Report

Emission factors programme Task 9 – Review of Particulate Matter Emissions from Industrial Processes

A report prepared for the Department for Environment, Food and Rural Affairs; the National Assembly of Wales: the Scottish Executive; and the Department of Environment in Northern Ireland

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Executive Summary

This report has been prepared for the Department for the Environment, Food and Rural Affairs; the National Assembly of Wales: the Scottish Executive; and the Department of Environment in Northern Ireland by **netcen** (an operating division of AEA Technology plc) under the contract EPG 1/3/195, "Emission factors for air pollutants".

The Department for Environment Food and Rural Affairs (Defra) Air and Environment Quality (AEQ) Division is responsible for maintaining the UK National Atmospheric Emissions Inventory (NAEI). The NAEI is maintained by **netcen** on behalf of Defra. As part of the ongoing quality control of the NAEI the quantitative uncertainty in the national emission total of each component pollutant in NAEI is reviewed annually. Based on the findings of this review project EPG 1/3/195 aims to characterise and minimise uncertainty in the emission factors used in the compilation of the NAEI and by association those of other UK inventories. The project has objectives (Tasks) that are set and reviewed annually; these comprise data collection and evaluation via literature review, personal contact with industrial representatives, direct source measurement and other means as appropriate.

The NAEI includes emission estimates for four Particulate Matter (PM) size fractions (PM_{10} , $PM_{2.5}$, $PM_{1.0}$, and $PM_{0.1}$). The aim of this task was to characterise and minimise uncertainty in the emission factors and speciation profiles used in the compilation of PM values from industrial processes of the NAEI and by association that of other UK inventories. The task comprised a desk-based search of all relevant information sources highlighting areas for development and proposed changes to emissions data for existing particulate size speciation for industrial and combustion sources in the NAEI.

Two activities have been undertaken under the task. Firstly, a review of the current NAEI database (2002) to determine any newer or more relevant reference emission data. The emissions profiles were also reviewed to determine whether the PM size speciation data applied in the NAEI is appropriate with respect to the type of process and abatement technology.

The second activity was a risk-based review of the most significant industrial and combustion source sectors in each of the size fractions used in the NAEI. The most significant sectors in each size range were identified and then five industry sectors selected for more detailed review including both the scientific and technical literature and, information held by regulators and industry. The new information was reviewed and assessed for relevance to UK industry.

The task has highlighted areas for development and proposed changes to the NAEI emissions data for PM_{10} and PM size speciation in several source sectors.

Contents

1 Introduction 1

2 Current NAEI database and process methodology 2

2.1 PM_{10} 2
2.2 SUB-PM_{10} PARTICULATE FRACTIONS 2

3 Methodology 3

4 Review of key source sectors 5

4.1 OVERVIEW 5
4.2 PM_{10} EMISSIONS FROM INDUSTRIAL SOURCES 5
4.3 MANUFACTURE OF NON-FLETTON BRICKS 6
4.4 MANUFACTURE OF CEMENT CLINKER 7
4.5 COMBUSTION OF COAL 8
4.6 IRON AND STEEL – SINTERING PLANTS 8
4.7 COMBUSTION OF NATURAL GAS 9

5 Recommendations 11

6 References 12

1 Introduction

This report has been prepared for the Department for the Environment, Food and Rural Affairs; the National Assembly of Wales: the Scottish Executive; and the Department of Environment in Northern Ireland by **netcen** (an operating division of AEA Technology plc) under the contract EPG 1/3/195 - Emission factors for air pollutants.

The Department for Environment, Food and Rural Affairs (Defra) Air and Environment Quality (AEQ) Division is responsible for maintaining the UK National Atmospheric Emissions Inventory (NAEI). The NAEI is maintained by **netcen** on behalf of Defra. As part of the ongoing quality control of the NAEI the quantitative uncertainty in the national emissions total of each component pollutant in NAEI is reviewed annually.

Task 9 under project EPG 1/3/195 aims to characterise and minimise uncertainty in the emission factors and speciation profiles used in the compilation of PM (Particulate Matter) inventories for industrial and selected combustion processes of the NAEI and, by association, that of other UK inventories.

The NAEI includes emission data for PM in the following size categories :

- PM_{10} - Particulate matter than nominally 10 µm
- $PM_{2.5}$ - Particulate matter than nominally 2.5 µm
- $PM_{1.0}$ - Particulate matter than nominally 1.0 µm
- $PM_{0.1}$ - Particulate matter than nominally 0.1 µm

Inventories have been developed for a variety of sources including industrial and combustion sectors. However, the inventories for these pollutants also have significant uncertainty within the NAEI. The emission factors and speciation profiles used to populate the 2002 NAEI are taken largely from data reported to regulatory authorities (PM_{10}) and information published in a TNO report[1].

These pollutants are of growing significance for abatement policy development and hence, the task was developed within the emission factor programme to review and improve the most significant sources for each particle size.

2 Current NAEI database and process methodology

2.1 PM_{10}

The NAEI database draws on several key resources to compile the UK PM_{10} emissions data. These data include annual emission estimates, emission factors and activity statistics.

The primary source of PM_{10} data for major industrial activities is the Pollution Inventory maintained by the Environment Agency (in England & Wales). Other regulatory authorities (for example the Scottish Environmental Protection Agency) also maintain inventories. The information is supplied to the UK regulatory authorities by operators of major industrial processes as part of the permitting regime applied to industrial processes. The operator estimates are based on a variety of methodologies (see section 4.2).

Other sources of PM_{10} data for industrial sources in the NAEI include information from industry and trade organisations. In the absence of such data, the NAEI estimates annual emissions of PM_{10} for industry sectors (in some instances for individual processes) using emission factors* and activity statistics**.

A key reference source of activity information is supplied by DUKES (Digest of UK Energy Statistics)[2]. The DUKES data provides total fuel consumption information for the UK by fuel type and consumer sector. The DUKES consumer sectors generally define the industry sectors used by the NAEI to categorize emissions. The NAEI can use UK fuel statistics with emission data from the England & Wales Pollution Inventory to extrapolate national PM_{10} emissions for some industry sectors.

The NAEI also estimates annual emissions from a range of other information sources, namely UK measurement programmes, literature sources (such as the TNO report[1]), Industry statistics and public domain inventory information (for example the USEPA[3], UNECE and EMEP/Corinair[4] emission factor database). This information combined with that taken from DUKES allows the NAEI to calculate total PM_{10} emissions for sectors which do not report PM_{10} emissions to a regulatory authority.

2.2 SUB-PM_{10} PARTICULATE FRACTIONS

Sub-PM_{10} particulate emissions are not reported by process operators at present. The NAEI applies 'size speciation profiles' to the PM_{10} inventory to calculate the smaller size fractions - $PM_{2.5}$, $PM_{1.0}$ and $PM_{0.1}$. The profiles are derived from a variety of sources including TNO and USEPA.

* Emission factor – A quantitative measure to describe the amount of pollutant produced by weight, from an activity statistic – for example the amount of fuel consumed.
** Activity statistics – A quantitative measure of production or other activity (for example fuel consumption)

3 Methodology

The annual review of NAEI data identified the need to understand and control the uncertainty in the emission factors and speciation profiles used PM for industrial processes. A desk-based study was undertaken to collate and review PM data and background information. Two parallel activities were undertaken :

(i) The emission factors used in the 2002 NAEI were reviewed against any updates of the referenced work from TNO, USEPA or other sources for process and fugitive emissions. The profiles were also reviewed to determine whether the size speciation distribution applied by the NAEI is appropriate for the type of process and abatement technology used.

(ii) A risk-based review of each of the size distributions in the NAEI was undertaken to determine the most significant of the source sectors to total UK industrial and combustion emissions of PM_{10} , $PM_{2.5}$, $PM_{1.0}$, and $PM_{0.1}$. The most significant sectors identified in each size range were reviewed to identify new emission information.

The most significant PM emissions in the 2002 NAEI are summarised in Table 1.

Table 1 – Summary of 2002 NAEI PM_{10} and sub-PM_{10} industrial emissions

PM fraction Ranking	Sector description	2002 Inventory ktonnes
PM 10		
1	Power stations >300MW – Coal	7.849
2	***Other Industry – Part B process – Non fuel***	4.551
3	Other Industry – Combustion of coal	3.751
4	Brick Manufacture – Non-Fletton	2.345
5	Iron and Steel - Sinter plant	2.140
6	Power stations >300MW – Natural gas	1.516
-	Cement, Clinker production	1.376
PM 2.5		
1	Power stations >300MW – Coal	3.453
2	Other Industry – Combustion – Coal	2.664
3	***Other Industry – Part B process – Non fuel***	2.276
4	Other Industry – Combustion – Natural Gas	1. 684
5	Iron and Steel sintering – Iron Production	1.605
6	Power stations >300MW – Natural Gas	1.516
-	Cement, Clinker production	0.743
PM 1.0		
1	***Other Industry – Part B process – Non fuel***	2.276
2	Other Industry – Combustion – Natural Gas	1. 684
3	Power stations >300MW – Natural Gas	1.510
4	Power stations >300MW – Coal	1.490
5	Brick Manufacture – Non-Fletton	1.384
6	Other Industry – combustion of coal	1.088
-	Cement, Clinker production	0.303
PM 0.1		
1	Other Industry – Combustion – Natural Gas	0.842
2	Power stations >300MW – Natural Gas	0.758
3	Iron and Steel sintering – Iron Prod.	0.728
4	***Other Industry – Part B process – Non fuel***	0.682
5	Brick Manufacture – Non-Fletton	0.680
6	Power stations >300MW – Coal	0.628
-	Cement, Clinker production	0.138

Table 1 shows that the ***Other industry part b processes*** is a significant source in all four size fractions and consequently a candidate for detailed review under this Task. However, due to the wide variety of the processes covered by this heading it has not been possible to conduct further investigation. Hence, the sixth highest UK emission for each PM fraction has been included in the review and the manufacture of cement clinker was also included as a significant source of PM.

Note that the ***Other industry part b processes*** classification in the 2002 NAEI differs from the 2001 NAEI. In the 2001 NAEI this sector was encompassed under the title 'Wood, Paper, pulp and food- Part B process – Non fuel'. It is not clear whether this is a simple case of renaming or, if the sector has been realigned to include other industrial types.

4 Review of key source sectors

4.1 OVERVIEW

This section of the report details the main findings of the research carried out. This has been broken down into key industrial sector. However, a further section discusses some of the issues in defining what constitutes PM_{10} (and sub-PM_{10}) emissions from an industrial or combustion process.

The sector "Other Industry – Part B process – Non fuel" is a composite of many different processes and could not be adequately examined within the scope of this task. A calculator approach (as adopted to estimate emissions from small combustion plant in Task 8a of the project) may be appropriate for this source sector.

Analysis of the most significant industrial emitters of PM_{10} and sub-PM_{10} indicates several common sectors within each pollutant category. These sectors include :

- 'Coal combustion,' and 'Natural gas combustion' for power generation public utility power stations or other industry subsectors,
- 'Iron and steel sintering plants',
- 'manufacture of non-fletton bricks'

Each of these sectors and the manufacture of cement clinker were reviewed.

It has been noted that for many sources, the reference documents generally refer to the USEPA publication AP42 for sources of raw data (often via several other references). While AP42 is a valued reference, it is important to note that, within a number of sections, emission data have not been updated for many years. This is particularly relevant to PM size speciation profiles some of which, despite advances in abatement technology, have not been updated for over a decade.

4.2 PM_{10} EMISSIONS FROM INDUSTRIAL SOURCES

The review of industrial emissions of PM_{10} has highlighted several issues including the fundamental question of what is PM_{10} when emitted from a process. In general, the NAEI includes emission estimates based on a 'filterable' PM_{10} release. However, the emission factors within the NAEI for natural gas combustion assessed in this Task also include a 'condensable' fraction.

The US Environmental Protection Agency (USEPA) defines two fractions to a PM_{10} emission from an industrial or combustion source. The filterable PM_{10} fraction in a stack emission can be determined using USEPA Method 201A and is essentially material which is smaller than nominally 10µm (separated from larger PM using a miniature cyclone) and which can be retained by a filter at stack temperature. Condensable PM is also considered to be PM_{10} and is material collected downstream of the sampling filter from probe rinses and material collected within a chilled impinger train (USEPA Method 202).

The test procedure for condensable PM (Method 202) is an official USEPA test procedure and emission inventories in the US are required to consider both filterable PM_{10} and the condensable PM_{10} emissions. However, the test method has been subject to considerable

debate concerning whether it provides data representative of condensable emissions. It is intended to replicate secondary formation of particulate by condensation downstream of the stack. However, although the sampling procedure lowers the temperature of the sampled gases, there is no concurrent dilution action. Interferent effects are also possible. Limited evidence from dilution tunnel experiments suggests that Method 202 may overestimate condensable emissions.

The NAEI incorporates PM_{10} data reported by process operators to the regulatory authorities. The regulatory authorities require operators of selected processes to report PM_{10} emissions for inclusion in the Pollution Inventory (or EPER) above a threshold of 10 tonnes per year. This information is then incorporated into the NAEI. The methodologies adopted by process operators for estimating PM_{10} emissions includes a mixture of direct measurements, emission factors, or factors applied to a total particulate emission.

The protocol for Inventory reporting adopted by the Electricity Supply Industry Joint Environment Programme (JEP) is typical in that it applies a PM_{10} factor to the total particulate emission. The JEP protocol states that the ESI total particulate emission data for coal-fired stations are based on continuous monitoring systems. These systems do not monitor the condensable fraction. Similarly other operators may base emissions data on short-term measurements of particulate emission which almost certainly do not include assessment of the condensable fraction. Conversely, other operators may include condensable material in their reports through use of USEPA default emission factors for their process.

The scale of these inconsistencies and their impact on the NAEI is unknown. The consistency of PI/EPER reporting by process operators will be addressed in time by various initiatives including guidance from the regulatory authorities or operator initiatives such as the JEP protocol.

Hence, methodology issues result in inconsistencies in the treatment of PM_{10} within the NAEI. This Task has sought to address these for the processes assessed. The bulk of existing PM_{10} emission data in the NAEI are for 'filterable' PM_{10} and hence, to ensure consistency within the NAEI, only filterable PM_{10} data should be considered. Default PM_{10} and other PM_{10} emission factors used in the NAEI for industrial and combustion sources should be reviewed to determine if any include a condensable component.

4.3 MANUFACTURE OF NON-FLETTON BRICKS

The Brick manufacture industry, involves taking raw materials, usually clay or shale, and then processing them for desired additional qualities and standards before firing the end product in a kiln. Particulate can be produced at several stages during the handling, transporting and processing of these materials, including the substantial potential particulate that can be produced during the firing stage.

Annual Emissions from the processes are not currently reported to the Environment Agency Pollution Inventory. The 2002 NAEI PM_{10} emission is calculated from estimates of UK non-fletton brick production data and an emission factor sourced from USEPA data. A review of the USEPA emission factors was undertaken and indicates that a 'worst case' factor has been applied but **netcen** considers that a more appropriate PM_{10} factor can be derived (see Table 2).

Table 2 – Comparison of NAEI and proposed emission factors for non-Fletton brick manufacture

Activity	Emission factor, ktonne PM_{10} /ktonne bricks	
	NAEI 2002	Proposed
Primary crusher with fabric filter	-	0.000000263
Processing dry material - uncontrolled	0.000257	-
Processing dry material with fabric filter	-	0.00000143
Extrusion line with fabric filter	-	0.00000161
Natural gas-fired kiln : Filterable PM_{10}	0.000125	0.000125
Total	**0.000382**	**0.000128**

The 2002 NAEI size speciation profile is based on kiln emissions and also derived from USEPA data but no new data could be identified and consequently the size speciation profile has not been modified. However, the sub-PM_{10} fractions would be reduced if the proposed PM_{10} emission factor were to be adopted (Table 3).

Current emissions figures listed for manufacture of non-fletton bricks in the NAEI database have been taken from the USEPA publication AP42, section 11.3-3 (August 1997). The emission figures together with the speciation profile (also taken from AP42) are further displayed in Table 7.3 below.

Table 3 – Sub-PM_{10} emissions for non-Fletton brick manufacture

Particulate Fraction	Speciation profile	UK Emissions (Kilotonnes)	
		NAEI 2002 emission data	Revised 2002 emission
PM_{10}	100%	2.345	0.851
$PM_{2.5}$	64%	1.501	0.545
$PM_{1.0}$	59%	1.384	0.502
$PM_{0.1}$	29%	0.680	0.238

There is lack of emission information for this industry sector and **netcen** recommends that measurements be undertaken to develop more robust size speciation data.

4.4 MANUFACTURE OF CEMENT CLINKER

The manufacture of Portland cement, involves heating raw material in a coal-fired kiln at temperatures up to 1500°C. A range of alternative fuels including tyres and recovered liquid fuels are also used by operators to displace use of coal.

The PM_{10} emission data currently quoted in the NAEI are sourced from the operators' estimates (for example the information in the EA Pollution Inventory). The sub-PM_{10} inventories are based on particle size data derived from US EPA publication AP 42, section 11.6 dated January 1995.

The size speciation profile is considered to be still the most appropriate for the NAEI. However, the particle size data are limited (the data are only for PM_{10} and $PM_{2.5}$.) The smaller PM fractions ($PM_{1.0}$ and $PM_{0.1}$) have been extrapolated from the USEPA PM_{10} and $PM_{2.5}$ data for kiln emissions.

In the absence of other data no change is proposed to the 2002 NAEI figures. However, apart from PM_{10} there is a lack of recent data for this industry sector and **netcen** recommends that measurements be undertaken to develop more robust size speciation data.

4.5 COMBUSTION OF COAL

Table 1 indicates that the combustion of coal is one of the major industrial sources of particulates across several size ranges and within two source sectors, Power stations and other industry.

Particulate emissions from combustion of coal at large combustion plant have been regulated for many years. Major combustion installations provide estimates of annual PM_{10} emissions to the UK regulatory authorities.

The Other Industry sector PM_{10} emission estimates for the 2002 NAEI are based on a USEPA emission factor for stoker-fired boilers. This factor is considered to have a high uncertainty for this broad sector which includes a wide range of combustion technologies and plant size. However, the PM_{10} factor has not been considered in this task as it is addressed elsewhere in this project (in Task 8a – the combustion calculator).

The current sub-PM_{10} emissions data used in the NAEI are derived from a speciation profile from the USEPA publication AP42. This provides a speciation profile for the $PM_{10,}$ $PM_{2.5}$ and $PM_{1.0}$ species for the combustion of coal using ESP (electrostatic precipitators) as abatement technology. Almost all major UK coal-fired power stations have ESPs for particulate abatement, two stations also have Flue Gas Desulphurisation scrubbers and one station (currently in receivership) has fabric filters. Other Industry sources include a range of abatement techniques however. In the absence of other data the NAEI speciation profile is based on the same USEPA data as for power stations.

The fraction of $PM_{0.1}$ has been extrapolated from the USEPA speciation profile. No newer or more relevant data were obtained consequently no change is proposed for the speciation data used by the NAEI database.

However, the USEPA speciation profiles are dated, are for non-uk plant (and fuel) and, there is no imminent requirement for plant operators to determine sub-PM_{10} particle sizes. Consequently, it is recommended that measurements are undertaken to obtain more appropriate data and assess the uncertainty of emissions associated with these sectors.

4.6 IRON AND STEEL – SINTERING PLANTS

The manufacture of iron and steel is a complex process requiring several key operations in succession to produce an end product. Sinter production is one of the key stages in this process. Iron ore, coke, limestone, mill scale and flue dust are mixed and roasted and ignited under gas burners to produce ‘sinter’. This product is then passed to the blast furnace. Flue gases are passed through an electrostatic precipitator to remove PM before being released to atmosphere.

The PM_{10} emissions data in the NAEI database have been compiled from operators’ data (information supplied to the Pollution Inventory) and are updated annually. The sub-PM_{10} size fractions are derived by applying a speciation profile to the PM_{10} data. The

speciation profile is from the USEPA AP-42 data but refers to data published in October 1986.

A more recent speciation profile has been sourced from the European IPPC bureau Best Available Technology Reference Note (BREF) for Iron and Steel production[5]. Table 4 compares the 2002 NAEI data and speciation profile with the proposed speciation profile and revised emission.

Table 4 - Speciation profiles and UK emissions for sinter plants

NAEI speciation profile		NAEI 2002 UK Emissions, ktonne	Proposed speciation profile		Revised 2002 Emissions, ktonnes	% Change
PM_{10}	100%	2.140	PM_{10}	100%	2.140	0
$PM_{2.5}$	75%	1.605	$PM_{2.5}$	84%	1.798	+12
$PM_{1.0}$	50%	1.070	$PM_{1.0}$	66%	1.412	+32
$PM_{0.1}$	34%	0.728	$PM_{0.1}$	9%	0.193	-74

4.7 COMBUSTION OF NATURAL GAS

Natural gas is a key fuel for industry and power generation. The combustion of natural gas appears in the highest five emitters of particulates for several PM fractions. This is perhaps surprising given the inherent low potential for particulate emission from combustion of refined gas. The scale of gas use is increasing and the significance of the sector is increasing as other sources decline. The emission of PM from combustion of natural gas is also significant for the 'other industry' sector.

At present, the UK Electricity Supply Industry JEP inventory reporting protocol reports PM_{10} emissions from gas combustion as zero or operators report emissions below the reporting threshold (10 tonnes per year). However, the NAEI estimates UK emissions of PM_{10} from combustion of natural gas using emission factors and activity statistics.

For the electricity supply industry the NAEI default emission factor is currently **154 kg/Mtherm** however, the source of this factor is unclear. The default factor is about half the USEPA emission factor for total PM (filterable and condensable PM) which is currently used for the 'other industry' and other gas combustion sectors within the NAEI (**338 kg/Mtherm**).

This review indicates that the USEPA emission factor for filterable PM from combustion of natural gas (**84 kg/Mtherm**) should be used by the NAEI in all sectors. Measurement of filterable PM_{10} at a power station combined cycle gas turbine for Defra and a smaller gas turbine for the EA and, data for gas combustion published by EMEP, indicate PM_{10} emission factors of similar order to the default USEPA factor. However, it should be noted that these emission measurements are likely to have a high uncertainty.

The proposed emission factor is approximately half that of the current 'default' factor used for electricity generation but is traceable and is consistent with PM_{10} emissions from combustion in other areas of the NAEI (that is it is consistent with the definition of PM_{10} from other sources reported to the Pollution Inventory).

The USEPA states that the particulate produced by combustion of natural gas is assumed to be the same for **all** natural gas combustion and is effectively $PM_{1.0}$. Therefore the value for $PM_{10,}$ $PM_{2.5}$ and $PM_{1.0}$ will be the same. The USEPA data does not include speciation data for the $PM_{0.1}$ fraction. Currently within the NAEI 2002 database, the $PM_{0.1}$ fraction is

half the value stated for $PM_{1.0}$. No new information has been found to justify modifying the speciation profile for gas combustion.

Table 5 – Gas combustion PM emissions

PM size fraction		Power station, emissions ktonnes		% Change	Other Industry emission, ktonnes		% Change
		NAEI 2002	Proposed 2002		NAEI 2002	Proposed 2002	
$_{PM10}$, $PM_{2.5}$ $PM_{1.0}$	100%	1.516	0.826	-46	1.684	0.434	-74
$PM_{0.1}$	50%	0.758	0.413	-46	0.842	0.217	-74

There is lack of data for gas combustion and available data indicate comparatively high emissions of PM_{10} from gas combustion. **netcen** recommends that measurements be undertaken to develop more robust PM_{10} and size speciation data for gas combustion.

5 Recommendations

This Task has provided a thorough examination of the PM_{10} and sub-PM_{10} fractions emissions data in the NAEI for the most significant industrial and combustion sources. The task has proposed some changes to the NAEI, highlighted some issues and areas for further development.

Definition of PM_{10} : methodology issues result in inconsistencies in the treatment of PM_{10} within the current NAEI. This Task has sought to address these for the processes assessed. To ensure consistency within the NAEI, only filterable PM_{10} data should be considered. Default PM_{10} and other PM_{10} emission factors used in the NAEI for industrial and combustion sources should be reviewed to determine if any include a condensable component.

Non-Fletton bricks: A revision to the emission factor used for PM_{10} is recommended. The report also recommends measurements to develop more robust size speciation data for this sector.

Manufacture of Cement Clinker: This report recommends no change to the current NAEI information. However, the size speciation data are dated and measurements are recommended to develop more robust speciation data for the sector.

Combustion of coal: This Task proposes no change to the current PM_{10} data emission data for power stations and, PM_{10} emissions from Other Industry are addressed elsewhere in the project. However the USEPA speciation profiles used by the NAEI to develop sub-PM_{10} inventories are dated and are for non-uk plant (and fuel). Consequently, it is recommended that measurements are undertaken to obtain more appropriate data and assess the uncertainty of emissions associated with these sectors.

Iron and steel sintering: The PM_{10} data used by the NAEI is taken from the Environment Agency Pollution Inventory and is considered to be the most appropriate data. However, a new sub-PM_{10} speciation profile is proposed based on more recent European emission data.

Combustion of natural gas: The current NAEI default PM_{10} emission factors for gas combustion should be modified to represent 'filterable' PM_{10} and hence maintain consistency with other sectors within the NAEI PM_{10} inventory.

6 References

1. Particulate Matter Emissions PM_{10} , $PM_{2.5}$, $PM_{0.1}$ in Europe in 1990 & 1993. Feb. 1997. TNO Institute of Environmental Sciences. TNO report MEP-R96/472.

2. Digest of UK Energy Statistics (DUKES)

3. Compilation of Emission Factors, Report AP-42 vol 1 US Environmental Protection Agency (USEPA)

4. Compilation of emission factors, EMEP Corinair

5. Best Available Techniques Reference Note (BREF) for Iron and Steel Production. European IPPC Bureau 2000

Annex 1 : Glossary of terms

Emission factor – A quantitative measure to relate the amount of pollutant produced by weight, from a process activity (for example the fuel consumed).

Activity rate – A quantitative measure of production or other activity (for example how much fuel is consumed).

PM_{10} Particulate matter that is nominally less than 10 microns in diameter.

$PM_{2.5}$, $PM_{1.0}$ and $PM_{0.1}$ particulate matter with diameters equal to, or smaller than 2.5 microns, 1.0 micron and 0.1 micron.

Speciation profile - the size distribution of particulate species – in the NAEI this is as a percentage of the PM_{10} value

Filterable PM - This is particulate matter retained on a filter at stack temperature (or other defined temperature).

Condensable PM - This is considered to be part of the total PM_{10} emission according to the USEPA and is material which is collected within a chilled collection system downstream of a filter.

Primary PM - This is particulate matter when it is emitted from the pollution source

Secondary PM - This is particulate matter that is formed from physical or chemical interactions after emission from the pollution source.