the UAT for the four years until 2009 when they decreased to between the LAT and UAT. As a result there is a definitive requirement for continued fixed measurements of nickel in Gibraltar. We therefore recommend the continuation of measurements at Rosia Road.

Modelling studies[8] undertaken on behalf of the Gibraltar Environmental Agency have indicated that fuel-oil and gas-oil combustion by near by shipping activities is a significant source of nickel in the area and is believed to be an issue across the Bay of Gibraltar.

3.4 Benzo[a]Pyrene

The LAT and UAT for Benzo[a]Pyrene (BaP) are based on an annual mean concentration with the LAT being 40% of the TV (i.e. 0.4 ng m^{-3}) and the UAT being 60% of the TV (i.e. 0.6 ng m^{-3}).

Table 3-4 Calculated exceedances of LAT and UAT for BaP in Gibraltar (2005-2009)

Year	Data capture %	Annual mean (ng m^{-3})	Assessment threshold status
2005	-----	-----	-----
2006	100%	0.09	BELOW LAT
2007	100%	0.15	BELOW LAT
2008	67%	0.08	BELOW LAT
2009	100%	0.12	BELOW LAT

The relevant metrics are shown for 2005-2009 in Table 3-4. As this shows, the site operation commenced in 2006 and data capture was good for all years except 2008 where it was marginally lower than 75%. The measured concentrations are shown to be below the LAT for 3 out of the 5 years of operating, indicating no mandatory requirement to continue fixed monitoring of BaP concentrations in the future.

[8] Abbott, J (2009) Contribution from shipping emissions to PM_{10} and nickel contents on Gibraltar (AEA Report to Gibraltar Environmental Agency: AEA/ED43072/R2833 Issue 1)

4 Conclusions and recommendations

The status of Gibraltar zone for different pollutants relative to the assessment threshold criteria prescribed in the Directives is summarised in Table 4-1.

The automatic measured data shows that several pollutants have exceeded the UAT (or LTO in case of ozone) or lie between the LAT and UAT for 3 of more years over the assessment period and therefore require fixed continuous monitoring. These are:

- NO_2
- PM_{10}
- $PM_{2.5}$
- benzene
- ozone
- nickel

The data indicates that concentrations of other pollutants over the assessment period are below the LAT for 3 or more years and therefore future fixed continuous monitoring is not required for compliance. These pollutants are:

- SO_2
- CO
- cadmium
- lead
- BaP

Despite the lack of mandatory requirement to continue measuring these pollutants, there are compelling arguments to retain these instruments in the network anyway:

- **Tracking progress of abatement measures and policy strategy**
  Pollutants such as SO_2 and CO are vital components to the network in terms of source apportionment and characterization. For Gibraltar, the need to monitor and demonstrate the success of abatement measures put in place for its PM_{10} and NO_2 Time Extension (TEN) applications, provides an argument to retain some pollutants. For example, measured SO_2 concentrations will demonstrate that the new power station at Lathbury Barracks is not causing dangerous emissions when it becomes operational. SO_2 is also associated with fuel combustion by shipping which is known to be a significant source of nickel in the Bay of Gibraltar. Maintaining monitoring for this pollutant in the network may provide useful proxy information for shipping contributions to measured concentrations in the future. CO is a useful proxy for road traffic exhaust emissions and this data can be used to provide context for other associated exhaust emissions (PM_{10} and NO_X and NO_2) that will require mandatory fixed monitoring.

- **Evidence base for future assessment**
  Despite the fact that recent historical data illustrates low concentrations of these pollutants, concentrations change continuously over time in relation to meteorology, local and transboundary sources. This is why the requirement to conduct regular Article 5 Assessments exists in the Directives. Retaining fixed monitoring of non-essential pollutants in the network provides a strong evidence base to inform future assessments rather than relying on less reliable evidence from indicative monitoring campaigns (such as passive sampling) or emissions inventories (the detailed information for which Gibraltar may not easily be able to provide).

- **Metals analysis**
  Continued fixed monitoring of lead and cadmium is not formally required but the requirement for fixed monitoring of arsenic (more data is needed to satisfy assessment criteria according to the Directive) and nickel concentrations (close to the 2010 Target Value) remains. Due to the method of collection (by chemical speciation from a Partisol filter) all heavy metals are obtained in the same process. Therefore, by retaining monitoring for nickel, monitoring for these other heavy metals is effectively retained too.

- **4th daughter Directive date**

Arsenic, cadmium, nickel and BaP are covered under the 4th daughter Directive which specifies Target Values to be achieved by 2012. It would be prudent to retain the monitoring for these pollutants until they can be directly compared with the TV (i.e. after 2012) and then review the continuing need for this monitoring.

Despite the relatively low measured concentrations of arsenic, the short data record, compounded by low data capture in some years were not enough to unambiguously classify this pollutant as below the LAT. Therefore this has been classified as 'not determined' and continued fixed monitoring at Rosia Road is required to obtain the necessary data to make a robust assessment in the future.

This assessment shows that the current network is compliant with the criteria specified in the CAFE and fourth Daughter Directive going into the next programme of operation.

We strongly recommend the continuation of fixed monitoring for all pollutants, even those that are not formally required for compliance according to the assessment criteria specified in the Directives. This is recommended because without these measurements there exists little alternative information about these pollutants to inform future requirements for monitoring and compliance (i.e. future Article 5 Assessments). In other Member States there is often a large volume of proxy information related to emissions or a large number of monitoring stations. This information does not exist for Gibraltar, therefore the few monitoring sites that exist are the only source of information on levels of pollutants. Given the lack of alternatives, each site in the Gibraltar Air Quality Monitoring Network can be considered 'critical' in terms of information. There are other reasons to retain monitoring of all pollutants – they provide vital information for policy and abatement strategy assessment and for scientific justification and analysis that underpins other submissions and legislative requirements (such as the time extension applications and associated monitoring). Given Gibraltar's exceedance status and requirement for time extensions, there is a need for as much data as possible to help support policy design, implementation and review over the time extension period and years immediately afterwards.

Table 4-1 Summary of monitoring requirements for compliance with Directives

Pollutant	Assessment threshold status	Formal requirement for fixed continuous monitoring	Recommendation for fixed continuous monitoring	Comments
NO_2	>UAT	Yes	Yes	Current monitoring satisfies Directive requirements
PM_{10}	>UAT	Yes	Yes	Current monitoring satisfies Directive requirements
$PM_{2.5}$	LAT-UAT	Yes	Yes	Current monitoring satisfies Directive requirements
SO_2	<LAT	No	Yes	Retain as useful indicator of shipping emissions. Will demonstrate AQ impact of new, cleaner power station at Lathbury Barracks.
CO	<LAT	No	Yes	Retain as useful indicator of traffic emissions (NO_X, NO_2 and PM_{10}, $PM_{2.5}$)
Benzene	LAT-UAT	Yes	Yes	Current monitoring satisfies Directive requirements
O_3	>LTO	Yes	Yes	Current monitoring satisfies Directive requirements
Arsenic	ND	Yes	Yes	Retain for future assessment when adequate data to make a robust determination of assessment status and for comparison against 2012 Target Value.
Cadmium	<LAT	No	Yes	Retain for comparison against 2012 Target Value. Available with formally required nickel monitoring at no additional expense.
Lead	<LAT	No	Yes	Retain for comparison against 2012 Target Value. Available with formally required nickel monitoring at no additional expense.
Nickel	>UAT	Yes	Yes	Current monitoring satisfies Directive requirements
BaP	<LAT	No	Yes	Retain for comparison against 2012 Target Value

ND = not determined owing to low data capture and/or short time-series

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