AEAT\EEQC-0025 Issue 2

Development of UK NMVOC Point Source Data

A report produced for DETR

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Contents

1 Introduction

This report describes work that has been carried out over the period 1997-1999 as part of the DETR research programme 'Emission Factors and Cost Curves for Air Pollutants' (EPG 1/3/134). This has enabled a significant improvement of the spatial disaggregation of emissions of non methane volatile organic compounds (NMVOC) in the National Atmospheric Emissions Inventory (NAEI).

Earlier work, reported in 1997 (Passant, Emmott & Wenborn, 1997), had investigated various methods for disaggregating industrial VOC emissions and had then used these methods to disaggregate emissions by region of the UK (i.e. counties in England and Wales, regions in Scotland, with Northern Ireland treated as a unit). Although, this earlier work represented a significant improvement in the spatial disaggregation of VOC emissions from industrial processes, further detail was needed. In particular, few large point sources could be identified and so the regional inventory did not include any information on the exact location of any emissions, merely identifying the region in which they occurred.

Early mapping of VOCs therefore only included detailed disaggregation of road transport emissions, together with a few well-quantified sources such as refineries and power stations. Most industrial sources were treated as area sources and dissagregated using surrogate statistics such as population, fuel usage, or employee numbers.

The work programme described in this report had the objective of developing point source data for larger industrial processes. As a starting point the data shown in Table 1, taken from the earlier report, were examined. These data consisted of estimates of the numbers of processes of each type, from which an average emission per plant in 1988 had been calculated. Although these average figures were expected to be fairly crude, they did provide a means for prioritising those sources for which point source data should be sought. Accordingly, data have now been developed for all of the sectors that were estimated to have an average emission per plant of more than 50 tonnes with the exception of petrol distribution stage 1A. In addition, the rubber processes sector has been split into tyre manufacture and general rubber goods as follows:

Sector	No of processes	Total emission	Emission per process
tyre manufacture	13	3.4 ktonnes	262 tonnes
general rubber	187	5.9 ktonnes	32 tonnes

Tyre manufacture was therefore added to the list of processes for which point source data were sought. This gave an estimated total of 1045 processes for which emissions data were required. Point source data for some of these large sources had already been developed as a result of research carried out under the DETR funded NAEI programme of work and so no further work was necessary. The following sectors describe how emissions data were obtained for the remaining sources.

Table 1. Average NMVOC emission per plant in 1988

Process type	Emission kt	Sources	Average Emission/t
Crude oil terminal (onshore)	72.9	5	15000
Oil refining	100	11	9100
Seed oil extraction	10	5	2000
Car manufacture	24	20	1200
Textile coating	16.3	18	910
Gravure publication printing	3	5	600
Film coating	28.9	50	580
Chemicals manufacture	152	340	450
Whisky manufacture	41.8	114	370
Petrol distribution: stage 1A	46	132	350
Coil coating	3.2	10	320
Gravure non-publication printing	9.9	47	210
Coating of metal packaging	15	75	200
Flexographic printing	13.8	88	160
Waste incineration	3.2	32	100
Leather coating	2.3	30	77
Electricity generation	2.7	50	54
Coatings manufacture	9.7	200	49
Wood preservation	21.6	456	47
Rubber goods manufacture	9.4	200	47
Breweries	2.2	107	21
Wood coating	14	834	17
Iron & steel rolling mills	3.2	259	12
Adhesives & sealants use	49.9	4000	12
Heat set web offset printing	1.1	95	12
Bread baking	9.2	1100	8.4
Petrol distribution – Stage 1B & 2	82	18550	4.4
General industrial coating	36.9	12000	3.1
Screen printing	4.5	1750	2.6
Metal cleaning	83	35000	2.4
Vehicle refinishing	22	10800	2.0
Dry cleaning	11.3	6000	1.9
Sheetfed offset printing	2.7	1500	1.8
Other food industry	20	12500	1.6
Cold set web offset printing	0.2	125	1.6
Landfill	10	12000	0.8
Industrial combustion plant	21	45000	0.5

2 Derivation of emission estimates

2.1 TRADE ASSOCIATIONS

In a number of cases, the industry's trade association has provided information on the emissions from each process. Trade associations that have either provided emission estimates or emission factors include:

- European Coil Coaters Association
- United Kingdom Offshore Operators Association (UKPIA)
- United Kingdom Petroleum Industry Association (UKOOA)

2.2 COMPANY ENVIRONMENTAL REPORTS

In a small number of cases, emissions data for particular sites was available from company environmental reports.

2.3 LOCAL AUTHORITIES & SEPA

Local authorities were approached and data on processes of interest were obtained. Information on the Part B processes authorised by most of the English and Welsh local authorities was available from the DETR in the form of a survey of processes by PG note (AQ4 (97)). This survey did not contain any processes in the case of forty-two councils, and so these councils were contacted in order to obtain information on what processes they authorised. The Scottish Environmental Protection Agency (SEPA) supplied lists of Part B processes in Scotland, although there were possibly some gaps in this record. In total, some 185 local authorities and various parts of SEPA were contacted.

Once a near complete record of Part B processes was available, emissions data were obtained from the regulating authorities either by way of visits to the premises or by telephone.

2.4 CHEMICAL RELEASE INVENTORY

The emissions data provided in the Chemical Release Inventory and Pollution Inventory have been used for the chemicals industry and for those petroleum processes that are not included in the data provided by UKPIA and UKOOA. The latter are referred to in the inventory as 'other petroleum processes'

2.5 LOCAL INVENTORY STUDIES

The local inventory studies carried out by the London Research Centre and RSK Environmental have included the gathering of emissions data for Part B processes in many metropolitan areas including:

- West Midlands
- Greater Manchester

- Merseyside
- West Yorkshire
- Bristol
- Southampton/Portsmouth
- Newcastle
- Middlesborough
- Glasgow

Information from some of the local studies has already been made available for use in the NAEI and a complete set of emissions data are currently being prepared by RSK Environmental.

2.6 NATIONAL EMISSION ESTIMATES

In the case of whisky manufacture, no emissions data are available for individual processes, although some information has been found on the location of manufacturing sites. In this case, the national emission estimate has been divided equally between each of the sites.

3 Results

3.1 CRUDE OIL TERMINALS

Emission estimates for crude oil terminals are supplied by the United Kingdom Offshore Operators Association (UKOOA), directly for use in the NAEI. There are ten sites listed in the UKOOA data, and the total emission from these sites is 98,133 tonnes. The average emission is therefore 9,813 tonnes, although two of the sites emit less than 50 tonnes of NMVOC.

3.2 OIL REFINERIES

There were eleven oil refineries in the UK up until the end of 1997 when one refinery ceased operation. The United Kingdom Petroleum Industry Association (UKPIA) has provided emission estimates for each UK oil refinery during 1997. Data for 1998 have been obtained from the Pollution Inventory in the case of eight refineries and UKPIA have supplied data for the other two. Total emissions from the sector in 1997 were 71,000 tonnes and emissions in 1998 were 62,975 tonnes. The average emission in 1997 was therefore 6298 tonnes and all sites emitted more than 50 tonnes.

3.3 SEED OIL EXTRACTION/EXTRACTION FROM VEGETABLE MATTER

Data on seed oil extraction plant was obtained from local authorities during 1997 although some earlier data from councils and process operators, obtained in 1995, also proved useful. AQ4 (97) listed 27 processes in 15 local authority areas that fell within the scope of PG 6/25 'Vegetable oil and fat and oil refining'. A further 4 were found in 3 local authorities not covered by AQ4 (97) together with one in Scotland making 32 in total. No seed oil extraction plants are known of in Northern Ireland. Most of the processes were oil and fat refining and involved no solvent. In total, one site was found that extracted seed oil without solvent and nine processes were found that used solvents either for seed oil extraction or for extraction of oils and flavourings from vegetable matter (5 processes were involved in large scale extraction of oil from oil seeds). Six sites emitted more than fifty tonnes. The total emission from the nine sites was 3143 tonnes in 1996, giving an average emission per site of 349 tonnes. The average emission from the seed oil extraction sites alone was 603 tonnes.

3.4 CAR MANUFACTURE

Data on car manufacturing processes was obtained from local authorities during 1998. Twenty-six processes, authorised by 17 local authorities were listed in AQ4 (97). A further 5 processes were found in 4 local authorities not covered by AQ4 (97). No car manufacturers are known in Scotland or Northern Ireland.

Following investigation, 21 processes in total were confirmed as vehicle manufacturing, with emissions data being collected for all. The total emission in 1997 was 14,659 tonnes. Of the 21 sites, 18 emitted more than fifty tonnes in 1997 and the average emission per site was 698 tonnes.

3.5 TEXTILE COATING

Textile coating processes were investigated during 1997. The DETR survey, AQ4 (97) lists 59 processes in 38 councils, to which were added 10 more in six other English local authority areas and 7 in Scotland making a total of 76 possible sites. Following further investigation involving contacting local authorities however, a total of 78 processes were located. There are also a number of textile coaters in Northern Ireland but the numbers, although likely to be small, are uncertain.

Emissions data were collected for 73 of the processes and the total emission in 1996 was 9494 tonnes, an average of 130 tonnes. However, despite this relatively high average emission, only 30 of the processes had emissions of greater than 50 tonnes. This is because many processes used little or no solvent. Assuming that the five remaining processes have average emissions (i.e. 130 tonnes) would suggest that the total emission for the sector was 10144 tonnes.

3.6 PUBLICATION GRAVURE

Publication gravure processes were investigated during 1999. Following discussions with the printing industry, it was confirmed that there are four processes operating in the UK. The regulating authorities were approached and emissions data collected. The total emission from the sector was 854 tonnes with three of the four sites emitting more than 50 tonnes. The average emission was 214 tonnes.

3.7 FILM COATING

Film coating processes were investigated during 1997. The DETR survey, AQ4 (97) listed 24 processes in 20 councils, to which were added 3 more in two other English local authority areas and 4 in Scotland making a total of 27 possible sites. In the event, following contacts made with local authorities, a total of 30 processes were located. No film coating processes are known in Northern Ireland.

Emissions data were collected for 29 of the processes and the total emission in 1996 was 14515 tonnes, an average of 501 tonnes. Of the 29 processes, 19 had emissions of greater than 50 tonnes. Emissions from the one process for which data were not collected were commercial-in-confidence and no allowance has been made for this process in the inventory.

3.8 CHEMICALS MANUFACTURE

Emissions data for chemicals manufacturing plant are available for England and Wales in the Pollution Inventory (PI) and, before that, in the Chemical Release Inventory (CRI). Data for

Scotland have been obtained from a number of sources including Company Environmental reports and from SEPA. Data from one Northern Ireland site have been taken from the company environmental report. A modifying factor has been applied for processes where it is suspected that reported data do not include fugitive emissions. The derivation of this modifying factor has been described elsewhere (Passant & Lymberidi, 1998). The CRI/PI data are all assumed to exclude fugitive emissions.

Emissions data have been collected for a total of 445 sites and the total emission from these sites in 1997 was 111,139 tonnes. The average emission is 250 tonnes and 80 sites have emissions of greater than 50 tonnes.

3.9 SPIRIT MANUFACTURE AND STORAGE

The manufacture and storage of whisky is an example of an industry that is concentrated in particular regions of the UK. During 1995, information was obtained from UK Customs and Excise on sites which were authorised to store goods on which excise duty was payable. The general nature of the goods stored was given. From this listing, sites that were involved in the storage of whisky were tentatively identified. Whisky distilleries, where spirit is manufactured prior to storage could be identified with far greater confidence and these were separated into distilleries manufacturing malt whisky and those manufacturing grain whisky. No activity statistics have been found for the distilleries and storage facilities and so the national emissions from whisky manufacture and storage have been divided equally over the relevant sites.

As an example, the emissions per site in 1997 were calculated to be as follows:

Malt whisky distillery	35 tonnes
Grain whisky distillery	762 tonnes
Other spirits distillery	203 tonnes
Whisky warehouse	361 tonnes

3.10 PETROL DISTRIBUTION STAGE 1A

To date, only an incomplete list of locations of large petrol terminals is available. These terminals are now subject to Local Air Pollution Control (LAPC) and so details of terminals could be obtained by contacting each local authority. However, a survey of local authorities would be needed in order to identify which authorities authorised processes.

3.11 COIL COATING

The European Coil Coaters Association have provided estimates of the capacity of coating lines in the UK. Using these estimates it is possible to disaggregate the UK emission estimate for coil coating processes. The total emission is estimated at 342 tonnes, an average emission of 49 tonnes at the seven sites. Only two of the sites emit more than 50 tonnes.

3.12 NON PUBLICATION GRAVURE AND FLEXOGRAPHIC PRINTWORKS

Non-publication gravure and flexographic printworks were investigated during 1999. The DETR survey of Part B processes suggested that there were 97 processes in 70 local authorities. An additional 15 processes in 11 English or Welsh authorities and 11 in Scotland were found making a total of 123 possible sites. No sites are known in Northern Ireland. Following investigation, a total of 121 sites were identified and emissions data collected for 106. The total emission from these 106 sites was 25,766 tonnes, an average emission of 243 tonnes. Assuming the same average emission at the remaining 15 sites suggests that the total emission from the sector was 29,413 tonnes. More than 50 tonnes of solvent was emitted at 59 sites.

3.13 COATING OF METAL PACKAGING

Metal packaging coating processes were investigated during 1997. The DETR survey, AQ4 (97) lists 40 processes in 36 councils, to which were added 3 more in three other English local authority areas and 3 in Scotland making a total of 46 possible sites. There are no metal packaging coaters in Northern Ireland. Following further investigation involving contacting local authorities, a total of 41 processes were located.

Emissions data were collected for 40 of the processes and the total emission in 1996 was 12544 tonnes, an average emission of 314 tonnes. A total of 27 sites emitted more than 50 tonnes.

3.14 WASTE INCINERATION

Point source data for municipal waste incinerators have been developed within the NAEI research programme and no further detail of the methods used are given.

In 1997 there were 8 sites. The total emission was 58 tonnes and the average emission was 7 tonnes. None of the sites emit more than 50 tonnes of NMVOC.

3.15 LEATHER COATING

Leather coating processes were investigated during 1997. The DETR survey, AQ4 (97) lists 21 processes in 13 councils, to which were added 2 in Scotland making a total of 23 possible sites. No leather coating processes are known in Northern Ireland.

Following further investigation involving contacting local authorities, a total of 18 processes were located. Emissions data were collected for 16 of the processes and the total emission in 1996 was 740 tonnes, giving a mean emission of 46 tonnes. Just four of the processes had emissions exceeding fifty tonnes. Assuming that the two remaining processes have average emissions (i.e. 46 tonnes) would suggest that the total emission for the sector was 832 tonnes.

3.16 ELECTRICITY GENERATION

Point source data for electricity generators have been developed within the NAEI research programme and no further details of the methods used are given.

Emissions data are available for 53 sites. The total emission is 7299 tonnes, equivalent to an average emission of 138 tonnes per site. Thirty-seven of the sites emit more than 50 tonnes of NMVOC per year.

3.17 TYRE MANUFACTURE

Tyre manufacturers were researched during 1999. A total of 12 sites are known including one in Northern Ireland. Following investigations, emissions data were obtained from 8 sites which had a total emission of 1515 tonnes. The average emission was 189 tonnes and 6 sites emitted more than 50 tonnes of solvent. Assuming that the remaining 4 sites have the same average emission, then the total emission from the sector can be calculated to be 2272 tonnes.

4 Summary

As a result of this research, information is available on a large number of point sources. This is summarised in Table 2. Point source data has also been developed as part of the DETR funded NAEI project, including for oil terminals, electricity generators and waste incinerators. It should be noted that the number of sites found in some sectors differ significantly from the number estimated in 1997 and used to prioritise sectors for spatial disaggregation (see Table 1). A good example of this is the metal packaging industry where only 41 sites were found compared with an estimate of 75 sites. Despite differences such as these, the author is confident that the work has identified all or almost all sites in each process type.

Table 2. Results of investigation of VOC point sources

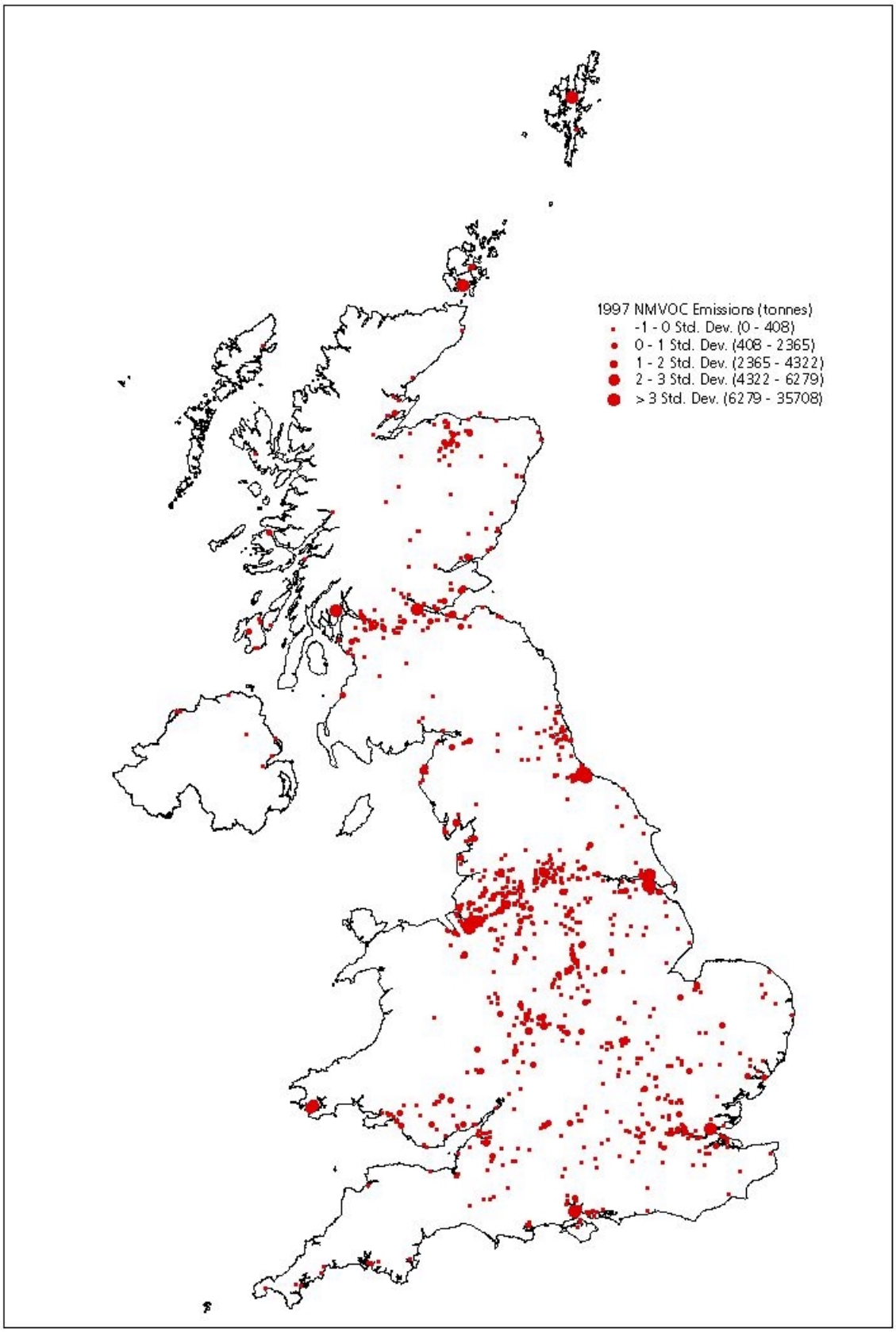
Process type	No of sites	Data collected for
Oil refining	11	11
Seed oil extraction	6	6
Other solvent extraction	4	4
Car manufacture	21	21
Textile coating	78	73
Gravure publication printing	4	4
Film coating	30	29
Chemicals manufacture	445	445
Spirit manufacture/storage	146	146
Petrol distribution: stage 1A	-	-
Coil coating	7	7
Printing of flexible packaging	121	106
Coating of metal packaging	41	40
Leather coating	18	16
Tyre manufacture	12	8
Total	944	917

The total emission from the 917 sites where emissions data were obtained was 287,266 tonnes, which is 23% of the total emission from stationary sources. The additional point source data developed by the NAEI research programme brings this total to 408,909 tonnes or 34% of the total stationary source emission. Of the remainder, some 16% is from domestic sources which can be adequately disaggregated using population, and 35% is from widely distributed activities such as small combustion plant, petrol stations, dry cleaning shops, bakeries, and general industrial cleaning and painting. This can be disaggregated with a reasonable degree of confidence using employment data. However, some of these sectors will include a small number of large point sources which, ideally, should be included in the inventory. Examples include pressure sensitive labels (a part of the adhesives coating sector) and some users of cleaning solvent. About 9% of the total stationary source emission is from offshore sites which, although not assigned to individual point sources, is disaggregated fairly accurately on the basis of the locations of offshore-facilities. The remaining 6% could be considered as coming from either large point sources, or at least a limited number of sites and might be considered for

further spatial disaggregation work. These emissions include those from paper coating, pet food manufacture and sugar production.

The point source data are shown pictorially in Figure 1. This shows that the point sources extend over all regions of the UK, although they are concentrated in areas of high population, such as the West Midlands and Merseyside. Greater London appears to have fewer processes than might be expected on the basis of population alone. Most of the largest point sources are located in estuaries: this reflects the fact that most of these large point sources are oil terminals or refineries and need access to the sea.

Figure 1 Emissions (tonnes) of NMVOC from UK point sources



5 Further work

Point source data are now available for a large number of industrial sites. This work has identified over nine hundred sites and emissions data for further sites, such as electricity generators and waste incineration plant, have been developed as part of the NAEI research programme.

Many thousands of other industrial sites emit NMVOCs. However it is likely that in most cases the emissions from individual sites will be small. However, a few industrial sectors may be characterised by large emissions of NMVOC from individual sites. These include:

- paper coating (processes covered by PG 6/18)
- pressure sensitive label manufacture
- food industry processes (sugar, pet-food)

These sectors are a priority for investigation should any development of new NMVOC point source data be carried out.

In addition, some individual sites within sectors that are generally characterised by small enterprises might merit inclusion in the point source database. For example, some sites where solvent cleaning is carried out may use considerable quantities of solvents, even though the sector generally consists of large numbers of processes using small quantities of solvent. However, there are difficulties in identifying such sites. Some sites can be identified simply because they have a high profile – they are major manufacturers for example. Other sites might be identified from the available local inventory data. It is not recommended however that a general survey be carried out of, for example, surface cleaning processes just to identify a few large point sources.

Emissions from each of the point sources already identified will change with time either due to changes in the level of industrial activity or changes in the way the process is operated. It will therefore be necessary to periodically update the emissions data. Some of the emissions data is available from the Pollution Inventory and can be readily updated. Other data had to be collected using more time consuming methods and for these sectors, the only reliable way to update the figures would be to repeat the data collection exercise. The major task would be repeating the collection of emissions data for solvent using processes authorised by local authorities. However, the effort necessary can be reduced by prioritising. For example, of the 316 processes for which data are available, only 170 emit more than 50 tonnes in 1997 and are responsible for 97% of the emissions from the whole set. It is recommended that emissions from the larger sites be checked on a periodic basis. The period between surveys would depend upon the likelihood of major changes in emissions e.g. the implementation of legislation controlling the sector, however it seems sensible to review emissions at least once every four years.

6 References

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