European Commission DG Environment

Assessment of the Implementation of the IPPC Directive Phase 3

Final Technical Report
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Document Revisions

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Executive Summary

Acknowledgements
We would like to express our thanks to all of the organisations and individuals that have contributed their time, expertise and information to this project. This includes representatives from IPPC installations, Member States, competent authorities, the European Commission and various other experts.

This study on the implementation of the IPPC Directive across European Member States is the third in a series seeking to understand in greater depth how Member States put into practice specific elements of the Directive with regard to individual permits issued to installations. The focus of this study was on the specific aspects of permit conditions, installation performance and application of BAT, notably in relation to the BAT-Associated Emission Levels (AELs) set out in the BREF documents and the relevant emission limits set out within the Sectoral Directives (Solvents Emissions Directive, Large Combustion Plant Directive and Waste Incineration Directive). The focus of this study was on implementation of the present IPPC Directive (2008/1/EC), not on the new Directive on industrial emissions (2010/75/EU).

The study comprised two key parts: the first a review of the formally adopted and draft BREF documents to extract relevant BAT-AELs for specific sectors and build a database that could be used by the study team, the Commission and other interested parties to quickly identify relevant BAT-AELs for specific pollutants, sectors and technologies. The second part of the study was an evaluation and assessment of 50 installations with associated site visits, the aims being to:

- Assess whether the permits have been issued in accordance with the requirements of the Directive;
- Determine whether conditions specified within permits are demonstrably based on BAT as set out in the relevant BREFs, including comparison of emission limits with the corresponding BAT-AELs; and
- Assess how competent authorities and operators are ensuring compliance with the limits and conditions set out within permits, including comparison of actual emissions with permit conditions and BAT-AELs.

In keeping with previous studies, the anonymous assessment reports for individual installations have been included in the report appendices to allow access to specific details on each case study.

Selection of the relevant case studies was made using an inclusive and transparent engagement process between the Commission, the consultants and Member State representatives. The focus of the selection was to generally include Member States and sectors that had not been examined as part of the two previous IPPC implementation studies.

The Member States that agreed to participate in this study were Belgium, Bulgaria, Denmark, Estonia, Finland, Hungary, Ireland, Portugal, Romania and Slovenia.
The sectors chosen for this study were gas and liquid-fired large combustion plants (activity 1.1), ferrous metal foundries (activity 2.4), manufacture of ceramic bricks and tiles (activity 3.5), incineration of hazardous and municipal wastes (activities 5.1 and 5.2) and surface treatment using solvents (activity 6.7).

The table below outlines the spread of permits examined in this study in terms of the above Member States and sectors.

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<tr>
<th></th>
<th>Belgium</th>
<th>Bulgaria</th>
<th>Denmark</th>
<th>Estonia</th>
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<th>Hungary</th>
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<th>Portugal</th>
<th>Romania</th>
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<td>Incineration of hazardous and</td>
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<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
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<td>municipal wastes (5.1 &amp; 5.2)</td>
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<td></td>
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<tr>
<td>Surface treatment using solvents (6.7)</td>
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<td>5</td>
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<td>50</td>
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**Summary of the Results**

The findings of this study, in common with the two previous implementation studies, show that the mechanisms to develop permit conditions and set main emission limit values vary amongst Member States and amongst sectors within some Member States. In reading the findings and main conclusions, the reader should make reference to specific details contained within the individual installation assessment reports.

The analysis of installation performance against permit ELVs, Sectoral Directive limits and BAT-AELs has been made in all cases based on annual average values. In addition, compliance rules set out in permits or elsewhere have not been taken into account. Therefore, the results of these comparisons are indicative and should not be interpreted as being conclusive on whether or not an installation is complying with its permit conditions, other relevant limits or has emissions below the upper end of the BAT-AEL range.

Where practicable, the detailed case studies do indicate where permit ELVs and/or BAT-AELs were exceeded based on the specific averaging periods that apply, rather than annual average values.

Of the 50 IPPC permits examined, 19 were issued between 2000 and 2005. 17 of the permits assessed were issued after 30 October 2007, which was the deadline for implementation of the IPPC Directive for existing installations. Of these, 4 were updates of existing IPPC permits, 11 were new permits for existing installations and 2 were new permits for new installations.
Inclusion of Emission Limit Values (ELVs) or Equivalent Parameters or Technical Measures or Reference to GBRs

In the majority of cases (30/50), permits were judged to contain emission limits, technical parameters or other measures for all of the main emission points and pollutants. In the other 20 permits, one of more ELV or equivalent measure had been omitted (based on main pollutants as defined by a BAT-AEL within the BREFs) although in some cases there was justification for the omission provided by the competent authority. In the 50 permits examined, significant use of alternative technical measures and equivalent parameters was not observed as it had been in previous IPPC implementation studies (for example in refineries). The graph below illustrates findings to the question of whether permits included ELVs for all main pollutants.

General Binding Rules (GBRs) were used in the setting of ELVs or other equivalent parameters in only 14 of the 50 permits. However, many permits make reference to common laws or rules that are used as a basis for the setting of one or more specific conditions in the permit. This is most notable for waste incineration and combustion plants, where national laws transposing the requirements and limit values laid down in the relevant Sectoral Directives are used to set ELVs in the permit.

Comparison of Permit Emission Limits against BAT-AELs

The graph below summarises the findings from the comparison of the emission limit values set in permits against the BAT AELs from the relevant BREFs.
Of the 9 installations that were judged to have all permit ELVs for the main pollutants set above the relevant BAT-AELs, 4 were LCPs, 2 were waste incineration plants, 2 were installations operating surface treatment with solvents and 1 was a ceramics manufacturing installation. Based on responses provided in the site interviews, the main reasons cited by authorities and/or operators for permit ELVs being set above the BAT-AEL ranges were:

- ELVs are based on national laws/decrees implementing the requirements of the relevant Sectoral Directives;
- The permit was developed prior to the formal adoption of the BREF and therefore BAT-AELs were not confirmed;
- BAT-AELs are not a legislative requirement, only a guide;
- ELVs have been set on the basis of technical characteristics or local environmental conditions.

Note that the three installations where it was concluded that there are no relevant BAT-AELs were shipyards covered by the Solvent Emissions Directive.

In 14 permits the ELVs set for the main pollutants were aligned with or stricter than the upper BAT-AEL value, where a relevant BAT-AEL existed. Of these 14 permits, 6 were in the foundry sector, while only one was in the LCP sector. By virtue of the closer alignment of the limits in the WI Directive with the BAT-AELs in the BREF on incineration of waste (compared to the LCP Directive and LCP BREF), WI permits typically had a greater number of ELVs in the permits set below the upper-end of the BAT-AEL ranges.

The graph below illustrates the number of permits for each sector where all ELVs were set below the upper end of BAT-AEL ranges (All), where some ELVs were but some were not (Mixed) and where all ELVs were above the BAT-AEL upper end values (None).

The above conclusions should be understood having regard to the fact that averaging periods expressed for ELVs are not, in some cases, aligned with those expressed for the BAT-AEL.
Interaction of Sectoral Directives and Permit ELVs

The requirements of the three Sectoral Directives (LCPD, WID and SED) applied in 30 of the 50 installations examined. 26 of the 30 permits contained conditions relating to emission limits or other equivalent measures that were judged to be consistent with the requirements of the relevant Sectoral Directive. In 4 permits, emission limits had been set less stringently than the minimum requirements or had not been set at all. 2 permits relating to shipyards had received formal derogations from the requirements to comply with the SED Annex IIA or Annex IIB requirements, which is provided for within the Directive. In 1 permit (a foundry) conditions in line with the requirements of the SED were not set. However, the operator had confirmed that a switch to water-based paint had taken place and the SED no longer applied at the installation. The findings relating to a comparison of permit ELVs to limits in the Sectoral Directives are summarised in the table overleaf:

Permit ELVs Compared to Limits in the Sectoral Directives

<table>
<thead>
<tr>
<th></th>
<th>Number of permits fully compliant with limits in Sectoral Directive</th>
<th>Number of permits not fully compliant with limits in Sectoral Directive</th>
<th>Number of permits where Sectoral Directives did not apply</th>
<th>Other</th>
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<td>LCP</td>
<td>7(Note 1)</td>
<td>1(Note 2)</td>
<td>1</td>
<td>1(Note 3)</td>
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<tr>
<td>Foundries</td>
<td>1 (SED)</td>
<td>1 (SED)</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Ceramics</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Waste Incineration</td>
<td>8(Note 4)</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Surface Treatment using Solvents</td>
<td>7(Note 5)</td>
<td>2(Note 6)</td>
<td>2(Note 7)</td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>23</strong></td>
<td><strong>4</strong></td>
<td><strong>20</strong></td>
<td><strong>3</strong></td>
</tr>
</tbody>
</table>

Note 1: Two installations set calculated ELVs (mixed-fuel firing) and one had less stringent ELVs until 2008 when ELVs were reduced in line with the LCP Directive and one adopted NERP provisions in LCP Directive.

Note 2: EE-01NOx ELVs set at 300 mg/m³ but mass limits covering entire installation also set.

Note 3: Installation regulated under NERP provisions.

Note 4: One permit did not contain an ELV for heavy metals in accordance with the requirements of the WI Directive.

Note 5: DK-05 using Annex IIB reduction scheme

Note 6: BE-05 fugitive VOC limit above SE Directive, EE-04 no total VOC limits, no fugitive VOC limits

Note 7: PT-06 and EE-05 received derogations from requirements of Annex IIA or Annex IIB due to uncontained conditions for treatment and coating activities

A clear finding from the study was that most of the LCP and WI permits set ELVs closely aligned to limits in the Sectoral Directives, mainly due to limits in permits being set on the basis of national laws transposing those Directives. 9 out of 13 permits where the SE Directive applied set some or all ELVs based directly on limits within the SE Directive although two had
received derogations (see above), one used a reduction scheme to comply and the Directive no longer applied at one installation due to a switch to water-based paints since the first IPPC permit was issued. All 8 waste incineration permits had all limits set at or below the limits in the WI Directive but 1 permit did not include an ELV for heavy metals.

In the three main sectors where Sectoral Directives apply (combustion, waste incineration and surface treatment using solvents), the main conclusion was that permit ELVs were more likely to be set at the limits specified in the relevant Sectoral Directive than based on the relevant BAT-AELs, which in some cases are lower. This confirms the findings from previous IPPC implementation studies. However, as the limits from the Sectoral Directives should in fact be considered as "minimum requirements", this practice is not necessarily sufficient for compliance with the requirements of the IPPC Directive.

Comparing Installation Performance against Permit Emission Limit Values

Monitoring data was requested from operators and competent authorities for 2008 and 2009 (as a minimum) in order to assess the performance of the installation. 45 permits set conditions that required the operator to monitor, a further two permits required some reporting of emissions but did not contain conditions and three set no monitoring requirements. There was only a single installation where no monitoring data was available to assess performance however three facilities reported calculated (mass-balance) values. In the majority of other cases, operators or Competent Authorities supplied data for at least 2008 and 2009 but many also supplied partial data for 2010 and several for pre-2008. There were several installations that supplied only 2009 or 2010; reasons included the facility being recently commissioned, installation of new abatement/monitoring equipment or changes in the types and scale of IPPC processes permitted.

The data supplied was typically provided in a consolidated format, being either monthly average values for key pollutants or an annual or spot-sample average from one or more periodic measurements. Several of the installations provided detailed data and many included a copy of the emissions data taken from the annual environmental report (or similar). The data was generally of sufficient detail to be able to calculate an annual average value for the main environmental pollutants. In several instances the monitoring data was supplied in units that made direct comparisons with the relevant BAT-AELs not possible.

In 20 cases, annual average concentrations of the main pollutants were lower than the values specified within installations’ permits for all of the main pollutants. These cases were spread across all sectors examined, with 5 being LCPs, 4 foundries, 5 ceramics, 4 waste incineration and 2 surface treatment using solvents. The analysis shows that 29 of the 50 installations reported annual emissions concentrations above at least one ELV over the years 2008 and 2009 (where data was provided). In one case, no monitoring data was available and no permit ELVs were set. The analysis of this data also indicates no specific sectoral trends. There is more detail on breaches of permit compliance and sanctions taken below and in Section 4.5.7.

The following graph illustrates the findings of the analysis of data with regard to whether or not performance appears to be in line with permit ELVs.
Further conclusions about installation performance are provided in the individual assessment reports.

Comparing Installation Performance against BAT-AELs
The graph below summarises the findings of the analysis of reported emissions performance data compared to BAT-AELs.

The results indicate that for 37 permits a comparison was possible between the actual emissions reported and the BAT AELs. Of those, only 12 installations reported data that indicated emission levels for the main pollutants were all below the upper BAT-AEL value. For 33 installations, it was demonstrated that annual average performance was in line with BAT-AELs for some or all of the emission points.

Analysis of the data by sector does show some sectoral trends, notably 5 foundries reporting all emissions below the upper BAT-AEL value for all pollutants. In the LCP sector, only 1 out of 10 installations assessed reported annual average emission figures lower than the BAT-AELs for all pollutants. 4 reported a mixed position and 5 reported averages higher than BAT-AELs in all cases.
It should be noted that the number of BAT-AELs defined in the BREF varies significantly between sectors and this needs to be accounted for when evaluating across different sectors.

The averaging periods used to report data on emissions varies and in general, averaging periods used by the installations assessed do not correspond in many cases to that specified in BREFs for the BAT-AELs. The difference in these averaging does not allow performance to be fully accurately compared to BAT-AELs.

**Comparing Installation Performance against limits set in the Sectoral Directives**

Amongst installations where limits specified within the Sectoral Directives applied, there was a greater number of installations whose performance was judged to be, for all relevant pollutants, in line with those sectoral limits than when performance was compared to BAT-AELs (22 versus 12). The reasons for this are that permit ELVs have in many cases been set higher than BAT-AELs, which are set lower than the minimum requirements in Sectoral Directives.

There were judged to be 9 installations that reported data which appeared to show for some pollutants, emissions were higher than the limits set in the Sectoral Directives. 3 of these were LCPs (although in one case the installation is part of a NERP). Monthly exceedances of NOx were reported from one LCP (high emissions from one boiler) and a single monthly exceedance of SO2 from the other. 5 WI installations reported exceedances of the daily average values. One surface treatment plant reported calculated fugitive emissions in exceedance of the SED limit value of 20% of total solvent input.

The graph below shows the total number of installations where performance was judged to be within limits set in the Sectoral Directives for all emission points; for some but not all emission points; for no emission points; and the number of installations for which the Sectoral Directives did not apply.

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1 Compliance rules were not taken into account in evaluating performance data.
Measures taken by the competent authority to ensure compliance with Permit Conditions

Breaches of compliance with permit conditions were reviewed with the competent authorities during site visits. There was a very mixed picture with regards to the level of compliance, with only 19 cases where no breaches of compliance were evident, 15 cases where sanctions had been used following a breach and 16 cases where a breach had been dealt with informally without sanctions. The findings, by sector, are outlined in the graph below and do not show any clear trends between sectors.

Examples of the formal sanctions used in the cases examined included formal letters, notice of non-compliance and rectification and additional inspection visits/audits. The operators and competent authorities confirmed in most cases that compliance was restored immediately or action taken to restore it. Sanctions were not applied in response to 16 of the 31 breaches. The reasons given by the competent authorities for not taking formal actions in these cases vary (see the individual assessment reports for further details). The most frequent rationale for formal actions (sanctions) not being taken relates to the fact that often the operator had already taken action to rectify the situation that led to the breach or had since applied different control measures to limit future risks of non-compliances.
Key Issues for Member States

Given the limited number of installations covered as compared to the total included under the IPPC Directive, it is not possible to draw conclusions that are necessarily representative of implementation of the Directive across a Member State. The findings set out in this section should also be read having consideration to the limitations of the numeric analysis and precision of the analysis given that, in all cases, comparability of performance against permits, BAT-AELs or limits within the Sectoral Directives is limited.

The table below summarises, for each Member State participating in this exercise, how many permits were examined and, for those permits: how many had ELVs applied for the main pollutants; how many ELVs were in line with BAT-AELs and limits set in the relevant Sectoral Directives; and how the performance of the installation (as judged by average annual performance) compared to permit ELVs, BAT-AELs and limits in the Sectoral Directives.

Of the permits examined, all Member States have set limits on emissions of most, if not all, of the main pollutants. The exceptions were a ceramics installation in Finland which had no ELVs in the permit and a shipyard in Portugal, which had received a derogation from ELVs under the SE Directive. There is however clear indication that, in all but two Member States (Slovenia and Portugal), some permits were issued without containing ELVs for all of the main environmental pollutants for which BAT-AELs exist or for which relevant limits are defined within the Sectoral Directives.

Analysis by Member State

<table>
<thead>
<tr>
<th>No. of installations assessed</th>
<th>ELVs applied for main pollutants?</th>
<th>Permit requirements/ELVs in-line with ... (where relevant)</th>
<th>Performance (2008/2009) in line with permit&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Performance (2008/2009) fully in line with...&lt;sup&gt;1&lt;/sup&gt;</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>Some</td>
<td>None</td>
<td>BAT-AELs</td>
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<tr>
<td></td>
<td>All</td>
<td>Some</td>
<td>None</td>
<td>All</td>
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<tr>
<td>BE</td>
<td>5</td>
<td>4</td>
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<td><strong>Total</strong></td>
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<td>31</td>
<td>17</td>
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</table>

<sup>1</sup> Note caveats on comparability of data apply to these conclusions. ELVs were not comparable with BAT-AELs at four installations - no BAT-AELs applied at three installations and no ELVs were set at one.

<sup>2</sup> The figure in brackets indicates the total number of permits for which the Sectoral Directives applied.

The analysis of permits from Portugal and Slovenia indicates that the permits had been issued in most cases with two sets of limits, the more stringent set (which in all cases are now in force) had been set aligned with the relevant BAT-AELs. The first set of limits had been set higher...
than BAT-AELs to allow transition time for the operator to improve performance through the application of BAT. For other Member States, the conclusions reached through this study (based on a very limited sample) are that most permit ELVs are set higher than the upper end of the BAT-AEL range.

In the two countries where GBRs had been used to set all main permit conditions relating to ELVs (Hungary and Slovenia), 1 permit in Hungary and 2 permits in Slovenia were judged to have ELVs aligned with BAT-AELs.

Analysing the information on breaches of permit conditions by Member State rather than sector indicates that the installations in Hungary appear to have complied with all their permit conditions whereas, for other Member States, some installations have reported a breach or breaches of one or more of their permit conditions. All installations assessed in Denmark, Belgium and Estonia appear to have reported breaches of one or more of their permit conditions over the period assessed (2008-2009 in most cases).

The assessment and judgements reached on whether an operator is applying BAT and why specific permit ELVs may have been set outside the BAT-AEL ranges was not, in all cases, comprehensively documented by the operator and/or competent authority. The extent and detail contained within technical documents supporting the competent authorities’ assessment of BAT for installations examined within this study varied between Member States. No specific conclusions on this were reached on this issue.
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Appendix A Review of BREFs and Production of a BAT-AEL Searchable Electronic Database Tool
Appendix B IPPC Implementation Case Study Assessment Reports 1 - 50
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Enotec
An AMEC company
1. Introduction

1.1 Project Background

The Integrated Pollution Prevention and Control (IPPC) Directive\(^2\) was adopted in September 1996 with all Member States being required to bring it into effect nationally by 30\(^{th}\) October 1999. It requires an integrated environmental approach to the regulation of certain industrial activities, which means that emissions to air, water and land plus a range of other environmental effects must be considered. This requires regulatory authorities in Member States to develop and set permit conditions for the operation of installations falling within the regime so as to achieve a high level of protection of the environment as a whole. These conditions should be based on the application of Best Available Techniques (BAT), but with the ability to take into account certain site-specific geographic and/or technical considerations as well as the local environmental conditions. The requirement for Member States to engage, consult with and enable contributions from members of the public is also a cornerstone of the Directive.

The timetable for the full implementation of the IPPC Directive in Member States was 30\(^{th}\) October 2007, at which point Member States were required to have completed the issuance of integrated permits for all existing installations. Research led by the Commission indicated that this was not achieved with a number of Member States reporting less than 100% progress in permitting relevant IPPC installations. The Commission has sought, through a number of interactions, to understand the reasons behind some Member States failing to fully implement the Directive in this respect and in some cases, has taken action against non-compliant Member States.

In the framework of the Commission-led review of the IPPC Directive and related legislation on industrial emissions and following completion of this review, assessment of the quality of IPPC implementation\(^3\) has been ongoing. These studies have aimed to provide a more detailed understanding of how Member States are developing permit conditions, how the permits are being enforced and how the installations are operated compared to their permit conditions and the best available techniques (BAT) as set out in the BAT reference documents (BREFs). The research has also sought to further understand the permitting and inspection processes, including use of General Binding Rules, interactions with other Community legislation and, critically, how information contained within the BREFs is being utilised by competent authorities in setting emission limit values and other conditions within permits.

These and other studies let by the Commission have been used to help support and enhance the correct implementation of the IPPC Directive and other related legislation as set out in the Commission's 2007 Action Plan for IPPC implementation\(^4\).


\(^4\) http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52007DC0843:EN:NOT
1.2 This Study

The Environment Directorate of the European Commission (DG Environment), under the terms of a Framework Contract, commissioned Entec UK Limited (Entec), in partnership with the Regional Environmental Centre for Central and Eastern Europe (REC), to conduct a third IPPC implementation study (Phase III). The study built on and complemented the knowledge and understanding gained within the previous IPPC implementation studies; focusing on the specific aspects of permit conditions, installation performance and application of BAT, notably in relation to the BAT-Associated Emission Levels (AELs) set out in the BREFs and the relevant emission limits set out within the sectoral directives.

Task 1 of this study focused on extracting and summarising the BAT-AEL information from the current BREFs in order to support the evaluation of case studies and to be of future use in evaluating BAT-AELs for specific industries, sectors and pollutants by other interested parties. The review has assessed the most recent complete BREF document for each sector and the output from this task is a searchable electronic database bringing the BAT-AELs from all the sectoral BREFs into a single consolidated format and a supporting report. This ‘BAT-AEL tool’, may be useful for Member States when assessing and setting emission limit values within new permits or when reviewing existing permits.

Task 2 of the study, through evaluation and assessment of 50 installation permits and associated site visits aimed to:

- Assess whether the permits have been issued in accordance with the requirements of the Directive;
- Determine whether conditions specified within permits are demonstrably based on BAT set out in the relevant BREFs, including comparison of emission limits with the corresponding BAT-AELs; and
- Assess how competent authorities and operators are ensuring compliance with the limits and conditions set out within permits, including comparison of actual performance with permit conditions and BAT-AELs.

The focus of this study was on implementation of the present IPPC Directive, not on the new Directive on industrial emissions.

Selection of the relevant case studies was made using an inclusive and transparent engagement process between the Commission, the consultants and Member State representatives. This selection method is outlined within Section 2.5.

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5 Framework Contract ENV C4/FRA/2007/0011 for services related to policy development and the assessment of the implementation of legislation on industrial emissions.


The Commission facilitated the installation selection process through a workshop held in Brussels in February 2010 and via formal communication with the Permanent Representations to the European Union from the selected Member States. The workshop was used as a forum for presenting the results of the previous Phase II study and to engage Member State representatives and experts to secure buy-in to this third study.

The outcome of Task 2 is this report that provides an assessment of how successful each competent authority and operating company associated with each case study installation has been in implementing the Directive and other sectoral legislation, in order to draw policy conclusions building on those drawn from the previous studies. This includes an assessment on a case study basis of which parts of the Directive, if any, have not been fully implemented and the reasons or rationale behind these decisions at the permit level.

1.3 Purpose of this Report

This report contains the agreed assessment methodology for undertaking the work, a review of the main emissions, impacts and conclusions concerning BAT from the BREFs for the sectors examined, and a series of 50 assessments with supplementary data on permit emission limit values (ELVs), summary assessment outcomes and interpretation of the findings and conclusions from the research.

The objective of the study as a whole was to support the Commission in its policy decision-making. As the specific findings and conclusions are likely to be of wider interest and, in keeping with previous studies, anonymised reports will be published on the Circa website.

1.4 Scope of the Tasks Covered in this Report

1.4.1 Review of the BAT Reference Documents and Compilation of the BAT and BAT-Associated Emission Levels

As part of the work required to underpin assessments of permits, permit conditions and installation performance against BAT, a full evaluation of all currently published BREFs has been made to achieve the following objectives:

- Identify the BAT and BAT-AELs for all activities covered by the BREFs (including those forming the scope of this study) to provide a consistent and agreed reference source for comparing permit emission limit values and installation performance against the information and values given in the BREFs; and
- Provide a source of information for the Commission and any potential future studies on summary BAT requirements, published BAT-AELs and monitoring associated with BAT.

The key information from the BREFs has been reviewed and transposed into an electronic format (using Microsoft Excel 2007) in order to provide the functionality of searching and enable any updates (for example as BREFs are reviewed and finalised) to be made easily. Whilst this tool will support the assessments carried out within this study, it may be of use to competent authorities and Member States when reviewing and determining permit conditions, particularly when setting emission limits and monitoring requirements.
1.4.2 Assessments of Permit Conditions Against the IPPC Directive and BAT and Installation Performance Against Permits and BAT-AELs

This task was to provide technical support to the Commission by assessing 50 IPPC permits and associated release monitoring data, based on installations selected using the methodologies outlined in this report. The installations covered a range of different main activities and are generally located in Member States that have not participated in previous IPPC implementation projects. They have also been selected on the basis of, inter alia, emissions data from the European Pollutant Release and Transfer Register (E-PRTR), the type and scale of the environmental impacts of the installations concerned and availability of BREFs for the sectors of the installations concerned.

This task involved collection of the integrated permit(s) and monitoring data for each installation and performing an assessment against the criteria detailed in Sections 1.4.2 and 1.4.3.

The assessment process was a two-stage approach: a desk-based review of documentation (with follow-up communications with site operators or competent authorities where appropriate) followed by a face-to-face interview with the site operator and the relevant competent authority, although in some cases, as a result of the separation of permitting and inspecting in some Member States, this was not the authority who determined the actual permit conditions. The scope of this task was to:

- Assess data from sources including, inter alia, E-PRTR and in cooperation with the Commission select a suitable number of Member States, industry sectors and installations to short-list candidates for potential participation in the study;
- Work in cooperation with the Commission, in particular outlining the scope and purpose of the study at a workshop hosted by the Commission, to present relevant short-listed installations to the competent authorities concerned and to encourage them to take part in the study;
- On the basis of documents supplied by Member States to the Commission, undertake such work as is necessary to interpret the main elements of the documentation so as to enable an evaluation in accordance with the key requirements of the task;
- Arrange and undertake a series of interviews with installation site operators and relevant competent authorities in their respective Member States;
- Write up the results of the assessment and interviews into a template report ensuring a consistent and accurate approach is made in each case; and
- On the basis of the above, interpret the findings and draw recommendations and conclusions together in a publishable final report that informs the Commission and interested parties as to the overall results of the study.

The assessment of each case study represents a systematic and methodical evaluation focusing on a number of main areas associated with full compliance with the IPPC Directive. The overall aim of each assessment was to draw conclusions for each case study on the following key questions set out in Box 1.
Box 1 – Key Study Questions

1. Have permits been issued or updated in accordance with the IPPC Directive?
2. Are the installations selected currently operating in accordance with their permits and BAT?

The assessment focused on the main activity relevant to the overall sectors chosen for this study. Where such an evaluation meant looking at two or more relevant IPPC permits, this has been done. However, where there more than one activity was taking place at the installation, only the activities relevant to the main activity reference were assessed.
2. Methodology

2.1 Introduction

As the third in a series of studies investigating the implementation of the IPPC Directive in Member States, the methods used in this study represent an evolution of the tools and techniques used successfully in previous studies.

For this study the scope of the assessment was on a more detailed and thorough evaluation of permit emission limits and installation performance against BAT-AELs, taking into account specific elements of monitoring parameters, required by the Commission.

2.2 Collation of Information from BREFs Concerning BAT Associated Emission Levels (BAT-AELs)

This task involved a review of 28 BREF documents (including both formally adopted and revised draft documents) to extract summary information on BAT (including on monitoring) and BAT-AELs. Although aspects of this task have been covered in previous implementation and related studies for specific sectors/activities/installation types, a comprehensive review and collation such as this had never been completed and a central reference source had not been prepared.

The tool was developed to allow the user to filter and search (a front sheet with user-defined search parameters was included) the BREF documents to identify the BAT-AELs relevant to a specific industry or sub-sector/activity within the industry.

The outputs (a searchable and updatable MS Excel 2007® database containing details of all BAT-AELs) provides an important reference source for assessment of permits and installation performance and provides a valuable reference tool for the future when checking the BAT-AELs from a number of BREFs without necessarily having to consult the BREF documents themselves.

Appendix 1 of this report contains a more detailed description of the tool and its functionality and should be referenced prior to using the BAT-AEL tool.

2.3 Assessment of Individual IPPC Installations and Their Respective Permits

This task involved assessing 50 specific installations selected using a methodology to be developed by the contractor and agreed by the Commission. The methodology for selecting the installations concerned (detailed in Section 2.5) allows for, as far as possible, examination of permits within Member States and activities not covered by previous studies, as well as some installations that are subject to sectoral Directives such as the Large Combustion Plants, Waste Incineration and Solvent Emissions Directives.
The draft list of installations was produced by the consultants and agreed with the Commission prior to being presented to Member State representatives for comment and discussion at a workshop held in Brussels on 11th February 2010. Following confirmation from Member States regarding their willingness to participate, the Commission facilitated requests for relevant data (permits, decision documents, technical letters and monitoring data for the years 2008 and 2009) through formal communication with Member States in March 2010.

Each case study is subject to full application of the assessment methodology and, therefore, by inference, the same elements are evaluated for each one. Whilst every assessment covers the same core areas, the level of detail presented in each case study assessment reports (Appendix 2) varies according to the scale, complexity and specific findings (issues).

2.3.1 Analysis of Permits and Conditions against the IPPC Directive and BAT

The analysis of permit conditions against the specific Articles of the IPPC Directive and against the BAT and BAT-AELs is conducted by a desk-based examination of the key documents: the permit(s) relevant to the main activity being examined, any associated formal document on decisions issued by the competent authority, relevant interrelated laws or general binding rules (GBRs) and consolidated sets of monitoring data for the period since permit issue. The key elements of this assessment are detailed in Table 2.1.

<table>
<thead>
<tr>
<th>Table 2.1 Element of the Assessments for Investigation of Permit Conditions and ELVs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Element of the Assessment</strong></td>
</tr>
<tr>
<td>1. What are the main permit conditions (emission limit values and other parameters and measures according to Article 9(3) of the IPPC Directive or general binding rules according to Article 9(8))?</td>
</tr>
<tr>
<td>2. Are the main permit conditions demonstrably based on BAT according to Article 9(4) of the IPPC Directive?</td>
</tr>
<tr>
<td>3. How do the emission limit values and other parameters set in the permit compare with BAT in the relevant BREFs?</td>
</tr>
<tr>
<td>4. Are there any pollutants for which BAT associated emission levels (BAT-AELs) are defined in the BREF, but for which no emission limit values have been set in the permit? What are the reasons for not including such values?</td>
</tr>
<tr>
<td>5. Were any trade-offs made to balance different environmental impacts (such as emissions to different media)?</td>
</tr>
<tr>
<td>6. Is there any evidence of any factors having influenced the permit conditions which are not compatible with the IPPC Directive (e.g. consideration of the economic circumstances of a particular operator)?</td>
</tr>
<tr>
<td>7. What are the emission monitoring requirements set in the permit? Does the permit contain an obligation to supply the competent authorities with data required for checking compliance with the permit? (Article 9(5)) How do these requirements take into consideration the relevant BREFs?</td>
</tr>
<tr>
<td>8. Does the permit include information on its duration?</td>
</tr>
<tr>
<td>9. If relevant, how are the sectoral Directives related to industrial emissions (LCP, SE and WI Directives) implemented in relation to the application of the IPPC Directive (Article 19(2))? Are the emissions limit values set in the permit in compliance with the requirements of these pieces of legislation?</td>
</tr>
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</table>
2.3.2 Analysis of the Current Operation of the Installations Selected Against their IPPC Permits and BAT?

By directly analysing the actual emissions of case-study installations, it is possible to draw conclusions as to whether they appear to be operating in accordance with the Directive and if not, in what areas there appear to be deficiencies and why. This question of why is particularly pertinent, as the Directive requires competent authorities to set conditions that are based on BAT whilst providing the ability to take into account the technical characteristics of the installation concerned, its geographical location and the local environmental conditions. The assessment investigates these areas through the set of questions outlined in Table 2.2.

Table 2.2  Elements of the Assessments for Investigation of Actual Performance Against Permit Conditions and BAT

<table>
<thead>
<tr>
<th>Element of the Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  What is the current emission monitoring performed by the operator (parameters, frequency, method) and how does this compare with the requirements of the permit, the BAT on monitoring and, where relevant, with the minimum requirements on monitoring set out in the sectoral Directives?</td>
</tr>
<tr>
<td>2  What are the current emissions of the installation (where available, to be based on the most recent monitoring data for the years 2008 and 2009 for all relevant parameters)? In all cases, where monitoring data exists and has been provided by competent authorities for installations since the date of permit issue (pre-2008), this data will also be considered within the assessment.</td>
</tr>
<tr>
<td>3  Does the installation comply with the emission limit values and equivalent conditions for its releases set out in its permit?</td>
</tr>
<tr>
<td>4  Where relevant, how do the current emissions of the installation compare with the emission limit values set out in the sectoral Directives?</td>
</tr>
<tr>
<td>5  How do the current emissions of the installation compare with BAT, in particular the BAT associated emissions levels determined in the relevant BREFs? What measures are taken to achieve these emissions levels?</td>
</tr>
<tr>
<td>6  Where an installation is not complying with its permit conditions are there enforcement actions pending for the installation concerned?</td>
</tr>
</tbody>
</table>

2.4 Overview of Process for Assessment of Installations

2.4.1 Collection of Information

The Commission facilitated communication through Member State representatives and utilised an information request factsheet (Appendix D) as the basis for providing clarity to Member States and their competent authorities on what data was required from participants. The factsheet acted as a useful guide and checklist for competent authorities when responding to formal requests for information and data and outlined the required information as follows:

- A copy of the IPPC permit(s) relevant to the installation selected, including any subsequent updates to the permit and/or conditions. Where there are large numbers of permits, those that relate to the main activities under consideration will be assessed;
• A copy of any relevant permit decisions drafted by the competent authority as part of determination of the permit and evaluation of the performance of the installation (notably against BAT) as described in the operator’s application and supporting documentation submitted by the operator;

• Copies of the most recent results of monitoring of releases to air, water and land (covering at least 2008 and 2009, where available) as required under the permit conditions (or general binding rules) referred to in Article 9 of the IPPC Directive and held by the competent authority. This data focuses on those pollutants that represent the key environmental issues for the sectors concerned (as determined by those pollutants for which a BAT-AEL exists in the relevant BREF document); and

• Reference to any general binding rules that may apply to the installations concerned and the location of where the relevant documentation may be obtained.

To provide the basis for a robust and consistent approach to the assessment of individual installations, an adapted ‘data collection and reporting template’ was developed, building upon similar templates used for the previous two implementation studies. The use of a template approach provided for standardisation across a range of permits/sectors with transparency and the ability to easily compare different case studies. It also provided a clear and consistent format for reporting the results of each assessment. The template covered the main elements as outlined in Table 2.1 and Table 2.2.

The timetable for the main data gathering and assessment phases of the project are shown in Figure 2.1 and the assessment flowchart (key activities) in Figure 2.2.

**Figure 2.1  Timetable of Assessment and Reporting Activities**

![Timetable of Assessment and Reporting Activities](image-url)
2.4.2 Data Validation, Assessment and Site visits

This first phase of the assessment involved an evaluation and analysis of information supplied including permits, technical documents and monitoring data. This process started following...
receipt of relevant documents for the installations selected in late May 2010. At this stage, a visual inspection of the documentation and the checklist\(^\text{10}\) was carried out to ensure there was sufficient data to perform the assessment. If not, further requests for information were made by the consultants directly with Member State competent authorities or at the face-to-face meetings. In all cases, an evaluation of the supplied data was made prior to beginning the desk-based assessment or arranging dates for site meetings.

Site visits and interviews were undertaken with operators and competent authority representatives to confirm the findings of the assessment and to seek additional context on decisions regarding the implementation of the Directive for the installations concerned. The project was not a legal check on compliance and details of the installations concerned have been kept confidential\(^\text{11}\). In addition, feedback was sought on the process of implementation to identify opportunities for improvement of the IPPC Directive and areas where the Commission may help with implementation of the Directive (e.g. through enhanced information exchange or provision of guidance).

The agenda for each site visit was kept flexible in order to enable the consultant to address areas of specific concern and gain insight into the rationale for setting conditions and limits on the issues raised through the initial evaluation of permits and data. Where required, a document detailing the key requirements and outcomes for each meeting was provided (an example is given in Appendix D).

2.4.3 Reporting

Each of the fifty case studies has its own unique assessment summary, main assessment report and emission limit and performance analysis (actual operational emissions against emission limit values and BAT-AELs; emission limit values against BAT-AELs). Each report has received an internal quality and technical review (to ensure consistent elements are assessed and conclusions are proportionate to the issues based on all case studies) and has been sent to the competent authority and operator to provide a check on the accuracy of the information presented and validity of conclusions drawn regarding implementation.

Managing the level of detail included in the reports was recognised as being vital to ensure readers would not be overwhelmed by the quantity of information but have sufficient supporting information to understand how the conclusions have been drawn. Supporting each of the main assessment reports (typically 8-12 pages) are a series of fifty summary sheets (2 pages) containing the outcomes and analysis of the most fundamental components of the assessment (i.e. the most important areas for implementation and performance evaluation). These summaries also include ‘snap-shot’ graphics depicting:

- A scatter plot showing how ELVs align with BAT-AELs (where a relevant BAT-AEL exists for the particular ELV); and

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\(^{10}\) The checklist was developed by the consultants in order to provide Member States and their competent authorities with a short list of the relevant documents that are required in order to perform each assessment (2.4.1). The list included contact details for the competent authority and operator and a series of check-boxes to validate each submission.

\(^{11}\) Mainly details that would allow individual installations or the employees of such installations to be identified or other information considered commercially confidential on a case-by-case basis.
• A scatter plot showing how installation performance (based on data submitted) aligns with BAT-AELs (where a relevant BAT-AEL exists).

**Figure 2.3** Example of the Scatter Plot used to Present Information on ELVs Against BAT-AELs in the Case Study Assessment Summary Sheets

![Scatter Plot](image)

Comparisons of permit ELVs against BAT-AELs (as illustrated above) have not in all cases made on the same basis (i.e. the permit ELV averaging period is not the same as that expressed for the BAT-AEL). Comparisons of performance against BAT-AELs have been made, where practicable, using an annual average value (calculated from reported performance data). In some cases monitoring data has been gathered using the same averaging period as the relevant BAT-AEL and in others it is has not. As this varies for each case study, detail on the data used in the assessment of performance is presented in each assessment report.

The assessment of each installation has been supported by the development of individual ELV and emission tables. Each table contains details of the permit ELVs and performance values (2008 and 2009) for the main pollutants (identified for each sector in Section 3).

### 2.5 Selection of Member States, Sectors and Installations

The focus of the selection was to generally include Member States and sectors that had not been examined as part of the two previous IPPC implementation studies and focusing on the sectors with BREF documents containing clear BAT-AELs and BAT conclusions. Agreement on the proposed method was reached during a discussion with the Commission at the inception meeting.
2.5.1 Selection of Member States

Table 2.3 sets out the criteria used for selection of Member States. These are based on the criteria used for the previous studies and taking into account issues raised through discussions with representatives of the Commission. Table 2.4 sets out the selected Member States.

Table 2.3 Criteria for Selection of Member States

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Member States not previously covered</td>
<td>To ensure greater coverage of the EU-27, the primary selection criteria will be Member States that have not previously participated in one of the two previous IPPC implementation studies led by the Commission.</td>
</tr>
<tr>
<td>Significance of overall emissions/discharges at a country level</td>
<td>The selection of Member States has been informed on the basis of those countries for which certain installations result in significant emissions at a national level.</td>
</tr>
</tbody>
</table>

Table 2.4 List of Selected Member States

<table>
<thead>
<tr>
<th>Member States</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium (BE)</td>
</tr>
<tr>
<td>Bulgaria (BG)</td>
</tr>
<tr>
<td>Denmark (DK)</td>
</tr>
<tr>
<td>Estonia (EE)</td>
</tr>
<tr>
<td>Finland (FI)</td>
</tr>
</tbody>
</table>

2.5.2 Selection of Sectors

Table 2.5 sets out the criteria used for selection of sectors. In adapting previously used criteria, this study prioritised sectors that are subject to sectoral Directives (including waste incineration, large combustion plant and solvent-using processes), have high environmental impacts (through their emissions or otherwise) and have not featured in either of the two previous IPPC implementation studies.

Additional criteria were to take account of findings from previous studies by selecting sectors where permit emission limits have been significantly above the relevant BAT-AEL as well as to select sectors for which the BREF conclusions (in particular the BAT AELs) were clear.
Table 2.5  Criteria for Selection of Sectors

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sectors subject to sectoral Directives including Waste Incineration,</td>
<td>Previous studies have shown that, in some cases, competent authorities have relied on the conditions and emission limits contained within sectoral Directives as the basis upon which to set permit emission limits as opposed to using the BAT-AELs set out in the BREFs. Therefore, the inclusion of sectors where such Directives are relevant will yield assessments that provide further insights on the issues identified in the previous studies and lead to a greater understanding of the wider picture in Member States.</td>
</tr>
<tr>
<td>Solvents Emission and Large Combustion Plant Directives</td>
<td></td>
</tr>
<tr>
<td>Environmental impacts of the installations</td>
<td>The focus of the assessment of sectors is on those that result in significant emissions to air, discharges to water or discharges to land at a sector and Member State level. Emissions data published in the European Pollutant Release and Transfer Register (E-PRTR) will be used to guide the assessment against this criterion. For the LCP sector, the LCP inventory study (European Commission, 2008) will be used to assess and shortlist based on emissions profiles.</td>
</tr>
<tr>
<td>Sectors not previously studied</td>
<td>Certain industrial sectors have not been included in previous studies regarding implementation of the IPPC Directive. In order to gain a wider perspective of IPPC implementation sectors (or specific sub-sets of sectors) not previously studied have been included.</td>
</tr>
<tr>
<td>Sectors with clear conclusions in the BREFs</td>
<td>BREFs have now been finalised for all sectors and the revision process is underway for certain sectors. However, the strength of conclusions regarding what constitutes BAT varies amongst the BREFs and in some cases it is less simple than others to provide an actual measure of permit conditions and performance against the BAT conclusions in the BREFs. The sectors selected should have BREFs with clear conclusions (for the main environmental issues to be addressed) against which implementation can be measured.</td>
</tr>
<tr>
<td>Sectors where previous studies have indicated differences between permit conditions and BAT as established in the BREFs</td>
<td>Other studies for the Commission have indicated that permit conditions are in many cases much less stringent than BREF BAT-AELs, and for some sectors the justification for permit conditions will be an important area of study.</td>
</tr>
</tbody>
</table>

The selection of sectors was an iterative task undertaken during the inception meeting. Based upon these discussions and the criteria in Table 2.5, the selected sectors are presented, together with commentary on justification, in Table 2.6.
### Table 2.6 Assessment and Selection of Sectors

<table>
<thead>
<tr>
<th>Sector</th>
<th>Justification for Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Combustion Plants (1.1) – focus is on gas and liquid-fired plants.</td>
<td>This sector is comprised of large and potentially complex installations with high overall environmental impact, especially with regard to emissions to air. The sector has previously been studied with regard to IPPC implementation (MS reports on emission limit values). However, the previous studies focused on coal and lignite-fired plants. The BAT conclusions presented in the BREF document are clear. The installations are also subject to the LCP Directive. There have been notable issues raised in previous studies on application of BAT-AELs within permit conditions. The decision was taken to focus on installations not previously examined, including biomass, liquid and gas-fired LCPs. Having already examined LCPs on refineries as part of the Phase II study, these have been excluded from the assessment.</td>
</tr>
<tr>
<td>Ferrous metal foundries (2.4)</td>
<td>This sector contains plants with significant environmental impacts, mainly through point source emissions of combustion gases (NOx, SO2 and dust) and through fugitive releases of dust. Dust is produced at almost all of the process stages and may contain metals and metal oxides plus a high mineral loading from raw material additions. There are also issues with VOC from certain activities. The BREF document contains a number of clear conclusions on BAT and the commonality of the process operations will contribute to an easier comparison across both Member States and installations.</td>
</tr>
<tr>
<td>Manufacture of ceramics (3.5) – focus is on brick, tile and concrete construction products manufacture using clay-based material</td>
<td>The ceramics industry is varied and often complex with numerous processes and sub-sectors. The BREF highlights that the bricks and roof tiles industry has the highest output compared to the other nine major ceramic sectors included in the report. The key environmental impacts are the generation of dust from processing of clays and the firing of the product in kilns, as well as a range of combustion by-products and impurities from the clays themselves (emitted in the gas stream during drying). The sub-sector of bricks and blocks has been chosen as the primary focus for this study based on numbers and size of installations in Member States selected. Where suitable installations are unavailable within Member States, alternative sub-sector installations will be considered.</td>
</tr>
<tr>
<td>Incineration of hazardous and municipal wastes (5.1 &amp; 5.2)</td>
<td>Waste incineration has not been studied in the previous implementation assessments and across Europe is a sector containing large installations that operate under IPPC as well as under the WI Directive. The main environmental emissions from the incineration of hazardous and municipal waste are combustion products (NOx, CO, dust) with potential for metals, PCDD/F and other acidic and volatile pollutants – depending upon the composition of the feedstock materials. Waste water may be an issue if wet flue gas treatment techniques are applied.</td>
</tr>
<tr>
<td>Surface treatment using solvents (6.7)</td>
<td>The IPPC activity &quot;surface treatment using solvents&quot; covers a large diversity of industrial sectors. The IPPC activities within the sector are also likely to be subject to the requirements of the SE Directive. The focus will be on those installations within the sector that emit the highest volume of VOC, either as waste gases or fugitive emissions as the main environmental issues relate to the emission of VOC to air, water and groundwater, and soil.</td>
</tr>
</tbody>
</table>

### 2.5.3 Selection of Installations

The shortlist of installations was compiled by the consultants based on analysis of the 2008 data reported to the E-PRTR supported with reviews of previous studies (e.g. the Commission’s LCP inventory study, 2008). Where no such data was available or conclusions were unclear from...
analysis of the E-PRTR, installations were confirmed as being suitable through EPER data and evaluation of published data on the company’s website (e.g. installation activities, annual environmental reports and reported emissions data).

Selection of specific installations for investigation was made by the Commission and relevant Member State representatives, and not by the local competent authority. This is to ensure that the selection was not biased towards certain permits. It should also be noted that permits selected were for installations for which the consultants had not participated in the permit application or have been consulting on the operation of the installation.

Table 2.7 Criteria for Selection of Installations

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Significance of emissions/discharges within a sector/Member State</td>
<td>Permits will be selected on the basis of those installations that result in significant emissions to air, discharges to water and discharges to land compared to total releases at a sectoral and Member State level (notwithstanding the need to also consider smaller installations). This data will be sourced from the E-PRTR database and the LCP inventory report (2008).</td>
</tr>
<tr>
<td>Availability of a permit</td>
<td>Based on discussions with the Member State authorities, installations will be selected on the basis that they have a permit in place (either issued or reconsidered in accordance with the IPPC Directive).</td>
</tr>
</tbody>
</table>

The availability of a permit for each chosen installation was confirmed by the relevant competent authority prior to finalising the selection and several chosen installations reported that they did not have an IPPC permit due to the scale of the facility being below the Annex 1 activity threshold. In these cases, a second ‘reserve’ installation choice was made based on the initial shortlist. The list of installations was presented to the relevant participating Member States’ representatives at the workshop in February 2010. Following agreement with all parties, a comprehensive finalised list was included within the workshop report.

The spread of selected installations, plotted against the respective Member States and sectors is presented in Table 2.8.
Table 2.8 Numbers of Installations in each Sector and Member State

<table>
<thead>
<tr>
<th></th>
<th>Belgium</th>
<th>Bulgaria</th>
<th>Denmark</th>
<th>Estonia</th>
<th>Finland</th>
<th>Hungary</th>
<th>Ireland</th>
<th>Portugal</th>
<th>Romania</th>
<th>Slovenia</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Combustion Plants (1.1) – gas, liquid and biomass-fired plants</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Ferrous metal foundries (2.4)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Manufacture of ceramics (3.5) – brick, tile and concrete construction products manufacture using clay-based material</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Incineration of hazardous and municipal wastes (5.1 &amp; 5.2)</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Surface treatment using solvents (6.7)</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5</strong></td>
<td><strong>3</strong></td>
<td><strong>6</strong></td>
<td><strong>5</strong></td>
<td><strong>6</strong></td>
<td><strong>5</strong></td>
<td><strong>6</strong></td>
<td><strong>4</strong></td>
<td><strong>5</strong></td>
<td><strong>50</strong></td>
<td></td>
</tr>
</tbody>
</table>

2.6 Presentation of the Study Findings

The main study findings are presented in Section 4 of this report, together with conclusions drawn from analysis of individual case studies and from cluster analysis by sector. The findings focus on the main issues highlighted previously in Tables 2.1 and 2.2. Although the findings and conclusions are a useful tool to present the outcomes of this project, the level of detail is such that, in some cases, it will be necessary to refer directly to the individual case study assessment reports, which contain significantly more detail on specific implementation issues than can be presented on a project-level basis. The case study reports, accompanying summaries and ELVs and emissions table are the primary output of the project and the reading of the findings should be undertaken whilst recognising the limitations of presenting specific implementation issues across installations in five different sectors and ten Member States.

Each assessment report (Appendix B) is intended to be a standalone and publishable document with a balance of readability and relevant detail that is of interest to the Commission, national and competent authorities, industrial operators and the wider public. Each report is supplemented by a summary sheet and a spreadsheet containing the following details for each installation:

- References for the installation (activity, sector, emission type, emission point);
- Details of pollutant limits and emissions including permit emission limits and the basis for the limit (i.e. on what averaging period the limit has been set), installation performance data for (where available), BAT-AELs and relevant sectoral Directive limits; and
- Details of the monitoring performed and reported by the operator in order to comply with the requirements of the permit.
3. Overview of the Sectors Examined

3.1 Introduction
This section provides context on the sectors examined in this study to support the reading of the study findings and the main elements of the assessments undertaken on each installation. It provides a summary of the main environmental impacts associated with each of the chosen sectors (extracted from the relevant BREF documents), which formed the focus of the assessments and subsequent analysis. Following this summary, the best available techniques for each sector and the results of the assessment for that sector are provided.

3.2 Combustion Plants >50MW (Liquid and Gas Fired)

3.2.1 Background to the Sector
The IPPC Directive covers combustion installations with a rated thermal input exceeding 50 MW (MW\textsubscript{th}).

The assessment in this report is specifically focused on combustion installations fired with liquid and gaseous fuels, covering steam thermal units, gas turbines and combined cycle units. Internal combustion units (engines) are not assessed.

The main focus has been on the combustion process and the resulting emissions to air and water, acknowledging that, as set out in the BREF for Large Combustion Plants (2006), other processes and techniques are also applied in these installations including unloading, storage and handling of fuel; fuel pre-treatment; and preparation and treatment of combustion residues and by-products.

The Large Combustion Plants Directive
Directive 2001/80/EC\textsuperscript{12}, referred to as the large combustion plants (LCP) Directive, applies to combustion plants with a rated thermal input of 50MW or more. The LCP Directive places requirements upon Member States to reduce emissions of sulphur dioxide (SO\textsubscript{2}), nitrogen oxides (NO\textsubscript{x}) and particulate matter (PM or dust) from combustion plants within power plants, petroleum refineries, iron and steelworks and other industrial processes.

According to the LCP Directive, plants licensed after 27 November 2002 (“new-new” plants) have to comply with the emission limit values for SO\textsubscript{2}, NO\textsubscript{x} and dust in part B of Annexes III to VII. Plants licensed after 1 July 1987 and before 27 November 2002 (“new” plants) have to comply with the emission limit values in part A of Annexes III to VII – these are less strict than the limits for "new-new" plants.

The LCP Directive also requires that, from 1 January 2008, “existing plants” (those licensed before 1 July 1987) either: (a) meet the emission limit values in part A of Annexes III to VII; or (b) are included in a national emission reduction plan that achieves overall reductions calculated using these emission limit values (this is based on mass emissions i.e. tonnes per annum).

Concerning gas turbines, the LCP Directive only applies to "new new" plants, and hence not to “existing” or “new” gas turbines.

The LCP Directive (article 4(4)) allows existing combustion plants to be exempted from compliance with emission limit values and from inclusion in a national emission reduction plan, provided that the operator had undertaken (by submitting a written declaration to the competent authority by 30 June 2004) not to operate the plant for more than 20,000 hours starting from 1 January 2008 and ending no later than 31 December 2015.

According to Article 19(2) of the IPPC Directive, the emission limit values set out in the LCP Directive shall be applied as minimum emission limit values. This means that the provisions of the LCP Directive do not remove the requirement under the IPPC Directive to set emission limit values based on BAT (or equivalent parameters or technical measures) in the environmental permit. In particular, the provisions of the LCP Directive related to the "limited life-time derogation" (article 4(4)) as well as the national emission reduction plan (article 4(6)) both explicitly mention that they apply without prejudice to the IPPC Directive.

This means that, even if an installation is subject to the "limited life-time derogation" or is covered by a national emission reduction plan, it still needs to operate in compliance with all the provisions of the IPPC Directive, including a permit containing emission limit values or equivalent parameters and technical measures determined according to the provisions of Article 9(4) or Article 9(8) of the IPPC Directive.

Although the primary focus of the assessments included in this study is on the IPPC Directive, the assessment for this sector also considers the LCP Directive, given the provisions of Article 19(2) of the IPPC Directive. The information presented (such as permit ELVs and emissions monitoring data) allowed for a comparison to be made with the key provisions of the LCP Directive.

The emission limit values within the LCP Directive are as set out in Table 3.1 and Table 3.2 below.
Table 3.1 Emission Limit Values in the LCP Directive for Liquid and Gas Fired combustion Plants (with the exception of gas turbines) (mg/Nm² dry flue gases at STP and oxygen content of 3%)

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Fuel</th>
<th>Plant category</th>
<th>50-100 MWth</th>
<th>100-300 MWth</th>
<th>300-500 MWth</th>
<th>&gt;500 MWth</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO₂</td>
<td>Liquid</td>
<td>Existing and “new”</td>
<td>1700</td>
<td>1700</td>
<td>1700 to 400 (linear decrease)</td>
<td>400</td>
</tr>
<tr>
<td></td>
<td>Liquid</td>
<td>“New new”</td>
<td>850</td>
<td>400 to 200² (linear decrease)</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>Gaseous fuels in general</td>
<td>All plants</td>
<td>35 (for all rated thermal inputs)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Liquefied gas</td>
<td>All plants</td>
<td>5 (for all rated thermal inputs)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low calorific gases³</td>
<td>Existing and “new”</td>
<td>800 (for all rated thermal inputs)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coke oven gas</td>
<td>“New new”</td>
<td>400 (for all rated thermal inputs)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Blast furnace gas</td>
<td>“New new”</td>
<td>200 (for all rated thermal inputs)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NOₓ</td>
<td>Liquid</td>
<td>Existing and “new”</td>
<td>450</td>
<td>450</td>
<td>450</td>
<td>400</td>
</tr>
<tr>
<td></td>
<td>Liquid</td>
<td>“New new”</td>
<td>400</td>
<td>200¹</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>Gaseous</td>
<td>Existing and “new”</td>
<td>300</td>
<td>300</td>
<td>300</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>Natural gas</td>
<td>“New new”</td>
<td>150</td>
<td>150</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Other gases</td>
<td>“New new”</td>
<td>200 (for all rated thermal inputs)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dust</td>
<td>Liquid</td>
<td>Existing and “new”</td>
<td>50 (for all rated thermal inputs)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Liquid</td>
<td>“New new”</td>
<td>50</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Gaseous fuels: as a rule</td>
<td>All plants</td>
<td>5 (for all rated thermal inputs)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Blast furnace gas</td>
<td>All plants</td>
<td>10 (for all rated thermal inputs)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gases produced by the steel industry which can be used elsewhere</td>
<td>Existing and “new”</td>
<td>50 (for all rated thermal inputs)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>“New new”</td>
<td>30 (for all rated thermal inputs)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1): Except in the case of the ‘Outermost Regions’ where 300 mg/Nm³ shall apply.
2): Except in the case of the ‘Outermost Regions’ where 850 to 200 mg/Nm³ (linear decrease) shall apply.
3): Low calorific gases from gasification of refinery residues, coke oven gas, blast furnace gas.
4): A limit value of 100 mg/Nm³ may be applied to plants licensed pursuant to Article 4(3) with a rated thermal input greater than or equal to 500 MWth burning solid fuel with a heat content of less than 5 800 kJ/kg (net calorific value), a moisture content greater than 45 % by weight, a combined moisture and ash content greater than 60 % by weight and a calcium oxide content greater than 10 %.
The NOx emission limit values for gas turbines of thermal input >50 MWth (at ISO conditions) are reproduced in Table 3.2. The ELVs apply to single gas turbine units, and apply only above 70% load. Gas turbines for emergency use that operate fewer than 500 hours per year are exempt from these limit values, although operators of such plants are required to submit a record of such used time to the competent authority each year.

Table 3.2  Emission Limit Values in the LCP Directive for “new new” Gas Turbines (mg/Nm³ dry flue gases at STP and 15% oxygen content)

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Fuel</th>
<th>Emission Limit Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOx</td>
<td>Natural gas (Note 1)</td>
<td>50 (Note 2)</td>
</tr>
<tr>
<td></td>
<td>Light and middle distillates (liquid fuels)</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>Gaseous fuels (other than natural gas)</td>
<td>120</td>
</tr>
</tbody>
</table>

Notes:
1) Natural gas is naturally occurring methane with not more than 20 % (by volume) of inerts and other constituents.
2) 75 mg/Nm³ in the following cases, where the efficiency of the gas turbine is determined at ISO base load conditions:
   - gas turbines used in combined heat and power systems having an overall efficiency greater than 75%;
   - gas turbines used in combined cycle plants having an annual average overall electrical efficiency greater than 55%;
   - gas turbines for mechanical drives.

For single cycle gas turbines not falling into any of the above categories, but having an efficiency greater than 35% – determined at ISO base load conditions – the emission limit value shall be 50*η/35 where η is the gas turbine efficiency expressed as a percentage (and at ISO base load conditions).

Compliance rules with regard to the emission limit values are set out in Article 14 of the LCP Directive.

In the event of continuous measurements, the emission limit values set out in part A of Annexes III to VII shall be regarded as having been complied with if the evaluation of the results indicates, for operating hours within a calendar year, that:

(a) none of the calendar monthly mean values exceeds the emission limit values; and

(b) in the case of: (i) sulphur dioxide and dust: 97 % of all the 48 hourly mean values do not exceed 110 % of the emission limit values, (ii) nitrogen oxides: 95 % of all the 48 hourly mean values do not exceed 110 % of the emission limit values.

In cases where only discontinuous measurements or other appropriate procedures for determination are required, the emission limit values set out in Annexes III to VII shall be regarded as having been complied with if the results of each of the series of measurements or of the other procedures defined and determined according to the rules laid down by the competent authorities do not exceed the emission limit values.
3.2.2 Key Environmental Issues

The combustion installations assessed as part of this project are those subject to IPPC, which sets a threshold of greater than 50MW\textsubscript{th}. The installations examined in this study are typically larger, with combined thermal inputs of greater than 1,000MW (with some exceptions).

The main environmental impacts result from the combustion process, which leads to the generation of emissions to air and, in some cases, also to water, particularly where wet flue-gas desulphurisation (FGD) is applied, and soil. The most important polluting substances emitted to air from the combustion of liquid and gaseous fuels are NO\textsubscript{X}, CO, SO\textsubscript{2}, dust/particulate matter (PM\textsubscript{10}) and greenhouse gases, such as CO\textsubscript{2} and N\textsubscript{2}O. In the case of natural gas combustion, emissions of SO\textsubscript{2} and dust are generally considered very small or negligible.

Other substances such as heavy metals, halide compounds and dioxins are emitted in smaller quantities from the combustion of liquid fuels (especially heavy fuel oil), although it is worth noting that, given the acute toxicity of some of these compounds, smaller absolute quantities can have potentially significant environmental effects.

For the purpose of this assessment, the main focus of the study has been on the emissions of NO\textsubscript{X}, CO, SO\textsubscript{2} and dust/particulate matter.

3.2.3 BAT and BAT-AELs for the Key Pollutant Emissions

Dust emissions: Gas fired combustion plants using natural gas as a fuel normally have very low dust emission levels, typically below 5 mg/Nm\textsuperscript{3}, such that no additional technical measures need to be applied. BAT for liquid-fired plants is to apply abatement measures such as electrostatic precipitators, fabric filters and wet scrubbing.

Table 3.3 BAT-AELs for the Reduction of Dust from Liquid-Fired Combustion Plants

<table>
<thead>
<tr>
<th>Capacity (MW\textsubscript{th})</th>
<th>Dust emission level (mg/Nm\textsuperscript{3})(3% O\textsubscript{2}) associated with BAT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>New plants</td>
</tr>
<tr>
<td>50 – 100</td>
<td>5 – 20*</td>
</tr>
<tr>
<td>100 – 300</td>
<td>5 – 20*</td>
</tr>
<tr>
<td>&gt; 300</td>
<td>5 – 10*</td>
</tr>
</tbody>
</table>

* Subject to split views. Refer to table 6.42 in the LCP BREF on page 398 for more information.

SO\textsubscript{2} emissions: BAT for liquid-fuel-fired plants is to use low sulphur fuel oil. Besides the use of low sulphur fuel oil, the techniques that are considered to be BAT are the wet scrubber (reduction rate 92 - 98 %), and the spray dry scrubber desulphurisation (reduction rate 85 – 92 %). Dry desulphurisation techniques, such as dry sorbent injection, are used mainly for plants with a thermal capacity of less than 300 MW\textsubscript{th}. Gas-fired combustion plants normally have very low SO\textsubscript{2} emission levels, typically below 10 mg/Nm\textsuperscript{3}.
Table 3.4  BAT-AELs for the Reduction of SO\(_2\) from Liquid-Fired Combustion Plants

<table>
<thead>
<tr>
<th>Capacity (MW(_{th}))</th>
<th>SO(_2) emission level (mg/Nm(^3))(3% O(_2)) associated with BAT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>New plants</td>
</tr>
<tr>
<td>50 – 100</td>
<td>100 – 350*</td>
</tr>
<tr>
<td>100 – 300</td>
<td>100 – 200*</td>
</tr>
<tr>
<td>&gt; 300</td>
<td>50 – 150*</td>
</tr>
</tbody>
</table>

*Subject to split views refer to table 6.42 in the LCP BREF on page 399 for more information.

**NO\(_X\) emissions**: BAT is primary measures (such as air and fuel staging, low NOx burners or re-burning) or, in larger plant, a combination of primary measures with selective non-catalytic reduction (SNCR), selective catalytic reduction (SCR) or combined techniques. Table 3.5 and Table 3.6 set out the applicable BAT-AELs for liquid-fired and gas-fired combustion plants respectively.

Table 3.5  BAT-AELs for the Reduction of NO\(_X\) from Liquid-Fired Combustion Plants

<table>
<thead>
<tr>
<th>Capacity (MW(_{th}))</th>
<th>NO(_X) emission level (mg/Nm(^3))(3% O(_2)) associated with BAT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>New plants</td>
</tr>
<tr>
<td>50 – 100</td>
<td>150 – 300*</td>
</tr>
<tr>
<td>100 – 300</td>
<td>50 – 150*</td>
</tr>
<tr>
<td>&gt; 300</td>
<td>50 – 100*</td>
</tr>
</tbody>
</table>

*Split views. Refer to table 6.44 in the LCP BREF on page 401 for more information.

Table 3.6  BAT-AELs for the Reduction of NO\(_X\) from Gas-Fired Combustion Plants (other than gas engines)

<table>
<thead>
<tr>
<th>Plant type</th>
<th>NO(_X) emission level (mg/Nm(^3)) associated with BAT</th>
<th>Reference O(_2) content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas turbines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>New gas turbines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry Low NOx for existing gas turbines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Existing gas turbines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas boilers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>New and existing gas-fired boilers</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

h:/projects/em-260\(\)26600 projects/26697 ppaq ec ippec implementation study iii/e - client/reports/6. final/01 - final - for print/final technical report110003.doc

June 2011

An AMEC company
### Plant type

<table>
<thead>
<tr>
<th>NOx emission level (mg/Nm³) associated with BAT</th>
<th>Reference O₂ content</th>
</tr>
</thead>
</table>

**Combined Cycle Gas Turbines (CCGTs)**

- New CCGT with or without supplementary firing
  - 20 – 50
  - 15% / plant specific

- Existing CCGT with or without supplementary firing
  - 20 – 90**
  - 15% / plant specific

*Split views in relation to these figures – refer to table 7.36 in the LCP BREF on page 482 for more information.

**Split views in relation to these figures – refer to table 7.37 in the LCP BREF on page 483 for more information.

**CO Emissions**

For liquid–fuel-fired combustion plants, BAT is to ensure complete combustion together with good furnace design, as well as the use of high performance monitoring and process control techniques and maintenance of the combustion system.

#### Table 3.7 BAT-AELs for the Reduction of CO Emissions from Gas-Fired Combustion Plants

<table>
<thead>
<tr>
<th>Plant type</th>
<th>CO emission level (mg/Nm³) associated with BAT</th>
<th>O₂ level (%)</th>
</tr>
</thead>
</table>

**Gas turbines**

- New gas turbines
  - 5 – 100
  - 15%

- Dry Low NOx premix burners for existing gas turbines
  - 5 – 100
  - 15%

- Existing gas turbines
  - 30 – 100
  - 15%

**Gas boilers**

- 30 – 100
  - 3%

**Combined Cycle Gas Turbines (CCGTs)**

- New and Existing CCGT without supplementary firing
  - 5 – 100*
  - 15%

- New and Existing CCGT with supplementary firing
  - 30 – 100
  - Plant specific

*Split views in relation to these figures for existing plants – refer to table 7.37 in the LCP BREF on page 483 for more information.

**Heavy Metal Emissions**

Liquid fuels, especially heavy fuel oil (HFO), typically contain heavy metals, in particular vanadium and nickel. BAT is to reduce emissions of heavy metals by the use of high performance electrostatic precipitators (ESPs), or in certain cases a fabric filter (when it is applied in combination with FGD). No BAT AELs have been defined in the BREF.

**Ammonia (NH₃) Emissions**

Emissions of ammonia arise from the use of ammonia in SNCR and SCR systems to abate NOx emissions. Ammonia concentration associated with BAT is below 5 mg/Nm³.
Monitoring of air emissions
For the main air pollutants (NOx, SO2, dust and CO) BAT is to have continuous monitoring of emissions. BAT is to periodically monitor emissions of heavy metals.

Emissions to Water
For liquid-fuel-fired boilers at combustion plants, BAT when applying wet flue gas desulphurisation (FGD) is related to the application of a waste water treatment plant (WWTP). Emission levels associated with the use of BAT have been set out in the BREF, but are not reproduced here as none of the assessed plants was applying a wet FGD.

3.2.4 Results from the Assessment of Gas and Oil-fired Combustion Plants Covered by the IPPC Directive

The assessments covered ten large combustion plants across ten Member States. An additional combustion plant >50MW (being part of an installation with main activity 6.7 surface treatment using solvents (Slovenia)) was also included in the analysis, making a total of 11 LCPs assessed. Seven of the plants used gas as their primary fuel source and the results presented in this study are reflective of emissions from combustion of gas-fuel only. A further four reported use of both gas and liquid; two multi-fuel firing plants, one plant using liquid as a supplemental fuel (but not at the same time as gas) and one using liquid as a back-up fuel. None of the plants assessed utilised wet flue gas desulphurisation technologies and therefore the water discharge BAT-AELs highlighted within the LCP BREF document are not relevant and no further comparison has been made.

The assessment results presented here are limited to the emissions of NOx, CO, SO2 and dust/particulate matter.

The data provided by the plant operators covers the years 2008 and 2009 and has been aggregated and averaged across 12 months from continuously monitored data. In two cases, the operator provided comprehensive datasets showing daily average values. In the other cases data was provided for the period 2008 and 2009 aggregated to a monthly average value. The aggregation to a single value for 2008 and 2009 was performed by the consultant teams based on supplied data. The individual assessments also considered (where data provided allowed) whether permit ELVs or BAT-AELs had been exceeded based on the averaging periods that applied. However, the analysis presented in this section has been done on the basis of annual average values.

Two plants reported results based on mixed gas/liquid firing (multi-fuel firing units) for which permit limits required a calculation to be made and no BAT-AELs exist. In these cases, the permits set limits for operating on liquid-only, gas-only or co-fired (using both liquid and gas simultaneously. Given that the monitoring data indicated changes in fuel used over the periods 2008 and 2009, a comparison of these plants was therefore not possible against other LCPs.

14 One plant (Slovenia) utilised periodic monitoring (annual).
15 According to article 8 of Directive 2001/80/EC.
Analysis of the permit ELVs shows that for 8 out of the 11 plants the permit ELVs were defined as daily averages, which allows comparison with the BAT AELs. In 3 permits, the limit values were monthly average values.

Many more of the permit ELVs were aligned to limits in the LCP Directive than to BAT-AELs: only in one installation were all permit ELVs equal to or less than the upper relevant BAT-AEL and, in 4 cases ELVs for main pollutants from every emission point were all set above the corresponding BAT-AELs. This is shown in Figure 3.1.

With regard to the annually-averaged emission concentrations\(^ {16} \) for 2008 and 2009 calendar years, only one installation appeared to have all emissions within the relevant BAT-AEL range with four indicating a mixed position (BAT-AELs were met for some but not all pollutants) and five having averaged emissions values for all pollutants above BAT-AELs. Emissions performance against limits in the LCP Directive indicated five installations showing values equal to or below those limits and four with a mixed position – some above, some below.

**Figure 3.1 Permit ELVs and Indicative Emissions Performance for LCPs against Relevant BAT-AELs and LCP Directive Limits for Main Pollutants**

Note: One installation was a gas turbine licensed before 27 November 2002 and therefore not within the scope of the LCP Directive

**Gas-fired LCPs**

The permit ELVs set for NO\(_x\) ranged from 75mg/m\(^3\) through to 300mg/m\(^3\) and, as indicated above, these limits appear to be more closely aligned with LCP Directive limit values than BAT-AELs in most cases. This was borne out in the discussions with competent authorities and operators, where, for 9 out of the 11 installations, the LCP Directive was referenced as a key source for setting the permit ELVs. The annual average emissions of the combustion installations showed a significant range; from 19.7 mg/m\(^3\) to 277 mg/m\(^3\).

\(^ {16} \)Reported values are not directly comparable with daily average values for BAT-AELs or LCP Directive limits as performance has been assessed based on annual average values from aggregated continuously monitored data. [It means that the assessment is likely to be overestimating the number of cases where performance is in line with the BAT AELs and LCPD limits]
Figure 3.2 provides a comparative picture of the relationship between values set through permit ELVs, reported averaged installation performance and BAT-AELs for the 8 gas-fired combustion plants examined in this study.

**Figure 3.2** Comparative Ranges for Installation Performance, Permit Limits, BAT-AELs and LCP Directive Limits for NOx Emissions from Gas-fired LCPs

![Diagram showing comparative ranges for installation performance, permit limits, BAT-AELs and LCP directive limits for NOx emissions from 8 gas-fired LCPs.](image)

Figure 3.3 below graphically shows the relationship between NOx permit ELVs, average figures for 2008 and 2009 and the relevant upper BAT-AELs (which vary according to LCP type).

**Figure 3.3** Relationship Between Permit NOx ELVs, BAT-AELs and Average Performance for 2008 and 2009 across 43 Emission Points at 8 gas-fired LCPs (units are mg/m^3)

![Diagram showing relationship between permit ELVs, BAT-AELs and average performance for NOx emissions from 8 gas-fired LCPs.](image)

The graph above shows that, in most cases, NOx emissions based on annual averages lie between the upper BAT-AELs (90-100 mg/m^3) and the permit limits. With the exception of one installation (3 measured emission points), reported emission values are within permit ELVs. Based on annual average performance values, emissions of NOx from gas-fired LCPs are not all within the relevant BAT-AEL range (though some are). This suggests that BAT may not have been consistently applied at the installation level in all cases.
ELVs set for CO ranged from 20 mg/m$^3$ to 100 mg/m$^3$ and thus all were within the relevant upper BAT-AEL value of 100 mg/m$^3$. Performance ranged from <1 mg/m$^3$ through to 103 mg/m$^3$. One result of 171 mg/m$^3$ was reported.

Figure 3.4 provides a comparative picture of the relationship between values set through permit ELVs, reported averaged installation performance and BAT-AELs for the 8 gas-fired combustion plants examined in this study.

The analysis suggests that, across the gas-fired LCPs examined in this study, permit ELVs for CO are set within BAT-AELs and that emissions performance with regard to CO is generally within the BAT-AEL range. The results show emissions of CO have been reported, in two cases, above the permit ELV and relevant BAT-AEL.

**Liquid-fired LCPs**

Three LCPs were examined in this study where the permit specified ELVs for the use of liquid fuel and for which monitoring data relating specifically to periods of operation using liquid fuel was provided. This analysis excludes two LCPs that were classified as multi-fuel, using gas and liquid fuels simultaneously.

Permit ELVs for SO$_2$ were most frequently set at 1700 mg/m$^3$. However in one permit for an installation with a thermal input greater than 500MW, the limit was set at 400 mg/m$^3$. The is a clear indication, confirmed by discussions at the sites that, in the permits examined in this study, permit ELVs for SO$_2$ emissions for liquid-fired plant have been based on the LCP Directive limit values. Performance based on annual average values ranged from 11 mg/m$^3$ to 1450 mg/m$^3$.

Figure 3.5 provides a comparative picture of the relationship between values set through permit ELVs, reported averaged installation performance, LCP Directive limit values and BAT-AELs for the 3 liquid-fired combustion plants examined in this study.

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17 Three combustion installations reported data operating on fuel oil only or mixes of fuel oil and gas (multi-firing)
Figure 3.5  Comparative Ranges of Installation Performance, Permit Limits and BAT-AELs for SO₂ Emissions from Liquid-fired LCPs

NOx ELVs for liquid-fired LCPs varied between 250 mg/m³ and 1100 mg/m³ with two permits setting limits in line with the relevant LCP Directive limit and one permit setting the ELV above. In all three permits ELVs were set above the upper BAT-AEL value.

Performance figures for NOx showed a similarly broad range: from 184 mg/m³ to 722 mg/m³. The LCPs operating on diesel showed the lowest NOx emissions (184-187 mg/m³) and those operating on heavy fuel oil showed the highest levels (199-722 mg/m³).

Figure 3.6 provides a comparative picture of the relationship between values set through permit ELVs, reported averaged installation performance, LCP Directive limit values and BAT-AELs for the 3 liquid-fired combustion plants examined in this study.

Figure 3.6  Comparative Ranges of Installation Performance, Permit Limits and BAT-AELs for NOx Emissions from Liquid-fired LCPs

Dust ELVs for liquid-fired LCPs varied between 1 mg/m³ (small LCP running on light fuel oil within a solvent coating installation) and 200 mg/m³ (LCPs running on heavy fuel oil with a permit limit up to 690 mg/m³ during soot blowing). The other LCP had dust limits set at 25 mg/m³ (diesel-fuelled). With the exception of the LCP within the solvents installation, all ELVs for dust were set above the BAT-AEL range of 5-20 mg/m³. Two out of three installations had permit ELVs for dust set within the limits set in the LCP Directive (50 mg/m³).
Emissions of dust\(^{18}\) ranged from 17 mg/m\(^3\) to 166 mg/m\(^3\), although the annual figures reported for the heavy fuel oil-fired LCPs include periods of soot blowdown, where dust emissions could be anticipated to be significantly elevated and are allowed for with higher ELVs during this activity. In all cases where data was provided, indicative performance has been judged to be above the upper BAT-AEL of 20 mg/m\(^3\).

Figure 3.7 provides a comparative picture of the relationship between values set through permit ELVs, reported averaged installation performance, LCP Directive limit values and BAT-AELs for the 3 liquid-fired combustion plants examined in this study.

**Figure 3.7** Comparative Ranges of Installation Performance, permit limits, LCP Directive limits and BAT-AELs for Dust Emissions from liquid-fired LCPs (chart) and Relationship Between Permit ELVs, performance and BAT-AELs for dust (mg/m\(^3\)) (radar graph)

Performance figures were only reported for two installations.

**Multi-fuel LCPs**

Two multi-fuel LCP installations were assessed as part of this study. There is a methodology contained within the LCP Directive for calculation of the appropriate permit emission limits (Article 8(1)(a)-(c)). However there is no current defined methodology for identifying relevant BAT-AELs and therefore no direct comparison was possible within the scope of this study.

For both installations, the analysis indicated that the permit ELVs had been set using the LCP Directive methodology.

### 3.3 Smitheries and Foundries

#### 3.3.1 Background to the Sector

The IPPC Directive, Annex I, activity 2.4 covers ferrous metal foundries with a production capacity exceeding 20 tonnes per day and activity 2.5(b) covers melting and alloyage of non-

\(^{18}\) Results were not available for one liquid-fired LCP.
ferrous metals and operation of non-ferrous metal foundries with a melting capacity exceeding 4 tonnes per day for Cd and Pb or 20 tonnes per day for all other metals.

Foundries melt ferrous and non-ferrous metals and alloys and reshape them into products at or near their finished shape through the pouring and solidification of the molten metal or alloy into a mould. A small series foundry is termed a ‘jobbing foundry’ and a large series one is termed a ‘series foundry’. Foundries can also be classified according to the type of metal manufactured (ferrous/non-ferrous) and the industry is diverse, with installations varying in size and consisting of a range of technologies depending on the size and type of product being produced.

The focus of this study is on ferrous foundries although some installations also produced alloyed metal components.

3.3.2 Key Environmental Issues and BAT

The main environmental impacts of foundries come from the melting and alloying of metals; the storage and handling of raw materials; and the use of energy. The main emissions subject to evaluation within the scope of this study are:

- **Dust**, both point source releases from main equipment such as the induction furnace and fugitive releases from sources such as storage and processing of scrap metals. Dust is the primary pollutant and is produced at all stages of the process including the metal melting, sand moulding, casting and finishing process. This also means that the dust could contain some metals and metal oxides.

- **NOx, CO and SO\(_2\)** emissions from the furnace\(^{19}\).

- **Dioxins**, which are produced as a by-product of incomplete combustion or other thermal processes that are not optimised in terms of operational parameters or raw material inputs.

- **Volatile organic compounds**, which are often produced within the foundry as a result of surface treatment (e.g. coating or stripping of metals) or the melting of metals finished with solvent-based coatings where some solvent remains in the coating.

The amount of water used within the process depends on the method and technology used within the process. The sector can also generate mineral residues such as slag and this material can be either re-used or disposed of.

Generic BAT relevant to the main emissions is to collect and treat dusty process emissions and off-gases (e.g. from melting, cutting, shot blasting and grinding) using a wet or dry system and to minimise fugitive releases of dust through containment and damping down where practicable.

BAT for **metal melting** is to use oxygen enrichment of the blast air; clean furnace off-gas by subsequent collection, cooling and dedusting (BAT for dedusting is to use a bag filter or wet scrubber); prevent and minimise dioxin and furan emissions and apply reliable and efficient process controls to shorten the melting and treatment time. It is also BAT to melt clean scrap; avoiding rusty and dirty inputs and adhering sand; apply good melting practice measures for the

\(^{19}\) SO\(_2\) emissions are only relevant to cupola and rotary furnaces.
furnace operation; and evaluate the possibility of waste heat recuperation. For induction furnaces, BAT is also to use a hood, lip extraction or cover extraction on each furnace to capture the off-gas and to maximise off-gas collection during the full working cycle and to use dry flue-gas cleaning; and keep dust emissions below 0.2 kg/tonne molten iron.

BAT for metal treatment (activities other than melting) if an AOD converter (application of dolomite refractory lining) is used for metal refining is to extract and collect the exhaust gas using a roof canopy; for nodularisation BAT is to select a nodularisation technique with no off-gas production or to capture the produced MgO smoke, using a lid or cover and dedust.

### 3.3.3 Main Emissions and Levels Associated with BAT

**Sources of Information**

The main emissions and levels associated with BAT have been taken from the BREF for Smitheries and Foundries (May 2005). BAT-AELs for emissions to air are summarised in the tables below.

#### Table 3.8 BAT Associated Emission Levels (AELs) for Cupola Melting of Ferrous Metals

<table>
<thead>
<tr>
<th>Process and furnace type</th>
<th>Pollutant</th>
<th>BAT-AEL (mg/Nm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cupola Furnace (Hot Blast)</td>
<td>CO</td>
<td>20 - 1000</td>
</tr>
<tr>
<td></td>
<td>SO₂</td>
<td>20 – 100</td>
</tr>
<tr>
<td></td>
<td>NOₓ</td>
<td>10 – 200</td>
</tr>
<tr>
<td>Cupola Furnace (Cold Blast)</td>
<td>SO₂</td>
<td>100 – 400</td>
</tr>
<tr>
<td></td>
<td>NOₓ</td>
<td>20 – 70</td>
</tr>
<tr>
<td></td>
<td>NMVOC</td>
<td>10 – 20</td>
</tr>
<tr>
<td>Cokeless</td>
<td>NOₓ</td>
<td>160 – 400</td>
</tr>
</tbody>
</table>

#### Table 3.9 BAT Associated Emission Levels (AELs) for the Electric Arc Furnace

<table>
<thead>
<tr>
<th>Process and furnace type</th>
<th>Pollutant</th>
<th>BAT-AEL (mg/Nm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Arc Furnace</td>
<td>NOₓ</td>
<td>10 – 50</td>
</tr>
<tr>
<td></td>
<td>CO</td>
<td>&lt; 200</td>
</tr>
</tbody>
</table>
Table 3.10  BAT Associated Emission Levels (AELs) for the Ferrous Metal Melting and Treatment (applies to furnace extraction and other emission points)

<table>
<thead>
<tr>
<th>Process and furnace type</th>
<th>Pollutant</th>
<th>BAT-AEL (mg/Nm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferrous metal melting and treatment</td>
<td>Dust</td>
<td>5 – 20</td>
</tr>
<tr>
<td></td>
<td>PCDD/PCDF</td>
<td>&lt;0.1 (ng TEQ/Nm³)</td>
</tr>
</tbody>
</table>

Table 3.11  BAT Associated Emission Levels (AELs) for the Rotary Melting of Ferrous Metals

<table>
<thead>
<tr>
<th>Process and furnace type</th>
<th>Pollutant</th>
<th>BAT-AEL (mg/Nm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotary melting of ferrous metals</td>
<td>SO₂</td>
<td>70 – 130</td>
</tr>
<tr>
<td></td>
<td>NOₓ</td>
<td>50 – 250</td>
</tr>
<tr>
<td></td>
<td>CO</td>
<td>20 – 30</td>
</tr>
</tbody>
</table>

For finishing of castings (for abrasive cutting, shot blasting and fettling), the BAT-AEL for dust is 5 - 20 mg/Nm³.

For the induction furnace, BAT is to limit dust emissions to below 0.2 kg/tonne molten iron.

Within the BREF, all of the AELs are quoted as an average over the practicable measuring period. Whenever continuous monitoring is practicable, the BREF indicates a daily average value should be used. Emission concentrations to air are based on standard reference conditions.

3.3.4 Results from the assessment of ferrous metal foundries covered by the IPPC Directive

The assessments covered 11 ferrous metal foundries across ten Member States; one plant per Member State except Portugal, where two were assessed. The findings with regard to main pollutant emissions are detailed below.

Dust Emissions

Analysis of the dust ELVs within permits (all dust generating processes) shows the range to be between 10 and 50 mg/m³, with Finland and Denmark setting the lowest ELVs in their permits at 10 mg/m³ for all sources. The Estonian permit sets limits based on mass (tonnes), which were incomparable with the provided data on dust emissions from other installations. Five permits had dust ELVs set within the BAT-AEL ranges for all sources; three had some but not all set within the BAT-AEL ranges. Two permits had higher limits (100/300 mg/m³) but these limits were reduced to 20 mg/m³ from January 2010.
The monitoring of dust emissions is typically carried out on a periodic basis, the evidence suggesting the frequency to be between quarterly (one case) and once every three years (one case). The most common monitoring frequency for dust emissions was twice per year. Averaging periods have not been specified within the permits in many cases, however where they have been, 30 minute averages are the most common (three cases).

Analysis of actual emissions of dust from ferrous metal foundries indicates that, as a general trend, the concentrations are well below the permit ELVs. No assessment has been made of fugitive emissions of dust from ferrous metal foundries as no data was provided on releases of fugitive dust from any of the 11 installations.

Figure 3.8 indicates the relative ranges of performance against permit limits and BAT-AELs for dust emissions from ferrous metal foundries.

![Figure 3.8 Comparative Ranges of Installation Performance, Permit Limits and BAT-AELs for Dust Emissions from Ferrous Metal Foundries](image)

Two installations were unable to provide comprehensive dust emissions data for 2008 and/or 2009. One foundry has since reduced ELVs from 300mg/m$^3$ to 20mg/m$^3$ in a permit revision issued in 2010 (300mg/m$^3$ limit was an interim limit).

Further analysis of dust emissions from the main emission points across the 9 installations that submitted dust emissions data (Figure 3.9) reveals that emission levels from the furnaces are typically lower than from the treatment/casting/finishing area but not generally lower than sand regeneration and mould preparation areas. Emissions over 30 mg/m$^3$ were reported from all main sources with the highest values being reported from shot blasting and finishing areas. Where these higher levels of dust emissions were reported, the indication from the permits and discussions with the operators was that abatement measures were being applied (e.g. bag filters). In two cases the reasons for the higher emissions were due to damaged filters and in one case no reason was given, although the permit ELV in this case was 50 mg/m$^3$, and the operator noted a lack of incentive to achieve lower levels.
Emissions from the Melting Process

The main emissions from the melting processes are off-gases and include dust, NOx, metal oxides, SO2 and CO. Only limited emissions monitoring data was provided by the plants assessed in this study.

NOx results were provided for three electric arc (induction) furnaces. Results varied between 0.5 and 34 mg/m³, all clearly below the upper BAT-AEL value. As shown in the graph below, permit limits on NOx emissions from the furnaces were typically set significantly higher than typical emission levels, between 50 and 500 mg/m³. A comparison between permit ELVs, performance and BAT-AELs is outlined in Figure 3.10.

Figure 3.9  Comparison of Dust Emission Levels for Main Foundry Processes (for 2008 and 2009, where data was provided)

Figure 3.10  Comparative Ranges of NOx Emission Levels for electric arc furnaces (for 2008 and 2009, where data was provided)
One installation operated a cupola furnace (cold blast), the NOx emissions were reported as being 37 mg/m³ (annual average), which is higher than many of the emissions recorded from the induction furnaces examined. In this case, the results from the cupola furnace were below the BAT-AEL of 20-70 mg/m³ and yet the permit limit was much higher at 500 mg/m³.

The highest NOx emission levels reported were from treatment furnaces, including a tension-relief furnace (74-255 mg/m³) and a heat treatment furnace (83 mg/m³).

Limits on dioxin emissions were set in only two of the eleven permits examined, at 0.1 and 0.25 ngTEQ/m³, respectively BAT-AEL upper value is 0.1 ng TEQ/Nm³). Dioxin emissions were only reported for three installations, although results were reported from seven separate furnace emission points (all induction furnaces). The emissions were in the range 0.001-0.07 ngTEQ/m³, so below the upper BAT-AEL. Figure 3.11 shows the relationship between emission limits, performance and BAT-AELs for dioxins.

**Figure 3.11** Comparative Ranges of Dioxin Emission Levels for Three Installations (7 furnaces in total for 2009 and 2010, where data was provided)

![Diagram showing dioxin emission levels](image)

### 3.4 Manufacture of Ceramics (Bricks, Blocks and Tiles)

The IPPC Directive, activity reference 3.5, covers the manufacture of ceramic products by firing, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain, with a production capacity exceeding 75 tonnes per day, and/or with a kiln capacity exceeding 4 m³ and with a setting density per kiln exceeding 300 kg/m³.

The ceramics industry is comprised of nine major sectors of ceramic products. The assessments in this report, and hence the content of this summary section, specifically focus on the **Bricks and Roof tiles** manufacturing sector.

#### 3.4.1 Background to the Sector

Generally the term ‘ceramics’ (ceramic products) is used for inorganic materials (with possibly some organic content), made up of non-metallic compounds and made permanent by a firing process.
Brick products are produced in large quantities and are used as materials in numerous branches of building and contracting. For the most part, bricks and tiles are not designated according to the shaping technique used, but according to the intended application: building bricks (clay blocks, facing bricks, engineering bricks (‘clinker bricks’) and lightweight bricks); roof tiles (extruded tiles, pressed tiles); paving bricks; and chimney bricks (chimney pipes).

The main process stages in both brick and roof tile manufacturing are: mining/quarrying of raw materials (not covered by Ceramics BREF); storage of raw materials; raw materials preparation; shaping; drying; firing; and subsequent treatment. Special requirements for the surface and colour of the products involve surface treatment by glazing, engobing or profiling.

### 3.4.2 Key Environmental Issues and BAT

The main environmental issues that arise from ceramic manufacturing installations are emissions to air and water, efficient use of energy, raw material and water usage, minimisation, recovery and recycling of process losses/waste and process wastewater.

The main emissions (subject to evaluation within the scope of this study) are:

- Dust, from the preparation and transportation of clays and other raw materials used in the brick manufacturing process.

- NOx, HF, HCl, VOCs, dust and SO2 (variable depending on S content in the clays) from the kiln (firing process) and residual emissions from the brick and tile drying process.

- Suspended solids and metals discharged to water. These are produced as a result of surface run-off and wash-down of plant and equipment.

The specific environmental issues can vary depending on the process and factory layout, the fuels used for drying and kiln operation and raw materials (clay composition) used to produce the products. The composition of chemical compounds within the clay in particular is highly sensitive to geography with clays displaying different chemical characteristics even within the same geographic region. These chemicals can react and be emitted during the kiln firing process and therefore adequate quality control measures should be used to reduce the emissions of key pollutants – this may include conditions on raw materials within IPPC permits such as tiered emission limits or blending of clays from different sites.

**Generic BAT** for ceramics manufacturing relevant to the main emissions includes reducing diffuse and fugitive sources of dust through containment and effective storage controls and from drying processes by cleaning the dryer, by avoiding the accumulation of dust residues in the dryer and by adopting adequate maintenance protocols.

For kiln-firing, BAT is utilisation of low ash fuels and control of charging ware to the kiln, together with applying dry flue-gas cleaning (fabric filters). BAT is to apply primary measures to reduce emissions of NOx.

BAT for the bricks and roofing tiles sub-sector is to reduce the emissions of gaseous compounds (i.e. HF, HCl, SO2) from the flue-gases of kiln firing processes by the addition of calcium-rich additives and to reduce the emissions of volatile organic compounds from the flue-gases of firing processes (depending on the raw gas characteristics, e.g. composition, temperature) by applying thermal afterburning either in a one or a three chamber thermo-reactor.
3.4.3 Main Emissions and Levels Associated with BAT

Table 3.13 BAT-AELs for Air Emissions from BREF on Ceramic Manufacturing

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>BAT-Associated Emission Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>HF</td>
<td>1 – 10 mg/m$^3$ (Note 1)</td>
</tr>
<tr>
<td>HCl</td>
<td>1 – 30 mg/m$^3$ (Note 2)</td>
</tr>
<tr>
<td>$SO_x$ stated as $SO_2$</td>
<td>$&lt;500$ mg/m$^3$ in case of sulphur content in raw material $&lt; 0.25%$</td>
</tr>
<tr>
<td>$NO_x$ stated as $NO_2$</td>
<td>$&lt; 250$ mg/m$^3$ (daily average value ) if kiln $&lt;1300\degree C$</td>
</tr>
<tr>
<td>$NO_x$ stated as $NO_2$</td>
<td>$&lt; 500$ mg/m$^3$ (daily average value ) if kiln $&gt;1300\degree C$</td>
</tr>
<tr>
<td>$VOCs$</td>
<td>$5 – 20$ mg/m$^3$ (daily average value stated as total C) (Note 4)</td>
</tr>
<tr>
<td>$VOCs$</td>
<td>$5 – 20$ mg/m$^3$ (daily average value stated as total C) (Note 4)</td>
</tr>
<tr>
<td>Particulates/Dust</td>
<td>Dusty operations: $1 – 10$ mg/m$^3$ (half-hourly average value)</td>
</tr>
<tr>
<td></td>
<td>Drying Processes: $1 – 20$ mg/m$^3$ (daily average value)</td>
</tr>
<tr>
<td></td>
<td>Kiln firing: $1 – 20$ mg/m$^3$</td>
</tr>
</tbody>
</table>

1. The higher BAT level can be lower depending on the characteristics of the raw material.
2. The higher BAT level can be lower depending on the characteristics of the raw material.
3. The higher BAT level only applies to raw material with extremely high sulphur content.
4. VOC BAT-AEL was confirmed not to be applicable in one Portuguese installation.

Table 3.14 BAT-AELs for Water Emissions from BREF on Ceramic Manufacturing

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>BAT-Associated Emission Level (based on 2 hours composite sample)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspended Solids</td>
<td>50 mg/l</td>
</tr>
<tr>
<td>Adsorbable Organic Halides (AOX)</td>
<td>0.1 mg/l</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>0.3 mg/l</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>2.0 mg/l</td>
</tr>
<tr>
<td>Cadmium(Cd)</td>
<td>0.07 mg/l</td>
</tr>
</tbody>
</table>

Notes:
If more than 50% of the process water is re-used in the manufacturing processes, higher concentrations of these pollutants may still be BAT AELs, as long as the specific pollutant load per production amount (kg of processed raw material) is not higher than the pollutant load resulting from a water recycling rate of less than 50%.

3.4.4 Results from the Assessment of Ceramics Installations (bricks, blocks and tiles) covered by the IPPC Directive

The findings of the analysis on the ten permits for brick and tile manufacturing installations were that nine permits contained ELVs for all of the main air pollutants. In one case, these limits were based on the contribution made by the installation to local ambient pollutant concentrations (i.e. an equivalent parameter) expressed as total emissions equals total background less ambient concentrations (judged from prior assessment of air quality). In one
permit, pollutant emission limits were set using different units (tonnes per year) and were therefore not directly comparable with BAT-AELs.

One permit (Finland) did not include any ELVs. The justification provided by the competent authority was that, based on an impact assessment and the operator’s application of the BAT to prevent or reduce pollution, limits were not considered necessary to regulate emissions from the installation. No evidence of the BAT assessment or judgement on it was provided during the site visit although it has been confirmed that releases to air were made without abatement, which appears to be not in-line with the requirements set out in the Directive.

One installation assessed was non-operational throughout 2009.

It appeared to be the case in four of the ten permits that the emission limits set (ELVs and/or equivalent parameters) were based on the application of BAT and would limit pollutant concentrations to levels equivalent to BAT-AELs given in the BREF for all main emissions. Three permits showed evidence of some but not all permit conditions being based on BAT / BAT-AELs and three permits showed no clear evidence of being BAT based.

Analysis of the permit emission limits from the kiln-firing process (the main emissions) indicates that:

- Dust ELVs ranged from 20 to 150 mg/m³ with the most common value being 50 mg/m³ (BAT-AEL upper value is 20 mg/m³). ELVs were based on daily averages in two permits and 30 minute averages in three permits. Four permits had no specified averaging period and one had no dust limits. Monitoring of dust was on a periodic basis in each case, with frequency ranging from monthly (one permit) through to every five years (one permit).

- NOx ELVs ranged from 250 to 1500 mg/m³ (mostly daily or 30 minute average values) and in one permit NOx limits were not set. In one permit no averaging period was set for ELVs. The majority of ELVs were set above the relevant BAT-AELs. Monitoring of NOx was typically on a periodic basis with frequency ranging from monthly (one permit) through to every three years. In one case, NOx emissions were calculated.

- SO₂ ELVs ranged from 236 to 1800 mg/m³, and all were within the BAT-AEL ranges. Two installations based their SO₂ ELV on using higher sulphur content clay (>0.25%). Emissions of SO₂ were monitored at the same frequency as NOx emissions.

- HF ELVs ranged from 5 to 15 mg/m³ and, with the exception of one installation, were within the BAT-AEL range. Five installations had no permit ELV for HF or had a value that was not comparable with the BAT-AEL (e.g. mass limits). Where a permit ELV was set, the averaging periods were defined in the permit as either 30 minutes or daily. Monitoring, in all cases, was periodic with frequencies the same as for the other gaseous pollutants.

- HCl ELVs were set at 30 mg/m³, i.e. at the upper end of the BAT-AEL range (1-30 mg/m³) for five permits and at 100 mg/m³ in one permit. HCl ELVs were not set in four of the ten permits examined although one of these set an equivalent parameter (environmental contribution) and one set mass-release-based limits (both of which were incomparable with the BAT-AEL).
Figure 3.12 is a series of tables graphically representing the comparative ranges of pollutant permit limits, emission levels and BAT-AELs for the major processes at ceramics manufacturing installations.

**Figure 3.12 Comparative Ranges of Main Pollutant Emission Levels from Ceramics Installations (2008 and 2009, where data was provided)**

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>BAT-AELs</th>
<th>Permit ELVs</th>
<th>Installation Performance (2008/2009)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dust</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NOx</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SO2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HCL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VOC</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The analysis of data provided by operators (for 2008 and 2009) indicates that, based on annual average emission values for the main pollutants, emissions from only four out of the ten installations were within their permit ELVs for all pollutants. Five installations were judged to have a mixed position; emissions from some points were below the ELV and from others they were above. One installation had no ELVs and therefore a comparison of performance was not possible.

Assessing the performance of each installation against relevant BAT-AELs indicates that, at two of the ten installations, emission levels for all main pollutants were within the BAT-AEL range. Seven of the ten installations were judged to have some emission levels above the relevant BAT-AELs. One installation reported no emissions data.

Comparing annual averaged actual emissions from the kiln-firing process to relevant BAT-AELs, the majority of reported main pollutant emissions were within the relevant BAT-AELs:

- NOx emissions were in the range 0.8-235 mg/m³, with all reported values being within the 250 mg/m³ upper BAT-AEL.
• SO₂ emissions were generally low with the exception of a single installation, which reported very high SO₂ emission concentrations up to 2360 mg/m³ but which used clays with a higher level of sulphur in.

• HCl emissions were mostly within the 1-30 mg/m³ range with the exception of one installation, which calculated (as opposed to measuring) HCl emissions from two emission points to be 50 and 70 mg/m³.

• HF emissions were generally very low; the majority of values were below 1 mg/m³, well within the BAT-AEL range of 1-10 mg/m³. One installation reported a value of 10.1 mg/m³ and one calculated their emissions and reported them to be 70 mg/m³.

Emissions of VOCs were in the range 2.9-127 mg/m³, with 5 of the 11 installations reporting average values that were above the BAT-AEL. The raw gas characteristics and concentration of VOCs was determined only at one installation and therefore a truly meaningful comparison against the BAT-AEL was not practicable.

Figure 3.13 graphically represents the annual average pollutant emission levels from the kiln-firing process for emissions reported for 2008 and 2009 from eight installations. One installation reported no values and one reported values in incomparable units.

**Figure 3.13** Main Pollutant Emission Concentrations from the Kiln-firing Process at Eight IPPC Ceramics Installations (annual average data, where available, from 2008 and 2009) (scale is logarithmic)

Dust emissions are another main pollutant from the ceramics manufacturing sector. Focusing specifically on dust emissions from separate sources, the analysis (Figure 3.14) indicates that concentrations are highest from the drying process, with significantly more averaged values
being above the BAT-AEL of 1-20 mg/m³ compared to other processes, although more data points were reported for these sources.

**Figure 3.14  Dust Concentrations from the Main Sources in Ceramics Manufacture (annual average data, where available, from 2008 and 2009)**

Concentrations of dust from the kiln-firing process were in the range 0.01-51 mg/m³, from the drying operations 0.8-54 mg/m³ and from other dusty operations 1.5-17 mg/m³. Figure 3.14 shows that 18 out of the 69 annual average values were above the upper BAT-AEL of 20 mg/m³. When evaluating reported values against the BAT-AEL range for dust, it should be noted that annual average values are not directly comparable with daily averages and therefore results are indicative (and conservative) rather than conclusive.

3.5 Incineration of Waste

The incineration of hazardous and municipal waste are activities listed within Section 5.1 and 5.2 of Annex I to the IPPC Directive. The assessment in this report is specifically focused on the dedicated incineration of waste and not other situations where waste is thermally treated e.g. co-incineration of waste in e.g. cement kilns and combustion plants.

3.5.1 Background to the Sector

The objective of waste incineration is to treat waste so as to reduce its volume and hazard, whilst capturing or destroying potentially harmful substances. Incineration processes can also provide a means to enable recovery of the energy, mineral and/or chemical content from waste. Waste is generally a highly heterogeneous material, consisting essentially of organic substances, minerals, metals and water.
3.5.2 Key Environmental Issues

The main environmental issues that arise from incineration installations include process emissions to air and water; fugitive emissions (including odour, mainly from waste storage); process residues; noise and vibration; energy consumption; and reduction of the storage/handling/processing risks of hazardous wastes.

Though the type of technology used in this sector has led to a reduction in emissions to air from incineration, this is still an important issue for this sector. The main emissions to air from the incineration process (and which form the focus of this study) are: Particulate matter, acidic compounds (including HCl, HF, SO₂, NOₓ, NH₃), heavy metals (Hg, Cd, Tl, As, Ni, Pb), CO, and organic compounds (VOCs, PCDD/F, PCBs).

The main potential sources of releases to water are from effluents from air pollution control devices; final effluent discharges from wastewater treatment plants; boiler cooling water; road and other surface drainage; incoming waste storage, handling and transfer areas; raw material storage areas; and residue handling, treatment and storage areas. The main water pollutants/parameters and those examined as part of the assessment of waste incineration installations are: Suspended solids, organic carbon, heavy metals, dioxins and biological oxygen demand.

One of the other environmental issues is the nature and quantity of residues produced. An examination of this issue has not been made as part of this study.


The WI Directive sets minimum requirements for waste incineration and co-incineration plants that apply to all new plants since December 2002 and existing plants since December 2005. Most types of waste incineration plants fall within the scope of the WI Directive, with some exceptions (such as those treating only biomass waste). The WI Directive specifies limit values for emissions to air as well as for emissions to water from cleaning exhaust gases, which must not be exceeded. It also sets requirements concerning operating conditions, including mandatory process and emission monitoring.

Many of the plants that are covered by the WI Directive are also covered by the IPPC Directive (where a capacity threshold applies).

According to Article 19(2) of the IPPC Directive, the emission limit values set out in the Waste Incineration Directive (2000/76/EC) shall be applied as minimum emission limit values pursuant to the IPPC Directive. This is confirmed by Recital 13 of the WI Directive:

“Compliance with the emission limit values laid down by this Directive should be regarded as a necessary but not sufficient condition for compliance with the requirements of Directive 2008/1/EC. Such compliance may involve more stringent emission limit values for the pollutants envisaged by this Directive, emission limit values for other substances and other media, and other appropriate conditions.”

It is therefore obvious that the WI Directive applies without prejudice to the IPPC Directive and hence does not remove the obligation to operate in compliance with a permit containing emission limit values or equivalent parameters and technical measures based on BAT. Table
3.15 and 3.16 outline the main limit values for air and waste water from flue gas cleaning, respectively, as set out within the WI Directive.

Table 3.15  Emission Limit Values for air as defined within the WI Directive

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>WI Directive emission limit values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WI Directive emission limit values</td>
</tr>
<tr>
<td></td>
<td>Daily Average Values</td>
</tr>
<tr>
<td>Total dust</td>
<td>10 mg/m³</td>
</tr>
<tr>
<td>Hydrogen chloride (HCl)</td>
<td>10 mg/m³</td>
</tr>
<tr>
<td>Hydrogen fluoride (HF)</td>
<td>1 mg/m³</td>
</tr>
<tr>
<td>Sulphur dioxide (SO₂)</td>
<td>50 mg/m³</td>
</tr>
<tr>
<td>Nitrogen monoxide (NO) and nitrogen dioxide (NO₂), expressed as nitrogen dioxide</td>
<td>200 mg/m³ (new incineration plants or existing plants &gt;6 tonnes per hour capacity)</td>
</tr>
<tr>
<td></td>
<td>400 mg/m³ (existing plants with capacity 6 tonnes per hour or less)</td>
</tr>
<tr>
<td>Gaseous and vaporous organic substances, expressed as TOC</td>
<td>10 mg/m³</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Emission limit value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon monoxide (CO)</td>
<td>50 mg/m³ (daily average – 97% of values need to comply with this)</td>
</tr>
<tr>
<td></td>
<td>150 mg/m³ (of 95% of all measurements as 10 minute average) or</td>
</tr>
<tr>
<td></td>
<td>100 mg/m³ (as half-hourly values over a 24 hour period)</td>
</tr>
<tr>
<td>Mercury and its compounds (as Hg)</td>
<td>Total 0.05 mg/m³ (sampling period minimum 30 minutes and maximum 8 hours)</td>
</tr>
<tr>
<td>Total cadmium and thallium (and their compounds expressed as the metals)</td>
<td>Total 0.05mg/m³ (sampling period minimum 30 minutes and maximum 8 hours)</td>
</tr>
<tr>
<td>Σ other metals</td>
<td>Total 0.5 mg/m³ (sampling period minimum 30 minutes and maximum 8 hours)</td>
</tr>
<tr>
<td>Dioxins and furans</td>
<td>0.1ng I-TEQ / Nm³ sampling period minimum 6 hours and maximum 8 hours</td>
</tr>
</tbody>
</table>

Reference conditions for the above ELVs are: Temperature 273 K, pressure 101.3 kPa, 11% oxygen (3% oxygen if burning waste oils), dry gas.
Table 3.16 WI Directive Emission Limit Values for Discharges of Waste Water from the Cleaning of Exhaust Gases

<table>
<thead>
<tr>
<th>Parameter</th>
<th>WI Directive emission limit values (unfiltered samples)</th>
<th>Compliance Rules (Article 11(10))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total suspended solids (as defined by Directive 91/271/EEC)*</td>
<td>95% 30 mg/l, 100% 45 mg/l</td>
<td>The emission limit values for water shall be regarded as being complied with if: (a) for total suspended solids, 95% and 100% of the measured values do not exceed the respective emission limit values; (b) for heavy metals, no more than one measurement per year exceeds the emission limit values set out in Annex IV; or, if the Member State provides for more than 20 samples per year, no more than 5% of these samples exceed the emission limit values; (c) for dioxins and furans, the twice-yearly measurements do not exceed the emission limit value.</td>
</tr>
<tr>
<td>Hg and its compounds, expressed as Hg</td>
<td>0.03 mg/l</td>
<td></td>
</tr>
<tr>
<td>Cd and its compounds, expressed as Cd</td>
<td>0.05 mg/l</td>
<td></td>
</tr>
<tr>
<td>Ti and its compounds, expressed as Ti</td>
<td>0.05 mg/l</td>
<td></td>
</tr>
<tr>
<td>As and its compounds, expressed as As</td>
<td>0.15 mg/l</td>
<td></td>
</tr>
<tr>
<td>Pb and its compounds, expressed as Pb</td>
<td>0.2 mg/l</td>
<td></td>
</tr>
<tr>
<td>Cr and its compounds, expressed as Cr</td>
<td>0.5 mg/l</td>
<td></td>
</tr>
<tr>
<td>Cu and its compounds, expressed as Cu</td>
<td>0.5 mg/l</td>
<td></td>
</tr>
<tr>
<td>Ni and its compounds, expressed as Ni</td>
<td>0.5 mg/l</td>
<td></td>
</tr>
<tr>
<td>Zn and its compounds, expressed as Zn</td>
<td>1.5 mg/l</td>
<td></td>
</tr>
<tr>
<td>Dioxins and furans, defined as the sum of the individual dioxins and furans evaluated in accordance with Annex I</td>
<td>0.3 mg/l</td>
<td></td>
</tr>
</tbody>
</table>

* Continuous measurement or alternatively spot sample daily measurements of a flow proportional representative sample over a 24 hour period.

3.5.4 BAT for the Incineration of Waste

BAT for the incineration of waste has been defined at the EU level in the BREF on Waste Incineration (adopted by the Commission in August 2006).

The BREF presents ‘generic BAT’ (applicable to all types of waste incineration), which includes the management and proper storage of incoming wastes prior to their treatment; avoiding pollution and odour releases; and treating incoming wastes to the degree required to meet the design specification. It covers minimisation of planned and unplanned shutdowns and use of combustion operating conditions specified in Article 6 of the WI Directive. The BREF also presents ‘process-specific BAT’, which covers the specific techniques and technologies employed within the waste incineration sector and the different waste types. These are clearly set out within the BREF and, for brevity, are not further repeated here.

3.5.5 Main Emissions and Levels Associated with BAT

The types and levels of pollutant emissions from the operation of waste incinerators are influenced by waste composition and content; furnace technical measures (design and operation); and the design and operation of flue-gas cleaning equipment.
### Emissions to Air

Municipal waste incineration plants generally produce flue-gas volumes (at 11 % oxygen) of between 4,500 and 6,000 m³ per tonne of waste. For hazardous waste incineration plants, this value (at 11 % oxygen) is generally between 6,500 and 10,000 m³, depending mainly on the average thermal value of the waste.

#### Table 3.17 Waste Incineration BREF BAT-Associated Emission Levels for Releases to Air

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>In case of non-Continuous monitoring</th>
<th>Half-hourly average in case of continuous monitoring</th>
<th>24 hour average in case of continuous monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total dust</td>
<td>1 – 20 mg/m³</td>
<td>1 – 5 mg/m³</td>
<td></td>
</tr>
<tr>
<td>Hydrogen chloride (HCl)</td>
<td>1 – 50 mg/m³</td>
<td>1 – 8 mg/m³</td>
<td></td>
</tr>
<tr>
<td>Hydrogen fluoride (HF)</td>
<td>&lt;2 mg/m³</td>
<td>&lt;1 mg/m³</td>
<td></td>
</tr>
<tr>
<td>Sulphur dioxide (SO₂)</td>
<td>1 – 150 mg/m³</td>
<td>1 – 40 mg/m³</td>
<td></td>
</tr>
<tr>
<td>Nitrogen monoxide (NO) and nitrogen dioxide (NO₂), expressed as nitrogen dioxide for installations <strong>using SCR</strong></td>
<td>40 – 300 mg/m³</td>
<td>40 – 100 mg/m³**</td>
<td></td>
</tr>
<tr>
<td>Nitrogen monoxide (NO) and nitrogen dioxide (NO₂), expressed as nitrogen dioxide for installations <strong>not using SCR</strong></td>
<td>30 – 350 mg/m³</td>
<td>120 – 180 mg/m³</td>
<td></td>
</tr>
<tr>
<td>Gaseous and vaporous organic substances, expressed as TOC</td>
<td>1 – 20 mg/m³</td>
<td>1 – 10 mg/m³</td>
<td></td>
</tr>
<tr>
<td>Carbon monoxide (CO)</td>
<td>5 – 100 mg/m³</td>
<td>5 – 30 mg/m³</td>
<td></td>
</tr>
<tr>
<td>Mercury and its compounds (as Hg)</td>
<td>&lt;0.05 mg/m³*</td>
<td>0.001 – 0.03 mg/m³</td>
<td>0.001 – 0.02 mg/m³</td>
</tr>
<tr>
<td>Total cadmium and thallium (and their compounds expressed as the metals)</td>
<td>0.005 – 0.05 mg/m³*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Σ other metals</td>
<td>0.005 – 0.5 mg/m³</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dioxins and furans</td>
<td>&lt;0.1 ng TEQ/m³</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ammonia (NH₃)</td>
<td>&lt;10 mg/m³*</td>
<td>1-10 mg/m³</td>
<td>&lt;10 mg/m³ **</td>
</tr>
</tbody>
</table>

* Split Views expressed on these values
NOTES:

- $\sum$ other metals = sum of Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V and their compounds expressed as the metals for which average values are expressed over the sample period of a minimum of 30 minutes and a maximum of 8 hours. These average values cover also gaseous and the vapour forms of the relevant heavy metal emissions as well as their compounds.
- Non-continuous measurements are averaged over a sampling period of between 30 minutes and 8 hours. Sampling periods are generally in the order of 4 – 8 hours for such measurements.
- All values are standardised at 11 % Oxygen, dry gas, 273K and 101.3kPa
- Dioxin and furans are calculated using the equivalence factors set out in Annex I of the WI Directive

Emissions to Water

The principal potential sources of pollutant releases to water come from the liquid discharges from the flue gas treatment plant. Wet flue-gas cleaning systems give rise to waste water whereas semi-wet and dry systems generally do not. Wet flue-gas cleaning is the main source of effluents, although in some cases waste water arising from wet gas scrubbing is evaporated in the incineration process using a spray dryer. In such cases the waste water is generally pretreated in an effluent treatment plant (ETP) before it is fed to the spray dryer.

Treatment in an ETP can help to prevent the recirculation and accumulation of some substances. Mercury recirculation is of particular concern to operators and specific reagents are usually added to provide a means for removal of mercury from the system. Salts can be recovered from the treated effluent for possible industrial uses, or may be collected in the flue gas treatment residues.

Waste water from municipal waste incineration plants mainly contains the following substances, which require treatment: heavy metals, including mercury; inorganic salts (chlorides, sulphates etc.); and organic compounds (phenols, PCDD/PCDF).

**Table 3.18 BREF BAT-Associated Emission Level Ranges for Discharges of Waste Water from the Cleaning of Exhaust Gases**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BREF BAT AEL range (in mg/l unless stated)</th>
<th>Sampling and data information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total suspended solids (as defined by Directive 91/271/EEC)</td>
<td>10 – 30 (95 % in range) 10 – 45 (100 % in range)</td>
<td>Based on spot daily or 24 hour flow proportional sample</td>
</tr>
<tr>
<td>Chemical oxygen demand</td>
<td>50 – 250</td>
<td>Based on spot daily, or 24 hour flow proportional sample</td>
</tr>
<tr>
<td>pH</td>
<td>pH 6.5 – pH 11</td>
<td>Continuous measurement</td>
</tr>
<tr>
<td>Hg and its compounds, as Hg</td>
<td>0.001 – 0.03*</td>
<td>Based on monthly measurements of a flow proportional representative sample of the discharge over a period of 24 hours with one measurement per year exceeding the values given, or no more than 6 % where more than 20 samples are assessed per year</td>
</tr>
<tr>
<td>Cd and its compounds, as Cd</td>
<td>0.01 – 0.05*</td>
<td>Total Cr levels below 0.2 mg/l provide for control of Chromium VI</td>
</tr>
<tr>
<td>Ti and its compounds, as Ti</td>
<td>0.01 – 0.05*</td>
<td></td>
</tr>
<tr>
<td>As and its compounds, as As</td>
<td>0.01 – 0.15*</td>
<td></td>
</tr>
<tr>
<td>Pb and its compounds, as Pb</td>
<td>0.01 – 0.1</td>
<td></td>
</tr>
<tr>
<td>Cr and its compounds, as Cr</td>
<td>0.01 – 0.5*</td>
<td></td>
</tr>
</tbody>
</table>
Parameter | BREF BAT AEL range (in mg/l unless stated) | Sampling and data information
--- | --- | ---
Cu and its compounds, as Cu | 0.01 – 0.5* | 
Ni and its compounds, as Ni | 0.01 – 0.5* | 
Zn and its compounds, as Zn | 0.01 – 1.0* | 
Sb and its compounds, as Sb | 0.005 – 0.85* | 
Co and its compounds, as Co | 0.005 – 0.05 | 
Mn and its compounds, as Mn | 0.02 – 0.2 | 
V and its compounds, as V | 0.03 – 0.5* | 
Sn and its compounds, as Sn | 0.02 – 0.5 | 
PCDD/F (TEQ) | 0.01 – 0.1 ng TEQ/l* | 

* Split views expressed by Member States on these BAT-AEL values

3.5.6 Results from the Assessment of the Waste Incineration Sector Covered by the IPPC Directive

The findings from the analysis of eight IPPC-permitted waste incineration installations were that ELVs were set for all the main pollutants (air and water) in seven out of the eight permits examined. One permit did not set a limit for ammonia emissions resulting from the treatment of the flue gases with SNCR (selective non-catalytic reduction). The rationale provided by the competent authority for not including a limit was that injection of ammonia was small and that entrained ammonia was cleaned from the gas stream during flue gas treatment.

Each of the installations assessed during this study employed techniques to prevent or, where not practicable, reduce emissions of the main air pollutants from the incineration process and treatment of flue gases. Table 3.19 summarises the range of abatement measures employed at each installation.

Table 3.19 Summary of abatement Measures for air pollutants Employed at the Eight Waste Incinerator Installations Examined as part of this Study

<table>
<thead>
<tr>
<th>FGT Scrubbing</th>
<th>ESPs</th>
<th>SNCR / SCR</th>
<th>Activated Carbon</th>
<th>Venturi / Cyclones</th>
<th>Bag Filters</th>
</tr>
</thead>
<tbody>
<tr>
<td>BE-05</td>
<td>Wet</td>
<td>Yes</td>
<td>SNCR</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>DK-04</td>
<td>Wet</td>
<td>Yes</td>
<td>SNCR</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>DK-05</td>
<td>Wet</td>
<td>-</td>
<td>SNCR</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>FI-04</td>
<td>Wet</td>
<td>-</td>
<td>SNCR</td>
<td>Yes</td>
<td>-</td>
</tr>
<tr>
<td>FI-05</td>
<td>Semi-dry</td>
<td>-</td>
<td>SNCR</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>HU-04</td>
<td>Semi-dry</td>
<td>-</td>
<td>SNCR</td>
<td>Yes</td>
<td>Yes – dual</td>
</tr>
<tr>
<td>PT-05</td>
<td>Semi-wet</td>
<td>-</td>
<td>SNCR</td>
<td>Yes</td>
<td>-</td>
</tr>
<tr>
<td>SI-04</td>
<td>Dry</td>
<td>-</td>
<td>SNCR</td>
<td>Yes</td>
<td>-</td>
</tr>
</tbody>
</table>
The performance of the installations based on emissions of the main pollutants to air and water was assessed using annualised average values for data taken during 2008 and 2009 where this was made available. Table 3.20 presents a summary of the analysis of the pollutant emissions data for the main air pollutants from the eight installations.

Table 3.20  Summary of Installation Performance Ranges (based on measurements made in 2008 and 2009 where data was available) for Key Pollutants Compared to Relevant BAT-AELs and Applicable WI Directive limits

<table>
<thead>
<tr>
<th>Emission range</th>
<th>Median Value</th>
<th>No. of measurements</th>
<th>Permit ELV range (daily average)</th>
<th>No. of Permit ELVs within BAT-AEL</th>
<th>BAT-AEL range</th>
<th>WI Directive limit value (daily average)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>≤BAT upper</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dust</td>
<td>0.01 – 3.3</td>
<td>0.62</td>
<td>32</td>
<td>32</td>
<td>5-10</td>
<td>1-5</td>
</tr>
<tr>
<td>CO</td>
<td>1 - 62.5</td>
<td>7.9</td>
<td>32</td>
<td>31</td>
<td>30-50</td>
<td>5-30</td>
</tr>
<tr>
<td>NOx</td>
<td>50 – 238</td>
<td>162.5</td>
<td>32</td>
<td>28</td>
<td>100-200</td>
<td>2</td>
</tr>
<tr>
<td>SO₂</td>
<td>1 – 32.9</td>
<td>7.3</td>
<td>32</td>
<td>32</td>
<td>40-50</td>
<td>2</td>
</tr>
<tr>
<td>HCl</td>
<td>0.1 – 8</td>
<td>2.7</td>
<td>32</td>
<td>32</td>
<td>8-10</td>
<td>1</td>
</tr>
<tr>
<td>HF</td>
<td>0.001 – 0.71</td>
<td>0.1</td>
<td>31</td>
<td>31</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>TOC</td>
<td>0.17 – 2</td>
<td>0.5</td>
<td>24</td>
<td>24</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Hg</td>
<td>0.0003-0.026</td>
<td>0.0009</td>
<td>32</td>
<td>32</td>
<td>0.05</td>
<td>0</td>
</tr>
<tr>
<td>Dioxins</td>
<td>0.001-0.047</td>
<td>0.006</td>
<td>32</td>
<td>32</td>
<td>0.1</td>
<td>8</td>
</tr>
<tr>
<td>NH₃</td>
<td>0.01 – 4.6</td>
<td>1</td>
<td>10</td>
<td>10</td>
<td>5-10</td>
<td>3</td>
</tr>
</tbody>
</table>

*Permit ELVs, BAT-AELs and WI Directive limit values are expressed in mg/m³ except for dioxins (ng TEQ/m³). They are daily average values. Performance ranges are show as annual average values from aggregated and annually averaged daily average data from continuous monitoring taken over 2008 and 2009 (where data was available). In case of non-continuous monitoring (e.g. PCDD/F), average of all values measured in one year. Results should be interpreted as indicative and not directly comparable or representative of compliance with ELVs. For specific details refer to individual assessment reports.

Examination of the data above indicates that, whilst for dioxins, HF and TOC permit ELVs are set within BAT-AEL ranges (note that for these pollutants the WID emission limit equals the upper end of the BAT AEL range), for other air pollutants this is not the case as permit ELVs are set in-line with WI Directive limit values. The view that most permit limits were set on the basis of WI Directive is consistent with feedback received from the site operators and the competent authorities at the site meetings.

Performance figures show that, for the majority of pollutants (the exceptions being CO and NOx), emission concentrations for all measurements provided were within the BAT-AEL ranges (note again that measured values are annual averages and hence not directly comparable to the BAT AELs which are daily averages). The single high CO value may have been an outlier but detailed statistical analysis on such a limited dataset was not undertaken. Two installations reported NOx emissions where annual average concentrations were above the upper BAT-AEL value of 180mg/m³ (up to 238.9 mg/m³) however the majority of reported averages were in the 150-180 mg/m³ range, which is below the upper end of the BAT-AEL range). Figure 3.15 presents the emissions release data for the main air pollutants in a graphical format.
Data on process water and discharges from treatment of the flue gas (where wet scrubbing is utilised) was extremely limited (two installations only: DK-04 and FI-04) and therefore no sectoral analysis has been made regarding water emissions. In these two cases, the results (annual average concentrations) show emissions were within BAT-AEL ranges for all pollutants.

3.6 Surface Treatment Using Solvents

3.6.1 Background to the Sector

The IPPC Directive, activity reference 6.7 covers “installations for the surface treatment of substances, objects or products using organic solvents, in particular for dressing, printing, coating, degreasing, waterproofing, sizing, painting, cleaning or impregnating, with a consumption capacity or more than 150 kg per hour or more than 200 tonnes per year”.

The surface treatment and coating industries have a major role to play in extending the life of metals, such as for automotive bodies, ships, aircraft and construction materials, as well as providing means of preserving and delivering food and other products in packaging. Installations within the sector use solvents for a wide range of activities. This study focused on the larger industrial installations, which included printing and preparation, coating and finishing of vehicles, ships and associated parts.
The activities covered by this study relate to the treatment and coating of surfaces and objects using solvents or solvent-based products. Specifically, the assessments focused on:

- The pre-treatment phase (surface preparation including shot and grit-blasting), which typically generates dust and particulate emissions;
- The painting and coating activities, which release volatile organic compounds; and
- Post coating finishing (such as lacquer/top-coats, polishing, buffing and grinding).


The Solvent Emissions Directive applies to a selection of defined activities, as set out in its Annex I, but only where solvent consumption is above the thresholds set out in its Annex IIA. Therefore, the scope of the Directives overlaps, but not completely. Many installations that are covered by the Solvent Emissions Directive (SED) consume too little solvent to be covered by the IPPC Directive. However, most installations falling under activity 6.7 of the IPPC Directive are also covered by the Solvent Emissions Directive.

The SED states in Article 4 that its requirements are to be applied without prejudice to the IPPC Directive.

The main requirement of the SED related to the reduction in VOC emissions from installations is set out in Article 5(2). This article provides a choice between two compliance routes, i.e.:

1. Installations may either comply with the emission limit values set out in Annex IIA (by either applying both waste gas and fugitive emission limit values, or applying the total emission limit values); or
2. Installations may comply through the application of a reduction scheme achieving an equivalent emission reduction, requirements for which are set out in Annex IIB. For coating activities, this involves limiting annual solvent emissions to a ‘target emission’ value defined by:
   - the mass of solids used in coatings;
   - multiplied by a factor for the activity type concerned to give an ‘annual reference emission’; and
   - multiplied by a percentage equal to the Annex IIA fugitive emission value for the activity plus either 5% or 15%.

Compliance route 2 (reduction scheme) essentially involves an alternative form of emission limit value (mass emissions) to the concentration limits in waste gases and fugitive emission limits of Annex IIA. In the STS BREF, many of the BAT-AELs are set using the reduction scheme approach, being expressed as percentages of the annual reference emission.

As a minimum, installations must comply with the requirements under SED. However, this is not necessarily sufficient for compliance with the IPPC Directive, under which there is a broader requirement to apply BAT, which covers not only VOC emissions but also other environmental impacts. Article 19(2) of the IPPC Directive states that ELVs in other EU legislation are to be applied as minimum ELVs for IPPC installations.
Table 3.21 indicates the thresholds for solvent consumption, emission limit values in waste gases and fugitive emissions values for the relevant activities from Annex IIA of the SED. It also presents the target emission according to Annex IIB for installations covered by the upper solvent consumption threshold of the activity concerned. (In practice most IPPC installations – but not necessarily all – will be in the upper solvent consumption class for the activities.)

The table only presents values based on the types of installations examined within the scope of this study, i.e. painting and coating of cars, trucks and ships and manufacture of membrane products using solvents.

### Table 3.21 Activities and Limit Values from the Solvent Emission Directive (relevant to installations examined as part of this study)

<table>
<thead>
<tr>
<th>SE Directive activity (with solvent consumption thresholds)</th>
<th>Threshold (solvent consumption in tonnes/year)</th>
<th>Emission limit values in waste gases (mg C/Nm$^3$)</th>
<th>Fugitive emission values (% of solvent input)</th>
<th>Target emission according to Annex IIB$^7$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other rotogravure, flexography, rotary screen printing, laminating or varnishing units (&gt; 15) rotary screen printing on textile / cardboard (&gt; 30)</td>
<td>15—25</td>
<td>100</td>
<td>25</td>
<td>Solids x 1$^8$</td>
</tr>
<tr>
<td></td>
<td>&gt; 25</td>
<td>100</td>
<td>20</td>
<td>Solids x 0.375$^9$</td>
</tr>
<tr>
<td></td>
<td>&gt; 30$^{(1)}$</td>
<td>100</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Other coating, including metal, plastic textiles, fabric, film and paper coating (including flexible and food contact packaging)</td>
<td>5—15</td>
<td>$100^{(3)}$</td>
<td>$20^{(5)}$</td>
<td>Solids x 1$^8$</td>
</tr>
<tr>
<td></td>
<td>&gt; 15</td>
<td>$50/75^{(4)}$</td>
<td>$20^{(5)}$</td>
<td>Solids x 0.5825$^9$</td>
</tr>
<tr>
<td>Manufacture of coating mixtures, varnishes, inks and adhesives</td>
<td>&gt;100</td>
<td>150</td>
<td>3—5$^{(6)}$</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Notes:

1. Threshold for rotary screen printing on textile and on cardboard.
2. Compliance in accordance with Article 9(3) of the SE Directive should be demonstrated based on 15 minute average measured.
3. Emission limit value applies to coating application and drying processes operated under contained conditions.
4. The first emission limit value applies to drying processes, the second to coating application processes.
5. Coating activities which cannot be applied under contained conditions (such as shipbuilding, aircraft painting) may be exempted from these values, in accordance with Article 5(3)(b) of the SE Directive.
6. Total emission limit value is 3—5% of total solvent input.
7. The target emissions are based on the mass of solids in coatings multiplied by the factor given in this column (which is derived from a ‘multiplication factor’ and the fugitive emission value. Only the upper solvent consumption figures have been taken when comparing performance.
8. Rotogravure printing; flexography printing; laminating as part of a printing activity; varnishing as part of a printing activity; wood coating; coating of textiles, fabric film or paper; adhesive coating.
9. Other coatings and rotary screen printing.
10. Food contact coating, aerospace coatings.

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Table continued…

<table>
<thead>
<tr>
<th>SE Directive activity (with solvent consumption thresholds)</th>
<th>Threshold (solvent consumption in tonnes/year)</th>
<th>Total emission limit values (new installations)</th>
<th>Total emission limit values (existing installations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coating of new cars (Annex IIA.II) (threshold &gt;8000)</td>
<td>&gt;15</td>
<td>45 g/m² or 1.3 kg/body + 33 g/m²</td>
<td>60 g/m² or 1.9 kg/body + 41 g/m²</td>
</tr>
<tr>
<td>Coating of new cars (Annex IIA.II) (threshold &lt;5000 monocoque, 3500 chassis-built)</td>
<td>&gt;15</td>
<td>90 g/m² or 1.5 kg/body + 70 g/m²</td>
<td>90 g/m² or 1.5 kg/body + 70 g/m²</td>
</tr>
</tbody>
</table>

The vehicle coating industry is subject to production thresholds as presented in Annex IIA II of the SE Directive, where limit values shall be expressed in terms of grams of solvent emitted in relation to the surface area of the product in m² or kilograms of solvent emitted in relation to the car body. The formula for calculating the electrophoretic coating area is set out within the SE Directive.

3.6.3 Key Environmental Issues

The main environmental impact is the release of point source and fugitive volatile organic compounds as a result of painting and coating using organic solvent-based products. The release of particulate matter, particularly from surface preparation (grinding, blasting, filing, cutting), but also from the paint particles and over-spray, may have a significant impact, especially in uncontained areas. NOx and CO emissions may be relevant where waste gases are incinerated.

3.6.4 Main Emissions, BAT and Levels Associated with BAT

Sources of information

The information below is taken from the BREF on surface treatment using organic solvents (2007), which contains significant further details and should be referred to for further information.

Generic BAT for the surface treatment using solvents sector is to reduce the emissions of VOCs where practicable by using a combination of measures, which includes reduction through design, management through a solvent management plan, capture (ideally with recovery and recycling) or destruction through incineration. The BREF outlines various process specific BAT, which for brevity have not been reproduced in this report. Table 3.22 illustrates the BAT-AELs for VOC emissions to air for the different types of activities and plant types covered by the case studies.

The BREF also contains a generic BAT-AEL (3 mg/m³ for new installations and 5 mg/m³) for existing installations for particulate emissions from coating and spraying activities within the sector using venturi and/or lateral scrubbers.
Table 3.22  BAT and Associated Emission Levels (AELs) for VOCs from BREF on Surface Treatment Using Organic Solvents (relevant to installations examined as part of this study)

<table>
<thead>
<tr>
<th>Type of plant (taken from STS BREF)</th>
<th>BAT-AEL (Units)</th>
<th>BAT-AEL lower value</th>
<th>BAT-AEL upper value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installations using solvent-based inks, varnishes and adhesives (including flexography and packaging gravure (flexible packaging printing)).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With oxidation / incineration</td>
<td>% of the reference emission (3)</td>
<td>7.5</td>
<td>12.5</td>
</tr>
<tr>
<td>With solvent recovery</td>
<td></td>
<td>10.0</td>
<td>15.0</td>
</tr>
<tr>
<td>Coating of cars</td>
<td>g/m² (1)</td>
<td>10</td>
<td>35</td>
</tr>
<tr>
<td>Coating of vans and trucks</td>
<td>g/m² (2)</td>
<td>15</td>
<td>50</td>
</tr>
<tr>
<td>Coating of Ships and Yachts</td>
<td>No BAT-AELs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) An equivalent AEL is 0.3 kg/body + 8 g/m² to 1.0 kg/body +26 g/m². The emissions and the surface area as the e-coat area are determined according to STS BREF Annex 24.5.

(2) The emissions and the surface area as the e-coat area are determined according to STS BREF Annex 24.5.

(3) The reference emission is defined in Annex IIB of the SE Directive. It is calculated by multiplying the mass of solids in the quantity of coating and/or ink, varnish or adhesive in a year by a factor that varies according to the activity undertaken.

3.6.5  Results from the Assessment of the surface treatment using solvents sector covered by the IPPC Directive

All 11 installations assessed within the scope of this part of the study were covered by the requirements of the SE Directive. The analysis conducted on reported emissions data focused on the release of point source or fugitive VOC emissions. The study examined permits from a range of installations applying surface treatment using solvents including packaging printing, car painting, wood treatment and shipyards. Three of these installations were classed as operating activities under uncontained conditions and, as such, may be exempted from the requirement to comply with specific limits set out within the SE Directive20.

The analysis of the permits and emission limits within them21 indicates that, out of 11 permits, six had all ELVs fully in line with the relevant requirements of the SE Directive. A further two had some ELVs that were in line but others that did not.

Three permits contained no total VOC limits as derogations from the requirement to comply with the ELVs within the SE Directive had been granted by the competent authorities. In two cases, there was clear evidence that the competent authority had determined that BAT was being

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20 According to Annex II A, coating activities which cannot be applied under contained conditions (such as shipbuilding, aircraft painting) may be exempted from the emission limit values in waste gases and fugitive emission values. In such cases, the reduction scheme is to be used, unless it is demonstrated to the satisfaction of the competent authority that this option is not technically and economically feasible. In such cases, the operator is required to demonstrate that they are applying BAT.

21 Not including broader requirements such as reduction schemes, equivalent measures or exemptions
applied by the operator. In one case it was not clear on what basis the derogation had been made. It would appear in these cases, despite derogation from SED requirements, that the IPPC Directive requirement to set ELVs for all main polluting substances may not have been fully complied with in these instances. Table 3.23 sets out the relevant type of installation and details relating to the ELVs or other measures used within the permits to reduce total VOC emissions from the installations.

Table 3.23 Summary of total VOC air ELVs and Emissions Reduction Measures Employed at the Eleven Installations operating Surface Treatment using Solvents which were Examined as part of this Study

<table>
<thead>
<tr>
<th>Installation Reference</th>
<th>Activity Description</th>
<th>Reduction Scheme applied</th>
<th>ELVs applied</th>
<th>Permit VOC Limit in waste gases</th>
<th>Fugitive Limit</th>
<th>ELVs within ranges</th>
</tr>
</thead>
<tbody>
<tr>
<td>BE-05</td>
<td>Adhesives mfr</td>
<td>No</td>
<td>Yes</td>
<td>50 (oxidiser) 150 (recovery)</td>
<td>20% of solvent input</td>
<td>N/A</td>
</tr>
<tr>
<td>DK-06</td>
<td>Shipyard</td>
<td>Yes</td>
<td>Target</td>
<td>None</td>
<td>375 g/kg solids</td>
<td>N/A</td>
</tr>
<tr>
<td>EE-04</td>
<td>Shipyard</td>
<td>No</td>
<td>Yes</td>
<td>50</td>
<td>20%</td>
<td>N/A</td>
</tr>
<tr>
<td>EE-05</td>
<td>Shipyard</td>
<td>Not clear</td>
<td>Mass</td>
<td>None</td>
<td>301.5 tonnes</td>
<td>N/A</td>
</tr>
<tr>
<td>FI-06</td>
<td>Printing of Packaging</td>
<td>Yes</td>
<td>Yes</td>
<td>20 mg/m³</td>
<td>12.5% of total solvent used</td>
<td>Yes</td>
</tr>
<tr>
<td>HU-05</td>
<td>Coating of cars</td>
<td>No</td>
<td>Yes</td>
<td>45 g/m³</td>
<td>45 g/m³</td>
<td>No</td>
</tr>
<tr>
<td>IE-04</td>
<td>Plastic coatings</td>
<td>Yes</td>
<td>No</td>
<td>75 mg/m³</td>
<td>5% of solvent input</td>
<td>N/A</td>
</tr>
<tr>
<td>IE-05</td>
<td>Printing of Packaging</td>
<td>No</td>
<td>Yes</td>
<td>100 mg/m³</td>
<td>20% of solvent input</td>
<td>N/A</td>
</tr>
<tr>
<td>PT-06</td>
<td>Shipyard</td>
<td>Yes</td>
<td>No</td>
<td>None</td>
<td>None</td>
<td>N/A</td>
</tr>
<tr>
<td>RO-04</td>
<td>Coating of wood</td>
<td>Yes</td>
<td>Mass</td>
<td>27.29 tonnes (2009)</td>
<td>20% of solvent input</td>
<td>Not comparable</td>
</tr>
<tr>
<td>SI-05</td>
<td>Coating of cars</td>
<td>No</td>
<td>Yes</td>
<td>60 g/m³</td>
<td>60 g/m³</td>
<td>No</td>
</tr>
</tbody>
</table>

1 ELVs are applied in the permit for specific VOCs and from defined point sources. ELVs in waste gases and fugitive emission limits are not set in the permit; however an annual report refers to 50 mg/m³ and 20% of total solvent input as being the relevant limits despite the permit not setting these.

2 Operators exempted from the requirements to comply with ELVs (Annex IIA) or the target values set under the reduction scheme (Annex IIB) on the basis of Article 5(3)(b).

3 Only for the three production lines not connected to the thermal oxidiser.

4 The permit set individual ELVs for solvent emissions from the wood treatment process, which are aligned with those specified in Annex IIA of the SE Directive.

**Manufacture of Adhesives**

One installation was examined as part of this study. The permit set ELVs for the main air and water pollutants including limits on the following pollutants from the thermal oxidiser: benzene, NOx, particulates, CO and total VOCs (set on 30 minute averaging periods), total VOC (as TOC) from the drying ovens and a fugitive total organic carbon limit (TOC). The ELVs set for total VOC in waste gases (50 mg/m³) are in line with the SED. The fugitive ELV (20% of total...
solvent input) is not in line with the SED under which a limit for existing installations of 5% of solvent input is set.

Very few actual results were provided from emissions monitoring at this installation. However, where data was available, the results show that ELVs were met for total VOC for the thermal oxidiser (36-43 mg/m³ based on 2009 and 2010 data). Emissions of NOx and dust were also lower than the ELVs, although emissions of CO and benzene were both (on an annual average basis) higher than the permit ELVs. There were no relevant BAT-AELs to compare reported performance with.

Print Packaging
Two packaging printing installations were examined as part of this study, both using thermal oxidisation to reduce emissions of VOCs. Both permits contained concentration-based limits on total VOCs from the incinerators; one permit set this level at 20 mgC/m³ and the other at 75 mgC/m³ (which are within the SED limit of 100 mgC/m³). Both permits set limits for fugitive VOC emissions; one set the limit as 12.5% of total solvent input (more stringent than SED) and the other at 20% of total solvent input (in line with SED).

One permit included conditions for three production lines not connected to the thermal oxidiser and in this case the requirement to comply with an emission reduction scheme. An annual mass solvent limit of 30 tonnes was set for each line as part of the reduction scheme.

Performance data for these two installations was available for both 2008 and 2009. Total VOC emissions from the thermal oxidisers were, in both cases, below the permit ELV, albeit quite different. Averaged TOC emissions (2008 and 2009) were reported as 6.6 and 10.5 mg/m³ for one installation and 73.6 and 79.7 mg/m³ for the other. Fugitive emissions were calculated to be 13.3% for one installation as opposed to 21.6% for the other (which is over the 20% limit set out in the SED). The emissions data provided are not comparable with the specified BAT-AELs based on the data provided.

Coating of Cars
Two permits relating to car manufacturing and painting plants were examined. The permit ELVs were 45 g/m² for one and 60 g/m² for the other. These values are based directly on those set out in Annex IIA(2) of the SED and related to new (one permit) and existing (one permit) facilities. In addition, one permit set specific limits on emissions of TOC for the incinerator (50 mg/m³), which is in line with the SED. Both permits set emission limits on discharges to water which includes limits on named hydrocarbons and total hydrocarbons.

The performance data for the two installations was reported for 2008 from one and 2009 for the other. Emissions of total VOC were calculated to be 5 g/m² and 33 g/m² respectively. Both these values are below the upper BAT-AEL of 35 g/m² and both are within the relevant permit ELVs.

Coating of Ships
Four shipyard permits were examined in this study. There are no BAT-AELs with which to compare performance and the four permits examined were judged to have taken a different approach to reducing the level of VOC emissions from the installation. Therefore it has not been possible to determine any sectoral conclusions as a whole. The following observations were made regarding the shipyards and permits examined:
• One permit set requirements for the operator to comply with the reduction scheme in accordance with Annex IIB of the SE Directive. The ELV set was 375 g/kg solids (which is consistent with the SE Directive); the performance achieved in 2008 was 279 g/kg solids. This permit and the performance of the installation appear to meet the requirements of the SE Directive.

• Two permits did not set total VOC ELVs or a fugitive VOC emission limit but did set individual ELVs for point source releases of VOC.
  - In one case, the competent authority indicated that VOC limits may have been omitted due to a misunderstanding about the need to include them to comply with the requirements of the SE and IPPC Directives. The emissions data submitted for 2008 and 2009 shows fugitive VOC emissions to be 31.5% in 2008 and 15.1% in 2009. The data from 2008 indicates emissions above the SE Directive limit value of 20% but lower in 2009.
  - In the second case, the installation appears to have received an exemption for the requirement to comply with ELVs set out in the SE Directive or the need to comply with the reduction scheme. No evidence of an evaluation of BAT was seen during the site meeting and further conclusions could not be drawn. Reported emissions for total VOC from this installation (calculated) were 166 tonnes (2008) and 130 tonnes (2009).

• One permit contained no ELVs for VOCs as the competent authority had derogated the installation from the requirement to comply with ELVs or the reduction scheme on the basis of it not being economically or technically feasible to reduce total VOC emissions in line with Annex IIB. In this case, the derogation appeared to be in line with Article 5(3)(b) as there was evidence that the operator was applying BAT and the competent authority had satisfied themselves this was the case.
4. Study Findings and Conclusions

4.1 Introduction

The main aim of this section is to provide information on implementation in relation to specific key elements of the IPPC Directive, in particular the setting of permit ELVs on emissions of the main pollutants, installation performance against those ELVs and how they compare with relevant BAT-AELs as expressed within the formally adopted BREF documents.

The findings of this study, in common with the two previous implementation studies, show that the mechanisms to develop permit conditions and set main emission limit values vary amongst Member States and amongst sectors within some Member States. The study findings set out in the following pages are intentionally made at a high-level. In reading the findings and main conclusions, the reader should make reference to specific details contained within the individual installation assessment reports, which are provided within Appendix B. It would be neither practicable nor desirable to transpose the full detail of each assessment into general findings; however such details are important in understanding the reasons why the IPPC Directive has been implemented in a particular way at individual installations and within sectors and Member States.

The remainder of this section is divided into four key sections:

1. Summary of the permits examined;
2. Assessment of the permit emission limits against BAT-AELs and relevant sectoral directive emission limits;
3. Assessment of the installation performance against permit ELVs, BAT-AELs and relevant sectoral directive limits
4. Analysis of the permits examined, including the basis of determination of BAT, the provisions for monitoring and reporting of pollutant releases and the level of compliance with permit conditions.

4.2 Summary of IPPC Permits Examined

Although Section 2 of this report details the scope of the sectors and Member States for which an assessment of the permits issued by competent authorities has been made, Table 4.1 repeats this information to provide a base context to the findings.
Table 4.1  Number of Permits and Industry Sectors Examined by Member State

<table>
<thead>
<tr>
<th>Industry Type</th>
<th>Belgium</th>
<th>Bulgaria</th>
<th>Denmark</th>
<th>Estonia</th>
<th>Finland</th>
<th>Hungary</th>
<th>Ireland</th>
<th>Portugal</th>
<th>Romania</th>
<th>Slovenia</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Combustion Plants (1.1) – gas and liquid-fired plants.</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1†</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Ferrous metal foundries (2.4)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Manufacture of ceramics (3.5)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1†</td>
<td>10†</td>
<td></td>
</tr>
<tr>
<td>Incineration of hazardous and municipal wastes (5.1 &amp; 5.2)</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0†</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Surface treatment with solvents (6.7)</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1†</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>5</td>
<td>3</td>
<td>6</td>
<td>5</td>
<td>6</td>
<td>5</td>
<td>6</td>
<td>4</td>
<td>5†</td>
<td>50</td>
<td></td>
</tr>
</tbody>
</table>

**Note**: 1 Two LCPs were examined in Slovenia, one being an integrated part of a manufacturing facility using solvents. However this was not examined as a separate case study and is therefore not listed independently in the table.

Of the 50 IPPC permits examined, 19 were issued between 2000 and 2005. 17 of the permits assessed were issued after 30 October 2007, which was the deadline for implementation of the IPPC Directive across European Member States. Of these, 4 were updates of existing IPPC permits, 11 were new permits for existing installations and 2 were new permits for new installations.

4.3 Assessment of the Permit Emission Limits against BAT-AELs and Relevant Sectoral Directive Emission Limits

4.3.1 Inclusion of ELVs or Equivalent Parameters or Technical Measures (Article 9(3)) or Reference to GBRs (Article 9(8))

In the majority of cases (30/50), permits were judged to contain emission limits, technical parameters or other measures for all of the main emission points and pollutants (i.e. those for which a BAT-AEL exists and which form the focus of this study). In the permits examined, significant usage of alternative measures and equivalent parameters was not observed as it had been in previous IPPC implementation studies – for example in refineries.

Two permits contained no ELVs. In one permit (Finland) the competent authority indicated that the operator had assessed the impact of emissions and was considered to be applying BAT at the installation to prevent or reduce pollution and the setting of ELVs in the permit was not considered by them to be appropriate or proportionate to the impacts. The authority judged, in this case, that ELVs would not offer any additional level of environmental protection. In the other case (Denmark), the permit did not contain ELVs but did contain equivalent measures.

22 These installations already had an IPPC permit in place at the 30 October 2007 deadline.
based on maximum ambient pollution concentrations in the surrounding environment (this is described further in case study DK-03). The limits set in the permit are based on limiting the ‘contribution’ to ambient pollution concentrations by providing an ambient concentration (above background) including pollution emitted from the installation. The competent authority interpreted these as being an equivalent measure to ELVs as the ambient concentrations reflected not only the general pollutant load from non-specific sources but also the specific contribution made by the emissions from the installation. The assessment for this site concluded, however, that because ambient values were set in national legislation and not on a site-specific basis, the setting of such limit values in the permit did not constitute a BAT-based limit but could be considered to be in accordance with the IPPC Directive.

**Figure 4.1 Are ELVs or Other Parameters/Technical Measures Included in Permits?**

In the 18 cases where a permit ELV was not set for one or more pollutants for which a relevant BAT-AEL exists, the most notable omissions were in Danish permits (5 out of 6) and in the foundry sector, where only two permits contained a limit for dioxins. Reasons for not including such limits were cited as being on the basis of modelling or monitoring that indicated no or extremely low levels of emissions. Figure 4.2 shows the breakdown by sector where permits omitted one or more ELV for the main pollutants.
Figure 4.2  Permits by Sector where ELVs Have Not Been Set for Some/All Key Pollutants

![Permits by sector where some or all ELVs have not been set](image)

### 4.3.2 Comparison of Permit Emission Limits against BAT-AELs

The main focus of this part of the assessment is on a quantitative analysis of permit ELVs against BAT-AEL ranges where relevant values are given and where a comparison could be made. The assessment also included qualitative analysis that sought to understand the relationship between how BAT was being applied to prevent or reduce pollution and how the permit conditions reflected this. Notably, how the Competent Authority had determined at what level to set limit values and, in those set above BAT-AEL upper values, the reasons why.

The assessment of how the BAT has been interpreted and applied in the setting of the main permit conditions relating to ELVs and/or equivalent measures was determined by a combination of expert judgement (desk-based review of permits and technical justifications) and further discussion with the competent authorities during site visits.

BAT as expressed in Article 9(4) of the IPPC Directive is a dynamic concept that should be applied at the site-specific level when setting permit conditions (with the possibility to take into account technical characteristics, local environmental conditions and geographic location of the installation concerned). In 25 of the 50 assessments, there was evidence to suggest that the main conditions relating to permit ELVs or technical measures had been set on the basis of consideration of technical characteristics, local environmental conditions and/or geographic location. Specific examples included the setting of lower limits than BAT-AEL upper values because a lower emission level was achieved through the use of BAT and also setting of ELVs higher than BAT-AELs (for dust) because of high levels of dispersion due to location and prevalence of strong coastal winds.

Feedback gathered at the site interviews indicates that there are a number of cases where the operator appears to have applied BAT but the permit ELVs have been set above the upper BAT-AEL values. This is particularly obvious in the LCP sector, where the majority of permits

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23 The assessment of how the BAT has been interpreted and applied in the setting of the main permit conditions relating to ELVs and/or equivalent measures was determined by a combination of expert judgement (desk-based review of permits and technical justifications) and further discussion with the competent authorities during site visits. It is a qualitative assessment rather than the more quantitative assessment detailed in Section 4.3.3, which compares permit ELVs against BAT-AELs.
were based on limits in the LCP Directive rather than on the relevant BAT-AELs (and yet the techniques considered to be BAT were still evidently being applied). There is strong evidence to suggest that Competent Authorities are taking BAT into account when setting emission limits and main permit conditions. In some, but not all cases, this means that either all or some of the permit ELVs are set in-line with BAT-AELs. 

However, there are cases where some of the ELVs are set above the upper BAT-AEL value because site specific issues have been taken into account or limits have been directly applied from the Sectoral Directives. Furthermore, in those cases where it was evident that BAT had been considered when setting main permit conditions but that ELVs had been set above the upper BAT-AEL values, the overriding reason for this was the setting of permit ELVs directly aligned with the limits in the Sectoral Directives or existing national legislation. It should however be noted that there was inconsistency even within the same permit. In the 21 permits where there was evidence to suggest BAT had not taken into account (or it was not clear how it had been) when setting ELVs, this did not apply (in most cases) to all ELVs.

In just over a quarter (28%) of the permits, all of the ELVs set were aligned with or stricter than the upper BAT-AEL value, where a relevant BAT-AEL exists (Figure 4.3). Of the 14 permits judged to have all ELVs set below the upper end of the BAT-AEL ranges, the foundry sector permits showed the highest number (6 permits). Explanatory factors here could be the low number of BAT-AELs for the sector (mainly dust), no minimum requirement limits set by a Sectoral Directive and the fact that BAT-AELs for different process releases are typically based on similar ranges (e.g. 5-20 mg/m³). Dust abatement techniques (i.e. fabric filters) considered to be BAT for the foundry sector are broadly similar for different processes within the installations (generally in the range 5-20 mg/m³). It should also be noted that only three permits contained an ELV for dioxins despite there being clear conclusions and a BAT-AEL for this pollutant within the BREF.

Of those that were judged to have no limits in line with relevant BAT-AELs (9 permits), 4 were permits for combustion plants. Figure 4.4 illustrates the breakdown of sectors where permit ELVs were and were not within the ranges of the relevant BAT-AELs.

**Figure 4.3 Comparison of Permit ELVs Against Relevant BAT-AELs**

<table>
<thead>
<tr>
<th>Are Permit ELVs set within BAT-AEL ranges?</th>
<th>Number of Permits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not clear from the assessment</td>
<td>1</td>
</tr>
<tr>
<td>There are no relevant BAT-AELs</td>
<td>3</td>
</tr>
<tr>
<td>No, ELVs are not set within BAT-AEL ranges</td>
<td>9</td>
</tr>
<tr>
<td>Mixed, not all ELVs are set within BAT-AEL ranges</td>
<td>23</td>
</tr>
<tr>
<td>Yes, all ELVs are set within BAT-AEL ranges</td>
<td>14</td>
</tr>
</tbody>
</table>
Note that the three installations where it was concluded that there are no relevant BAT-AELs were shipyards covered by the Solvent Emissions Directive.

Figure 4.4  Comparison of permit ELVs against relevant BAT-AELs

There is no single sector where permit ELVs have been consistently set within BAT-AEL ranges for the main pollutants. The LCP sector demonstrated a notably low number (1 permit) where it was evident that ELVs for all main pollutants were set within BAT-AEL ranges and a much higher proportion where all ELVs for the main pollutants were set higher than the upper BAT-AELs (4 permits). This is because in most cases permits were based on national laws directly transposing the limit values within the LCP Directive. The foundries (1 permit), ceramics (3 permits) and waste incineration (2 permits) sectors showed evidence that the permit contained all ELVs set for the main pollutants above the corresponding BAT-AELs.

The study found that, in many cases, competent authorities indicated that the BREF documents had been referenced in determining BAT for the installation. However, the analysis suggests that what was actually adopted in the form of permit ELVs was not necessarily based on BAT-AELs. In several cases, the responses given by the competent authority indicated that the permit conditions and limits were determined prior to the formal adoption of the BREF and therefore limits were based either on a Sectoral Directive or a prescribed limit in a GBR or national law.

Based on responses given by competent authorities when questioned about why a limit or limits were not set within the BAT-AEL range, several responded that they believed that they had gathered sufficient evidence to make a justification (based on their understanding, the evidence available to them and the national regulatory protocols) as to why limits and conditions should be set as they are in the permits and not based on the BAT-AELs. However, the majority of the justifications were made on one of the following bases: that a relevant Sectoral Directive limit applied, BAT-AELs were not mandatory, emissions were insignificant and/or the operator had demonstrated (through gap-analysis, direct release monitoring or modelling of emissions) that

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An AMEC company
the installation was currently using techniques considered to be BAT to prevent or reduce pollution; and that tighter ELVs would have no direct impact on the level of pollution.

It therefore appears evident that competent authorities are considering, at permit application and permit writing stages, whether the operator applies the Best Available Techniques at the installation and how permit conditions should be set having regard to this. It does not necessarily follow that the permit ELVs (assuming the operator is judged to be applying the BAT (and in some cases they were judged not to be)), in all cases, are supporting the outcomes of these judgements in setting permit limits as ELVs have been set above the BAT-AELs. In several cases (e.g. some installations in Romania and Portugal) the permits contained interim ELVs clearly not in-line with BAT-AELs but which have since been reduced to levels within the BAT-AEL ranges in subsequent permit revisions.

Analysis of the averaging periods shows that in some sectors (notably combustion) the averaging period set against the permit ELVs differs from that expressed in the BREF document for the BAT-AEL. Common reasons for this relate to the use of limits (and associated averaging periods) in the Sectoral Directives, the reference out in permits to the averaging periods specified in international monitoring standards (CEN/ISO) or the use of national level laws or decrees on monitoring setting an averaging period, which in some cases may be based on existing Directives or in others historical factors or techniques. There are no common reasons (even in some cases within the same sectors) why averaging periods on permit ELVs are not, in all cases, based on those specified for the BAT-AELs although several competent authorities noted that the use of BREF was not mandatory and as a preference they would go to national law or European Directives first.

4.3.3 Impact of Sectoral Directives on Permit Conditions (ELVs)

Previous studies have concluded that, in some cases, permit emission limits have been set by competent authorities through direct transposition of the minimum standards (including emission limits) given within the Sectoral Directives. This is not necessarily sufficient for compliance with the requirements of the IPPC Directive.

Therefore, a greater focus has been given within this study on the interaction of Sectoral Directives with the IPPC Directive in the setting of emission limit values. Whilst this summary evaluation presents an assessment based on the findings of the consultants, it is important to refer to text contained within the individual assessment reports to understand the final conclusions that have been drawn for each study with regard to how, where and why the requirements of the Sectoral Directives may or may not have been used in setting permit conditions.

The findings from the individual case studies indicate that a relevant Sectoral Directive applied in 30 of the 50 case studies. Of these, 23 permits had all ELVs set in line with or at more stringent levels than emission limits in the relevant Sectoral Directive or used equivalent compliance measures. 4 permits showed a mixed picture with some set in line and others not. In 3 other cases, a NERP was used for an LCP and two shipyards had received derogations from requirements to comply with SE Directive Annex IIA or IIB. There were 20 permits where the Sectoral Directives did not apply and in these cases:

- 7 installations showed annual average performance for all main pollutants lower than the upper BAT-AEL values;
• 7 installations showed a ‘mixed’ picture, with some annual average values above the upper BAT-AEL and some below;
• 2 installations showed annual average performance for all main pollutants above the upper BAT-AEL values; and
• 2 were ‘not clear’ from the data provided and 2 had no relevant BAT-AELs with which a comparison could be made.

Table 4.2 Permit ELVs Compared to Limits in the Sectoral Directives

<table>
<thead>
<tr>
<th>Number of permits fully compliant with limits in Sectoral Directive</th>
<th>Number of permits not fully compliant with limits in Sectoral Directive</th>
<th>Number of permits where Sectoral Directives did not apply</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7(Note 1)</td>
<td>1(Note 2)</td>
<td>1(Note 2)</td>
<td></td>
</tr>
<tr>
<td>Foundries</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 (SED)</td>
<td>1 (SED)</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Ceramics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Waste Incineration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8(Note 4)</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Surface Treatment using Solvents</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7(Note 5)</td>
<td>2(Note 6)</td>
<td>2(Note 7)</td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>4</td>
<td>20</td>
<td>3</td>
</tr>
</tbody>
</table>

Note 1: Two installations set calculated ELVs (mixed-fuel firing) and one had less stringent ELVs until 2008 when ELVs were reduced in line with the LCP Directive and one adopted NERP provisions in LCP Directive.

Note 2: EE-01NOx ELVs set at 300 mg/m³ but mass limits covering entire installation also set.

Note 3: Installation regulated under NERP provisions.

Note 4: One permit did not contain an ELV for heavy metals in accordance with the requirements of the WI Directive.

Note 5: DK-05 using Annex IIB reduction scheme

Note 6: BE-05 fugitive VOC limit above SE Directive, EE-04 no total VOC limits, no fugitive VOC limits

Note 7: PT-06 and EE-05 received derogations from requirements of Annex IIA or Annex IIB due to uncontained conditions for treatment and coating activities

Of the relevant sectors, the LCP and WI sector permits showed the greatest level of alignment with limits specified in the LCP Directive (7 permits) and WI Directive (7 permits). Permit compliance with requirements of the SE Directive was also high with seven permits fully complying (one had chosen to apply the reduction scheme in accordance with Annex IIB), two partially complying (see Note 6 above) and two permits identified that the installations had been derogated from ELVs and the reduction scheme in accordance with Article 5(3)(b) as the operations were not under contained conditions.
Analysing the detail provided in the assessment reports on how ELVs were set having regard to the interaction with the Sectoral Directives, of the 28 permits where Sectoral Directive limits applied, 26 showed evidence that permit limits had been based, at least in some cases, on the Sectoral Directive limits.

- In the LCP sector, 7 out of 10 permits set the main (or all) ELVs based directly on limits in the LCP Directive (one permit set limits higher than the LCP Directive but reduced these in 2008 (Bulgaria); one installation (Ireland) is covered under the NERP (provided for in the LCP Directive), one (Estonia) set higher NOx ELVs and one gas turbine, permitted prior to 27 November 2002, falls out of the scope of the LCP Directive.

- In the solvents sector, 9 out of 13 permits where the SE Directive applied set some or all ELVs based directly on limits within the SE Directive; and

- In the waste incineration sector all 8 permits set ELVs within limits contained within the WI Directive although HU-04 did not include an ELV for heavy metals.

In the three main sectors where Sectoral Directives apply (combustion, waste incineration and solvents), the analysis indicates that there were a greater number of permit ELVs set within the limits of the relevant Sectoral Directives than the relevant BAT-AEL. This may be explained by the limits of the Sectoral Directives being lower than BAT-AELs in most cases and compliance being mandatory in most cases.

The conclusion to be drawn from this limited sample is that, in sectors where Sectoral Directives apply, it is more likely that permit ELVs will be based on limits set within the Sectoral Directive than based on BAT-AELs; and consequentially less likely that they will be set within the BAT-AEL ranges. In a sector such as combustion, where there is a wider gap between limits expressed in the Directive and those in the BREF, this conclusion can be anticipated where BAT-based permitting is not applied.

### 4.4 Assessment of the Installation Performance against Permit Conditions and BAT-AELs

#### 4.4.1 Comparing Installation Performance against Permit Emission Limits

To draw accurate conclusions on whether the installation performance is fully or partially in line with its permit ELVs, measured emissions need to be in a form that is consistent with the way in which ELVs are specified in the permit, particularly in relation to the units and averaging period that apply.

Taking into account the desk-based assessment of the permits together with more qualitative questioning at the site visits, the general finding is that, in most cases, the results provided by operators appear to have been measured using the same averaging periods as specified within the permit. In many cases there was however a lack of tangible evidence of this. In the mass majority of cases, data was provided in the form of monthly emission averages (continuously monitored data) or a single average value (periodic data).
The fact that permits do not, in all cases, clearly state the basis used to set the emission limits further limits the ability to compare as the averaging period is not immediately clear. In questioning operators, the reliance on external contractors to conduct routine emissions monitoring and analysis was clear in a lot of cases, leading to the operator having very little technical knowledge about this issue.

This study was not intended to be a check on compliance and, in many permits, there are also compliance rules (additional clauses relating to compliance) supporting the basis of compliance with an ELV. Where such additional rules are clearly specified in permits, details have been included within the specific installation assessment reports. However, these compliance rules were not a key focus for this study nor has any numeric sensitivity analysis been conducted upon them. For this reason:

**It is important to note that the conclusions drawn on how actual installation performance compares to permit ELVs and BAT-AELs are based on ‘comparisons with’ and not analogous to ‘compliance with’ permit limits or BAT-AELs.**

Monitoring data was requested from operators and competent authorities for 2008 and 2009 (as a minimum) in order to assess the performance of the installation against the specified ELVs and relevant BAT-AELs. Where possible, the analysis has made a comparison between permit ELVs and emissions performance on the same basis (i.e. averaging period). However in some cases this was not practicable as it was not possible to disaggregate data to the daily, hourly or half-hourly average level. Instead, data was provided as monthly averages or aggregated annual averages such as might be found in an annual environmental report.

Therefore, the assessments (in some instances) may have concluded that installation performance is in line with permit ELVs despite there being instances where ELVs were exceeded based on the averaging periods actually applied in the permits. Wherever the study team were able to gather such supplemental data on level of compliance or number of exceedances, details have been included within the individual assessment reports. Whilst all reasonable attempts have been made to examine the monitoring data in detail to achieve comparability, the summary findings presented here should be read in conjunction with specific details contained in the individual assessment reports and with the above provisos in mind.

The results from the analysis of annual data (Figure 4.5) indicates that in 20 cases, the data indicates that the annual average concentrations of the main pollutants are lower than the values specified within installations’ permits for all the main pollutants. Examination of the installations which fall into this category shows that they are spread across all sectors examined: 5 were LCP, 4 foundries, 5 ceramics, 4 waste incineration and 2 surface treatment using solvents. The analysis suggests that 29 of the 50 installations reported annual emissions concentrations above at least one ELV over the years 2008 and 2009 (where data was provided). The analysis of these data also indicates no specific sectoral trends.
Having regard to the points made previously in this section, it is difficult to draw further conclusions about the installation performance without presenting specific individual cases and therefore the reader is directed towards the individual assessment reports.

4.4.2 Comparing Installation Performance against BAT-AELs and limits given in the Sectoral Directives

The results show only 12 installations reported data that indicated emission concentrations for the main pollutants were all below the upper BAT-AEL value. This compares with 20 based on an evaluation of the same data against permit ELVs. 33 out of the 37 permits where a comparison was possible demonstrated that annual average performance was in line with BAT-AELs for some or all of the emission points.

Analysis of the data by sector does show some sectoral trends, notably 5 foundries reporting all emissions below the upper BAT-AEL value for all pollutants. In the LCP sector, only 1 out of 10 installations assessed reported annual average emission figures lower than the BAT-AELs for all pollutants. 4 reported a mixed position and 5 reported averages higher than BAT-AELs in all cases. The number of BAT-AELs within each sector varies and this needs to be accounted for when evaluating across different sectors.
It should be noted that the above data relate to situations where data was provided. If no data was provided on a particular emission source, no conclusion was drawn for that particular source.

Analysis of the reported averaging periods²⁴ used to report data on emissions varies and in general, averaging periods used by the installations assessed do not correspond in many cases to that specified in BREFs for the BAT-AELs. The difference in these averaging periods (noted in the table below), does not accurately allow performance to be compared to BAT-AELs. Notable from the results is that Romanian installations reported data for the main pollutants that has been averaged on the same periods as the BAT-AEL in each case and Slovenia on more stringent 30 minute averages. The averaging periods in the waste incineration sector for reported emissions were the same in each case as those specified in both the WI Directive and the WI BREF.

Table 4.3 summarises by sector and Member State the averaging periods for reported emissions data and how they compare with averaging periods for the BAT-AELs.

²⁴ The averaging periods upon which data on emissions performance is reported to the competent authority or relevant Inspectorate body
Table 4.3 Are reported performance measurements for main air pollutants based on the same averaging periods as defined in the BREF documents?

<table>
<thead>
<tr>
<th>LCP</th>
<th>BAT</th>
<th>BE</th>
<th>BG</th>
<th>DK</th>
<th>EE</th>
<th>FI</th>
<th>HU</th>
<th>IE</th>
<th>PT</th>
<th>RO</th>
<th>SI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D</td>
<td>No</td>
<td>M</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Foundries</td>
<td>D</td>
<td>NS</td>
<td>No</td>
<td>30</td>
<td>No</td>
<td>60</td>
<td>NS</td>
<td>No</td>
<td>60</td>
<td>No</td>
<td>30</td>
</tr>
<tr>
<td>Ceramics</td>
<td>D</td>
<td>Yes</td>
<td>D</td>
<td>No</td>
<td>30</td>
<td>No</td>
<td>ELV</td>
<td>No</td>
<td>ELV</td>
<td>No</td>
<td>30</td>
</tr>
<tr>
<td>Waste Incineration</td>
<td>D/30</td>
<td>All reported values were taken on basis of 30 minute and daily averages</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface Treatment (Solvents)</td>
<td>N/A</td>
<td>No clear conclusions can be drawn due to incomparable units in each case</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Key: 30 (30 minute), D (daily average), M (monthly), A (annual), NS (not specified), N/A (no BAT-AEL)

Amongst installations where limits specified within the Sectoral Directives applied, there was a greater number of installations whose performance was judged to be, for all relevant pollutants, in line with those sectoral limits than when performance was compared to BAT-AELs (21 versus 12). The reasons for this are that permit ELVs have in many cases been set higher than BAT-AELs, which are set lower than the minimum requirements in Sectoral Directives.

There were judged to be 9 installations that reported data which appeared to show\(^{25}\), for some pollutants, emissions were higher than the limits set in the Sectoral Directives. 3 of these were LCPs (although in one case the installation is part of a NERP). Monthly exceedances of NOx were reported from one LCP (only one boiler plant) and a single monthly exceedance of SO\(_2\) from the other. 5 WI installations reported exceedances of the daily average values. One surface treatment plant reported calculated fugitive emissions in exceedance of the SED limit value of 20% of total solvent input.

Figure 4.7 indicates the total number of installations where performance was judged to be within limits set in the Sectoral Directives for all emissions, some but not all, none and at how many the Sectoral Directives did not apply.

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\(^{25}\) Compliance rules were not taken into account in evaluating performance data.
4.5 Analysis of the Permits Examined – Other Elements

Figure 4.8 indicates when the permits examined in this study were issued and for how long the current permit (i.e. that in force at the time of the study) remains valid for.

35 of the 50 permits had an expiry date, the most common duration being between six and ten years. In two cases (one in Hungary and one in Belgium), the validity of the permit for the LCPs was 20 years. It was explained by the competent authority in Hungary (where 20 years is not the normal duration for an IPPC permit) such an extension was to provide the operator with an increased level of assurance around limits and conditions of operation in order to enable the operator to make substantial investment in longer-term installation improvements.

Of the 15 permits with no expiry date, these were permits in Bulgaria, Denmark, Estonia and Ireland.
Of the 50 permits assessed in total, all had either a time-limited validity or a mechanism for review of conditions; most had both. 27 of the permits assessed had been reviewed one or more times since first issue and 23 were the first IPPC permits issued for the installations. 18 permits were reviewed and re-issued permits where a pre-existing permit was in place and 32 were new IPPC permits.

4.5.1 Basis of the Determination of Permit Conditions

In assessment of the 50 permits, there were a number of sources used by competent authorities to determine suitable permit conditions that were based on the BAT for the installations concerned and to transpose these into permits. These are highlighted in Figure 4.9. In several cases, more than one source was used, with the result that the total number is 131 sources for 50 permits.

The most common source referenced was a sector-specific BREF document, although in ten cases the competent authority specifically commented that the draft BREF document was used as the final published version was unavailable at the time of permit development. This is supported by the fact that a significant proportion of the permits assessed were issued prior to 2005, when a number of BREF documents had not been formally adopted. A number of competent authorities reportedly chose, in some cases, not to base emission limits in the permit on the draft BREF as there was uncertainty regarding whether values would change when the document was formally adopted. In one case, the fact that only a draft BREF was available was cited by the competent authority as one factor as to why ELVs were not aligned with BREF BAT-AELs and instead a limit had been set based on national laws.

Figure 4.9 Basis of BAT Determination for IPPC Permits

Whilst permit applications were not examined in any detail as part of this study, it was evident from questioning the operators that, in most cases, the operator had made an assessment or analysis of operations against BAT (as provided in the draft or formally adopted BREF). In one case, specific conditions in the permit requiring the operator to undertake such an assessment upon publication of the BREF were set. In 16 cases, the competent authority directly referenced the operator’s assessment of BAT as being one of the sources of information used when setting permit conditions.
There was significant use of existing national laws/decrees and/or limits set within the sectoral Directives, particularly with regard to the setting of relevant emission limits in permits. The use of General Binding Rules was referenced as a basis for determining or partially determining BAT in 14 permits.

4.5.2 Use of General Binding Rules

The majority of permits assessed (36) did not use GBRs to set any conditions or limits in the permit. However, this study has found that many permits make reference to common laws or rules that are used as a basis for the setting of one or more specific conditions in the permit. This is most notable in sectors such as waste incineration or combustion, where national laws transposing the requirements and limit values laid down in the relevant Sectoral Directives are used to set ELVs in the permit. This is common across a number of Member States although they are not described as GBRs insofar as these laws are used only as a reference for the limits and conditions and are not used to set permit conditions. A study published by the Commission in 2007 provided more detail about the interaction of GBRs with IPPC26. It is also of note that there seems to be some difference in interpretation of the term general binding rule amongst Member States27.

Slovenia and Hungary set the permit conditions, including ELVs, on the basis of GBRs, often referencing a national law or Decree as the basis for the GBR. Belgium has set some permit conditions using site-specific assessments. However, in four out of the five case studies, GBRs were used to set at least some permit ELVs and other main conditions. There is limited evidence of a correlation between the use of GBRs and the permit (main conditions and ELVs) being based on BAT, with fewer than 50% (5 out of the 12) of the permits where GBRs have been used judged to have ELVs based on BAT. Figure 4.10 indicates the usage of GBRs for setting ELVs and main conditions relating to ELVs in the permits examined.


27 The new Industrial Emissions Directive (2010/75/EU) defines GBRs as emission limit values or other conditions, at least at sector level, that are adopted with the intention of being used directly to set permit conditions.
4.5.3 Inclusion of Requirements for release Monitoring Requirements and Data Submission (Article 9(5))

The majority of the 50 permits (43) contained monitoring requirements and an obligation or condition requiring the operator to submit details of the release monitoring to the competent authority. Figure 4.11 shows the breakdown.

For 32 permits the assessment concluded that the release monitoring requirements set in the permit were in line with those specified within the corresponding BREF document and the Sectoral Directive (where applicable). In seven cases, the release monitoring requirements were transposed directly from the relevant Sectoral Directive and exhibited variation from the BREF
recommendations; of these, three of the seven were LCPs, two were waste incineration plants, one a solvents installation and one a foundry (SE Directive applied to surface coating of iron).

For eight permits, the monitoring requirements were judged not to be in line with the Sectoral Directive or the BREF. The main reasons were conditions requiring periodic monitoring rather than continuous and calculation rather than direct monitoring. In Estonia, monitoring requirements at four installations were judged not to be in line with the BREF, two without monitoring requirements at all and two with only partial monitoring and surrogate abatement equipment checks in place of emissions monitoring.

In three cases it was not possible to compare the monitoring requirements with the BREF and/or the Sectoral Directives. Two permits contained no release monitoring requirements (the foundry in Estonia and the surface treatment with solvents plant in Ireland, which did not require monitoring of air emissions although VOCs were a main pollutant). One permit (shipyard) allowed the operator to calculate VOC mass emissions (EE-04); however an audit of the calculation and methodology used was not conducted during the assessment.

### 4.5.4 Actual Monitoring Undertaken Compared to Permit Conditions, Requirements of Article 9(5) and BAT

For almost all of the case studies assessed, the operator conducted release monitoring as part of routine operations and, in the majority of cases, that monitoring was aligned with the requirements of the permit and the BREF document (where applicable information is given in the BREF). Figure 4.12 illustrates the findings.

**Figure 4.12 Analysis of Actual Monitoring Against Permit Conditions and BREF**

In those cases where the findings were mixed, there was evidence that monitoring was being conducted for certain parameters but not all or that actual monitoring conducted was not aligned with the monitoring frequencies set out in the permit in all cases.
4.5.5 **Factors Influencing Permit Conditions that are Incompatible with the IPPC Directive**

In order to support the desk-based assessment of permits, the competent authorities interviewed were asked to confirm if any trade-offs were made when setting permit conditions (such as whether setting looser conditions for one environmental medium was balanced by setting tighter conditions for another medium). It was also investigated whether factors not compatible with the IPPC Directive have been taken into account when determining permit conditions (e.g. the economic circumstances of the operator). Analysis of the permits were made in each case to determine if there was any evidence of such factors being taken into account (e.g. through technical letters, justifications on BAT or other supporting permit documents).

The IPPC Directive allows Member State competent authorities to set conditions, taking into account specific technical characteristics of the installation, geographic location or local environmental factors. Previous implementation studies have highlighted that it is common for various factors to be taken into account (in addition to BAT) when setting permit conditions and limits. Typically these have included:

- The specific financial circumstances of the operator or controlling company;
- The resources available to the operator (technical and material) in order to ensure the plant operates at a standard commensurate with the BAT for the sector; and
- The circumstances surrounding operation of the plant, which can include technical limitations due to the age or condition of the plant, imminent closure or major refurbishments planned, a limited or restricted operation schedule.

The findings of this study indicated that, for 8 out of 50 installations, factors not compatible with the IPPC Directive appeared to have been taken into account when setting permit conditions. Of these, 7 related to cost or commercial considerations (the economic situation of the operator) being used and one also referenced the imminent closure of an installation. In all cases these factors were discussed with competent authorities and details of the justifications can be found within the individual case study assessment reports.

4.5.6 **Public Participation in Permit Issue (Article 15)**

The findings of this study are that, in all cases, there was evidence provided either within the permit or during the site interview that members of the public had been given the opportunity to comment on the issue of the permit and the conditions set therein.

4.5.7 **Measures taken by the Competent Authority to Ensure Compliance with Permit Conditions (Article 14)**

Breaches of compliance with permit conditions have been reviewed with the competent authorities during site visits. The findings from the assessments show a very mixed picture with regards to the level of compliance, with 19 cases where no breaches of compliance were evident, 15 cases where sanctions had been used following a breach and 16 cases where a breach had been dealt with informally without sanctions. The findings, graphically illustrated by sector in Figure 4.13, do not show highly significant trends between sectors.
Analysing the information by Member State (Table 4.4) rather than sector indicates that the installations in Hungary appear to have complied with all their permit conditions whereas for other Member States, installations have reported a breach or breaches of one or more of their permit conditions. Based on the evidence, no installations in Denmark, Belgium or Estonia appear to have complied with all their permit conditions over the period assessed (2008 – 2009 in most cases). Sanctions were not applied in 16 of the 31 breaches; the reasons given by the competent authorities for not taking formal actions in these cases vary (see individual assessment reports for further detail). The most frequent rationale for formal actions (sanctions) not being taken relates to the fact that often the operator had already taken action to rectify the situation that led to the breach or had since applied different control measures to limit future risks.

Table 4.4 Details of number of permits complying with permit conditions and whether or not action was taken by Competent Authorities in Member States as a result of a breach of permit conditions being reported

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>BE</th>
<th>BG</th>
<th>DK</th>
<th>EE</th>
<th>FI</th>
<th>HU</th>
<th>IE</th>
<th>PT</th>
<th>RO</th>
<th>SI</th>
</tr>
</thead>
<tbody>
<tr>
<td>There have been no breaches of</td>
<td>19</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>4</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>compliance for the period assessed</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>There have been (a) breach/breaches</td>
<td>15</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>2</td>
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<tr>
<td>of compliance and sanctions have been</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>There have been (a) breach/breaches</td>
<td>16</td>
<td>4</td>
<td>5</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>of compliance and no sanctions were</td>
<td></td>
<td></td>
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</tbody>
</table>
4.6 Key Issues for Member States

4.6.1 Overview
This section provides a brief commentary on some of the issues identified with regard to implementation of the IPPC Directive for the 50 case study installations investigated in this study, both in terms of the sectors and in terms of the Member States covered. The main points include comments on common or recurring themes or on key observations regarding the installations covered.

As noted in previous implementation reports, given the relatively limited number of installations covered as compared to the total included under the IPPC Directive, it is not possible in most cases to draw conclusions that are necessarily representative of implementation of the Directive across a sector or a Member State. Rather, the information presented in this section may provide an indication for the Commission, Member States and industry of further work that could be done to further implement, or to support implementation of, the IPPC Directive.

The findings set out in this section are reflective of a conservative approach and should also be read having consideration to the limitations of the numeric analysis and level of precision. Compliance rules detailed in permits were not taken into account in the high-level analysis and comparability of performance against permits, BAT-AELs or limits within the Sectoral Directives is limited. The incomparability of these datasets affects the ability to draw accurate conclusions from the results of this study. Generalised conclusions have therefore been avoided.

4.6.2 Member States
Table 4.5 outlines a summary by Member State of how many permits were examined and for those permits, how many had ELVs applied for the main pollutants, how many ELVs were in line BAT-AELs and limits outlined in the relevant Sectoral Directives and how the performance of the installation (as judged by average annual performance) compares to permit ELVs, BAT-AELs and limits in the Sectoral Directives.

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28 The comparability of data relates to correct alignment of the averaging periods for monitored data against permit ELVs, BAT-AELs and Sectoral Directive limits and the availability of complete datasets.
Table 4.5 Summary by Member State of detailed findings on how permit ELVs compare to BAT-AELs and Sectoral Directive limits (where relevant) and how indicative emissions performance compares to permit ELVs, BAT-AELs and Sectoral Directive limits

<table>
<thead>
<tr>
<th>No. of installations assessed</th>
<th>ELVs applied for main pollutants</th>
<th>Permit requirements/ELVs in-line with ... (where relevant)</th>
<th>Performance (2008/2009) in line with permit</th>
<th>Performance (2008/2009) fully in line with...</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>Some</td>
<td>None</td>
<td>BAT-AELs</td>
</tr>
<tr>
<td>BE</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>BG</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>DK</td>
<td>6</td>
<td>2</td>
<td>4</td>
<td>-</td>
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<tr>
<td>EE</td>
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<tr>
<td>SI</td>
<td>5</td>
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</tr>
<tr>
<td>Total</td>
<td>50</td>
<td>31</td>
<td>17</td>
<td>2</td>
</tr>
</tbody>
</table>

Note: caveats on comparability of data apply to these conclusions. ELVs were not comparable with BAT-AELs at four installations - no BAT-AELs applied at three installations and no ELVs were set at one.

2 EE/PT: two permits had received formal exemptions from the SE Directive requirements.

3 The figure in brackets indicates the total number of permits for which the Sectoral Directive applied.

4 BE: one case not clear from the assessment. BG: 2 installations all pollutants indicatively above the BAT-AELs. DK: BAT-AELs not relevant at one installation and not clear at another. EE: no relevant BAT-AELs for 2 permits, 1 permit performance above BAT for all and 1 permit no data to compare.

5 One installation used the reduction scheme.

The analysis presented in Table 4.4 indicates that, of the permits examined, all Member States have set limits on emissions of most, if not all, the main pollutants. The exceptions were a ceramics installation in Finland (which had no ELVs in the permit) and two shipyards; one in Portugal and one in Estonia, which had received derogations from ELVs or a reduction scheme under the SE Directive. There is however clear indication that, in all but two Member States (Slovenia and Portugal), permits are being issued without containing ELVs for all of main environmental pollutants for which BAT-AELs exist or relevant limits are defined within the Sectoral Directives.

For all Member States, the conclusions reached through this study (based on a very limited sample) are that many permit ELVs are set higher than the comparable upper BAT-AEL value. The analysis of permits from Portugal indicates that the permits had been issued in all cases with two sets of limits, the more stringent set (which in all cases have been in force since 2010) have been set aligned with the relevant BAT-AELs. The competent authorities in Portugal made reference to the fact that, whilst installations had received a higher emission limit (in some instances) to allow a ‘transition’ and time to implement BAT, they had applied BAT-based permitting when setting revised permit limits.
There were 17 permits across the 50 examined where it appeared (from the desk-based review and later conversations with competent authorities) that BAT had been evaluated when setting permit ELVs and main conditions. In 14 of these permits, the evidence indicated that permit ELVs were aligned with BAT-AELs; in the other 3 they were not. There are no Member State trends to note with regard to this as these 3 instances were all in different Member States.

There were four permits when one or more ELV had been set in the permit at a level higher than the minimum requirements set out in the relevant Sectoral Directive. Two cases were in Estonia where the LCP permit had a NOx ELV at 300 mg/m³ but also set total mass limits and the shipyard where no total VOC emission limits were set. One case in Portugal related to a foundry (SED) permit which set a fugitive limit of 25% rather than required 20%. The final case related to surface treatment with solvents plant in Belgium, where a fugitive limit had been set higher than the required 5%. In these four permits, all other conditions relating to compliance with emission limits or other measures were in line.

In the two countries where GBRs had been used to set all main permit conditions relating to ELVs (Hungary and Slovenia), (as Table 4.5 shows) 1 permit in Hungary and 2 permits in Slovenia were judged to have ELVs aligned with BAT-AELs.

The main other qualitative findings regarding Member States (from observational rather than numerical evidence) were as follows:

- Permits issued by Portugal’s competent authorities lacked any averaging periods within them, rendering an accurate comparison of ELVs to BAT-AELs and of performance to ELVs and BAT difficult;

- The setting of units for permit ELVs aligned with units expressed in the Sectoral Directives and/or BREF documents allows competent authorities to compare actual installation performance with BAT and seek further improvements where emission levels are consistently higher. The lack of comparability was noted in several permits, where mass-based performance data, in most cases, was not comparable with existing BAT-AELs; and

- The assessment and judgements reached on whether an operator is applying BAT was not, in all cases comprehensively documented. The extent and detail contained within technical documents supporting the competent authorities’ assessment of BAT for installations examined within this study varied between Member States. No specific conclusions on this were reached.
5. References


BAT Reference Document on the Chlor-alkali manufacturing industry (Adopted BREF 2001)


BAT Reference Document on the Ferrous metals processing industry (Adopted BREF 2001)

BAT Reference Document on the Food, drink and milk industries (Adopted BREF 2006)

BAT Reference Document on the Glass manufacturing industry (Adopted BREF 2001)

BAT Reference Document on Industrial cooling systems (Adopted BREF 2001)

BAT Reference Document on the Large combustion plants (Adopted BREF 2006)

BAT Reference Document on the Large volume inorganic chemicals – ammonia, acids and fertilisers industries (Adopted BREF 2007)

BAT Reference Document on the Large volume inorganic chemicals – solids and others industry (Adopted BREF 2007)


BAT Reference Document on the Manufacture of organic fine chemicals (Adopted BREF 2006)


BAT Reference Document on the Non-ferrous metals industries (Adopted BREF 2001)

BAT Reference Document on the Production of iron & steel (Adopted BREF 2001)

BAT Reference Document on the Production of polymers (Adopted BREF 2007)

BAT Reference Document on the Production of speciality inorganic chemicals (Adopted BREF 2007)

BAT Reference Document on the Pulp & paper industry (Adopted BREF 2001)


BAT Reference Document on the Waste treatments industries (Adopted BREF 2001)


European Commission (2007) Assessment of the application and possible development of community legislation for the control of waste incineration and co-incineration, Ökopol GmbH

European Commission (2009) Assessment of the implementation of the IPPC directive – Phase II Study, Entec UK Ltd


## 6. Glossary of Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Av</td>
<td>Averaging period – the period over which an emission limit value is based and upon which monitoring of emissions should be conducted in order to demonstrate compliance.</td>
</tr>
<tr>
<td>BAT</td>
<td>Best available techniques (as defined in Article 2(12) of the IPPC Directive).</td>
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<tr>
<td>BAT-AEL</td>
<td>BAT-associated emission level.</td>
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<tr>
<td>BREF</td>
<td>Best available techniques (BAT) reference document.</td>
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<tr>
<td>CA</td>
<td>Competent authority.</td>
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<tr>
<td>CO</td>
<td>Carbon monoxide.</td>
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<tr>
<td>EC</td>
<td>European Commission.</td>
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<tr>
<td>ELV</td>
<td>Emission limit value.</td>
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<tr>
<td>EPER</td>
<td>European Pollutant Emission Register.</td>
</tr>
<tr>
<td>E-PRTR</td>
<td>European Pollutant Release and Transfer Register (replaces EPER).</td>
</tr>
<tr>
<td>EQS</td>
<td>Environmental quality standard.</td>
</tr>
<tr>
<td>ESP</td>
<td>Electrostatic precipitator.</td>
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<tr>
<td>ETP</td>
<td>Effluent treatment plant.</td>
</tr>
<tr>
<td>ETS</td>
<td>Emissions trading scheme.</td>
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<tr>
<td>EU</td>
<td>European Union.</td>
</tr>
<tr>
<td>EU27</td>
<td>European Union Member States.</td>
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<tr>
<td>FGD</td>
<td>Flue gas desulphurisation.</td>
</tr>
<tr>
<td>FGT</td>
<td>Flue gas treatment.</td>
</tr>
<tr>
<td>GBR</td>
<td>General binding rule (provided for in Article 9(8) of the IPPC Directive). The definition applied herein is &quot;limit values or other conditions (defined in particular in environmental laws, regulations and ordinances) at sector level or wider, that are given with the intention to be used directly to set permit conditions. They provide direct conditions or minimum standards. GBRs are binding either to the authority or to the operator. However, under certain conditions, some general rules may not be mandatory and deviation will be allowed, although the normal expectation would be that the rules be used directly.&quot; (Based on a report for the European Commission conducted during the review of the IPPC Directive.)</td>
</tr>
<tr>
<td>HCl</td>
<td>Hydrogen chloride.</td>
</tr>
<tr>
<td>HF</td>
<td>Hydrogen fluoride.</td>
</tr>
<tr>
<td>IPPC</td>
<td>Integrated pollution prevention and control.</td>
</tr>
<tr>
<td>LCP</td>
<td>Large combustion plant.</td>
</tr>
<tr>
<td>MS</td>
<td>Member State.</td>
</tr>
<tr>
<td>N/A</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>NEC</td>
<td>National emission ceilings (Directive).</td>
</tr>
<tr>
<td>NH₃</td>
<td>Ammonia.</td>
</tr>
<tr>
<td>NMVOC</td>
<td>Non-methane volatile organic compound.</td>
</tr>
</tbody>
</table>
NOx  Nitrogen oxides
PM  Particulate matter
SCR  Selective catalytic reduction
SED  Solvent Emissions Directive
SO2  Sulphur dioxide
SNCR  Selective non-catalytic reduction
STS  Surface Treatment using Solvents
TOC  Total organic carbon
VOC  Volatile organic compound

Member State abbreviations
AT  Austria
BE  Belgium
BG  Bulgaria
CY  Cyprus
CZ  Czech Republic
DE  Germany
DK  Denmark
EE  Estonia
EL  Greece
ES  Spain
FR  France
HU  Hungary
IE  Ireland
IT  Italy
LT  Lithuania
LV  Latvia
LU  Luxembourg
MT  Malta
NL  Netherlands
PL  Poland
PT  Portugal
RO  Romania
SE  Sweden
SI  Slovenia
SK  Slovakia (Slovak Republic)
UK  United Kingdom
Appendix A
Review of BREFs and Production of a BAT-AEL Searchable Electronic Database Tool

Provided on CD Rom
Appendix B
IPPC Implementation Case Study
Assessment Reports 1 - 50
Appendix C
Information Request Factsheets/Checklists