Defra would like to acknowledge the work of the Environment Agency’s Local Authority Unit in the drafting of this guidance note.
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1 Introduction

Background

1.1 This sector guidance note is issued by the Secretary of State and the Welsh Assembly Government (WAG), following consultation with relevant trade bodies, representatives of regulators including members of the Industrial Pollution Liaison Committee, and other interested organisations.

1.2 The note constitutes statutory guidance under regulation 37 of the Pollution Prevention and Control (England and Wales) Regulations 2000, SI 1973 (Ref 1) on the integrated pollution control standards appropriate for the generality of new and existing A2 installations in the surface treating using organic solvents sector.

These installations require a permit to operate in accordance with the 2000 Regulations under what is known as the Local Authority-Integrated Pollution Prevention and Control (LA-IPPC) regime. Local authority regulators are required by regulation 37 to have regard to this guidance. The Secretary of State / WAG will also treat this guidance as one of the material considerations when determining any appeals made under the Regulations against a local enforcing authority decision.

1.3 The guidance also (where appropriate) gives details of any mandatory requirements affecting emissions and impacts from these installations, which are in force at the time of publication. These include requirements contained in directions from the Secretary of State / WAG, which implement the provisions of the Solvent Emissions Directive 1999/13/EC (SED) (Ref 2)

1.4 This is one of a series of such guidance notes aimed at providing a strong framework for consistent and transparent regulation of LA-IPPC installations.

1.5 General guidance explaining LA-IPPC and setting out the policy and procedures, is contained in the “General Guidance Manual on Policy and Procedures for A2 and B Installations” (Ref 3) available from www.defra.gov.uk/environment/ppc/index.htm, to be referred to in this document as the “General Guidance Manual.” This is designed for operators and members of the public, as well as for local authority regulators.

Best Available Techniques (BAT)

1.6 BAT is the main basis for determining standards in LA-IPPC. This sector guidance note addresses what is considered by the Secretary of State/WAG to constitute BAT for surface treating using organic solvents.

As made clear in chapter 12 of the General Guidance Manual, BAT for each installation should be assessed by reference to the appropriate sector guidance note, and these notes should be regarded by local authorities as their primary reference document for determining BAT in drawing up permits. In general terms what is BAT for one installation is likely to be BAT for a comparable installation. However, determination of what is BAT is ultimately a matter for case-by-case decision taking into account that individual circumstances may affect BAT judgements and what are the appropriate permit conditions.

Thus, for each surface treating using organic solvents installation, local authorities (subject to appeal to the Secretary of State / WAG) should regard this guidance note as a baseline, but ensure they take into account any relevant case-specific factors such as the individual process configuration and other characteristics, its size, location, and any other relevant features of the particular installation. Further guidance on this, including the issue of taking account of operators' individual financial position, is contained in chapter 12 of the General Guidance Manual.

1.7 If there are any applicable mandatory EU emission limits, these must be met, although BAT may go further. The same applies to UK regulations, such as The Control of Pollution (Oil Storage) (England) Regulations 2001, SI 2954. (Ref 4)
Who is this guidance for?

1.8 This guidance is for:

• local authority regulators: who must have regard to the guidance when determining applications and when regulating installations which have a permit
• operators: who are best advised also to have regard to it when making applications and in the subsequent operation of their activities
• members of the public: who may be interested to know what standards are envisaged for the generality of installations in this sector.

1.9 The guidance is based on the state of knowledge and understanding of installations in this sector, their potential impact on the environment, and the available control techniques at the time of writing. The guidance may be amended from time to time in order to keep abreast with developments, including improvements or changes in techniques and new understanding of environmental impacts and risks. Any such amendments may be issued in a complete revision of this note, or in separate additional guidance notes which address specific issues. (N.B. It may not always be possible to issue amending guidance quickly enough to keep in absolute step with rapid changes, which might be another justification in particular cases for diverging from this note.) Steps will be taken to ensure that those who need to know about changes are informed of any amendments. Operators (and their advisers) are, however, strongly advised to check with the relevant local authority whether there have been any amendments before relying on this note for the purposes of applying for a permit or making any other decisions where BAT and related matters may be a consideration.

Terminology

1.10 In addition to the General Guidance Manual referred to above, explanation or clarification of certain terms used in this sector guidance note may be found in a general guidance note issued under Part I of The Environmental Protection Act 1991: ‘Interpretation of terms used in process guidance notes’, known as General Guidance Note 4 - GG4 - published by HMSO in 1991. Where there is any conflict between GG4 and the guidance issued in this note or in the General Guidance Manual, the latter two documents should prevail, as should any subsequent guidance issued in relation to LA-IPPC.

Installations covered

1.11 This guidance note covers installations described in Section 6.4 Part A(2) (in England and Wales) of Schedule 1 to the PPC Regulations (Ref 1) as follows:

"Surface treating substances, objects or products using organic solvents, in particular for dressing, printing, coating degreasing, waterproofing, sizing, painting, cleaning or impregnating, in a plant with a consumption capacity of more than 150 kg per hour or more than 200 tonnes per year, where not covered by the Part A1 definition. (Ref 1)."

In cases where there are several activities within 6.4 Part A(2) on site, which together add up to more than the above mentioned capacity figures, regard should be had to paragraph 9 of Part 2 of Schedule 1 to the PPC Regulations.

All installations covered within this note are also required to meet the mandatory requirements for VOC of the Solvent Emissions Directive 1999/13/EC. These mandatory requirements are written in italic text.

1.12 This guidance note refers to the:

• coating of substrates to provide a decorative, protective or other functional effect on the surface and may be carried out using a number of application techniques such as spraying, brushing, application by roller, air knife or Meyer bar. Coating operations are sometimes carried out with associated activities such as printing and surface cleaning of the substrate which may be carried out before, after or during the coating operations. In addition they may be associated with cutting, shaping and machining operations in the production of the finished item
• printing of/on substrates, to reproduce text and/or images transferring ink onto a substrate by the use of an image carrier. Printing operations may sometimes be associated with surface cleaning of the substrate that may be carried out before, after or during the printing operation. In addition they may be associated with the pre-printing operations of image and image carrier production and the post-printing operations of cutting and buffing in order to produce the finished item
• impregnation to provide a protective or preservative loading to the surface and subsequent layers of objects and products. Impregnation activities may sometimes be associated with coating and printing, although they are most commonly associated with operations for machining the impregnated product into finished item

*Coating includes dressing, waterproofing, sizing and impregnating*
1.13 This guidance note also addresses the following aspects of the prescribed installation, which are considered to be "surface treatment" operations.

- storage and handling of input (raw) materials (page 17)
- printing (page 19) including:
  - image preparation
  - proofing
  - image carrier production
  - printing
  - finishing
- coating general (page 31):
  - coil coating (page 36)
  - textile coating (page 42)
  - film coating (page 48)
  - vehicle coating (page 52)
  - winding wire coating (page 59)
  - coating and printing of metal packaging (page 63)
  - wallpaper manufacture (page 69)
- emissions control (page 70)
- management (page 78)
- raw materials (page 80)
- waste handling (page 83)
- waste re-use, recovery, recycling and disposal (page 84)
- energy (page 85)
- accidents (page 87)
- noise and vibration (page 89)
- monitoring (page 90)

1.14 The installation includes the main activities above plus the associated activities which have a technical connection with the main activities and which may have an effect on emissions and pollution.
Review and Upgrading Periods

Existing installations or activities

1.15 The previous guidance (reference PG 6/7(97), 6/8(97), 6/13(97), 6/14(97), 6/16(97), 6/17(97), 6/18(97), 6/20(97), 6/23(97), 6/32(97) and the manufacture of adhesives, coatings, or printing inks which are used within the installation 6/10(97), 6/11(97)) advised that upgrading to that standard should other than in exceptional circumstances have been completed within the time scales given in Table 1 below. Provisions still outstanding from any existing upgrading programme should be completed.

Table 1: Existing compliance timetable

<table>
<thead>
<tr>
<th>Guidance</th>
<th>Existing compliance date</th>
</tr>
</thead>
<tbody>
<tr>
<td>PG6/7 (97) Coating and Printing on Metal Packaging</td>
<td>1 December 1998</td>
</tr>
<tr>
<td>PG6/8 (97) Textile and Fabric Coating and Finishing Processes</td>
<td>1 September 1999</td>
</tr>
<tr>
<td>PG6/13 (97) Coil Coating Processes</td>
<td>1 October 1997</td>
</tr>
<tr>
<td>PG6/14 (97) Film Coating processes</td>
<td>1 June 1998</td>
</tr>
<tr>
<td>PG6/16 (97) Printworks</td>
<td>1 June 2002</td>
</tr>
<tr>
<td>PG6/17 (97) Printing on Flexible Packaging</td>
<td>1 December 1998</td>
</tr>
<tr>
<td>PG6/18 (97) Paper Coating Processes</td>
<td>1 September 1999</td>
</tr>
<tr>
<td>PG6/20 (97) Paint Application In Vehicle Manufacturing</td>
<td>1 April 2001</td>
</tr>
<tr>
<td>PG6/23 (97) Coating of Metal and Plastic</td>
<td>1 April 1998</td>
</tr>
<tr>
<td>PG 6/32 (97) Adhesive Coating Processes</td>
<td>1 April 1999</td>
</tr>
</tbody>
</table>

1.16 The new provisions of this note and the dates by which compliance with these provisions is expected, are listed in Table 2 below, together with the paragraph number where the relevant guidance is to be found. Compliance with the new provisions should normally be achieved by the dates shown. Permits should be drafted having regard to this compliance timetable.

(1) Where this guidance note specifies provisions which are additional to, higher than or different to those in PG notes (reference PG 6/7(97), 6/8(97), 6/10(97), 6/11(97), 6/13(97), 6/14(97), 6/16(97), 6/17(97), 6/18(97), 6/20(97), 6/23(97), 6/32(97)), only in exceptional circumstances should upgrading of existing installations and activities having regard to these additional/higher/different provisions be completed later than the compliance date specified in Table 2 below.

(2) Where standards or provisions in PG notes (reference PG 6/7(97), 6/8(97), 6/10(97), 6/11(97), 6/13(97), 6/14(97), 6/16(97), 6/17(97), 6/18(97), 6/20(97), 6/23(97), 6/32(97)) have been deleted in this guidance note or where this guidance note specifies less stringent provisions than those in PG notes (reference PG 6/7(97), 6/8(97), 6/10(97), 6/11(97), 6/13(97), 6/14(97), 6/16(97), 6/17(97), 6/18(97), 6/20(97), 6/23(97), 6/32(97)), these should be included in the new LA-IPPC permit and have immediate effect.

1.17 A programme for upgrading within the specified timescales, to those new / additional provisions in this guidance which involve significant improvement work, should be submitted to the relevant local authority regulator within 6 months of the date of issue of the permit.
1.18 Replacement abatement plant for VOC must be designed to meet the appropriate standards specified for new installations or activities. Other replacement plant should normally be designed to meet the appropriate standards specified for new installations or activities.

New installations or activities

1.19 For new installations or activities - from the first day of operation the permit should have regard to the full standards of this guidance.

Substantially changed installations or activities

1.20 For substantially changed installations or activities - as from the first day of operation, the permit should normally have regard to the full standards of this guidance with respect to the parts of the installation that have been substantially changed and any part of the installation affected by the change.

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Reference</th>
<th>Compliance date</th>
</tr>
</thead>
<tbody>
<tr>
<td>New limits for VOC emissions from contained releases and Fugitive Emission Value requirements</td>
<td>Table 5</td>
<td>31 October 2007</td>
</tr>
<tr>
<td>OR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>New total emission limit values for VOC</td>
<td>Table 5</td>
<td>31 October 2007</td>
</tr>
<tr>
<td>OR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>New VOC Reduction Scheme requirements</td>
<td>Table 5</td>
<td>31 October 2005</td>
</tr>
</tbody>
</table>

The operator should inform the regulator by the 31 October 2004 which of the above compliance methods for VOC will be employed by 31 October 2004.

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Reference</th>
<th>Compliance date</th>
</tr>
</thead>
<tbody>
<tr>
<td>New requirement to Replace, Control and Limit VOC with Risk Phrases R45,R46,R49,R60,R61</td>
<td>Table 4, Row 16 and BAT 206</td>
<td>Shortest possible time</td>
</tr>
<tr>
<td>New requirement to Control and Limit Halogenated VOC with Risk Phrase R40</td>
<td>Table 4, Row 15</td>
<td>Shortest possible time</td>
</tr>
<tr>
<td>Requirements on new VOC abatement plant fitted to existing installations</td>
<td>Paragraph 1.18</td>
<td>Immediately</td>
</tr>
<tr>
<td>Limitation on sulphur in fuel burnt</td>
<td>Table 4, Row 9</td>
<td>1 January 2008</td>
</tr>
<tr>
<td>Addition of CO or O2 monitoring</td>
<td>BAT 268</td>
<td>Within 2 years of the issue of the permit</td>
</tr>
<tr>
<td>Water Audit</td>
<td>BAT 211</td>
<td>Within 2 years of the issue of the permit</td>
</tr>
<tr>
<td>Waste Audit</td>
<td>BAT 209</td>
<td>Within 18 months of the issue of the permit</td>
</tr>
<tr>
<td>Energy Audit</td>
<td>BAT 224</td>
<td>Annually</td>
</tr>
<tr>
<td>Long-term study of alternative raw materials</td>
<td>BAT 205</td>
<td>Within 6 years of the publication of this note</td>
</tr>
<tr>
<td>All other provisions</td>
<td>-</td>
<td>To be complied with as soon as practicable, which in most cases should be within 12 months of the permit</td>
</tr>
</tbody>
</table>

Table 2: Compliance timetable
Permit reviews

1.21 Permits should be reviewed in accordance with the guidance in chapter 26 of the General Guidance Manual. The review frequencies given in that chapter are considered appropriate for activities and installations covered by this sector guidance note.

**Summary of releases**

Table 3: Summary of releases

| Source                                      | Releases          | Offset printing | Flexography | Screen printing | Gravure | Print finishing | Coating general | Coating of paper | Film coating | Adhesive coating | Coating / printing of metal packaging | Paint application in vehicle manufacture | Coating of winding wire | Surface cleaning of substrates | Machine cleaning in situ | Mixing and blending operations | Solvent recovery plant | Cooling operations | Boilers, engines and turbines | Drying | Oxidation plant | Effluent plant |
|---------------------------------------------|-------------------|----------------|-------------|----------------|---------|----------------|----------------|----------------|-------------|----------------|------------------------------------|---------------------------------|--------------------------|--------------------------|--------------------------|---------------------------|--------------------------|--------------------------|----------------|----------------|----------------|
| Oxides of sulphur                           |                   | A             | A           | A             | A       | A             | A             | A             | A           | A             | A                                  | A                               | A                        | A                        | A                        | A                        | A                        | A                        | A                        | A                        |
| Oxides of nitrogen                          |                   | A             | A           | A             | A       | A             | A             | A             | A           | A             | A                                  | A                               | A                        | A                        | A                        | A                        | A                        | A                        | A                        | A                        |
| Carbon dioxide                              |                   | A             | A           | A             | A       | A             | A             | A             | A           | A             | A                                  | A                               | A                        | A                        | A                        | A                        | A                        | A                        | A                        | A                        |
| Carbon monoxide                             |                   | A             | A           | A             | A       | A             | A             | A             | A           | A             | A                                  | A                               | A                        | A                        | A                        | A                        | A                        | A                        | A                        | A                        |
| Ammonia                                     |                   | A             | A           | A             | A       | A             | A             | A             | A           | A             | A                                  | A                               | A                        | A                        | A                        | A                        | A                        | A                        | A                        | A                        |
| VOC                                         |                   | A             | A           | A             | A       | A             | A             | A             | A / W       | A             | A                                  | A                               | A                        | A                        | A                        | A                        | A                        | A                        | A                        | A                        |
| Halogenated VOC Risk Phrase R40             |                   | A             | A           | A             | A       | A             | A             | A             | A / W       | A             | A                                  | A                               | A                        | A                        | A                        | A                        | A                        | A                        | A                        | A                        |
| VOC Risk Phrase R45, R46, R49, R60, R61     |                   | A             | A           | A             | A       | A             | A             | A             | A / W       | A             | A                                  | A                               | A                        | A                        | A                        | A                        | A                        | A                        | A                        | A                        |
| Isocyanates                                 |                   | A             | A           | A             | A       | A             | A             | A             | A / W       | A             | A                                  | A                               | A                        | A                        | A                        | A                        | A                        | A                        | A                        | A                        |
| Formaldehyde                                |                   | A             | A           | A             | A       | A             | A             | A             | A / W       | A             | A                                  | A                               | A                        | A                        | A                        | A                        | A                        | A                        | A                        | A                        |
| Ozone                                       |                   | A             | A           | A             | A       | A             | A             | A             | A / W       | A             | A                                  | A                               | A                        | A                        | A                        | A                        | A                        | A                        | A                        | A                        |
| HF                                          |                   | A             | A           | A             | A       | A             | A             | A             | A / W       | A             | A                                  | A                               | A                        | A                        | A                        | A                        | A                        | A                        | A                        | A                        |
| Solid waste or sludge                       |                   | L             | L           | L             | L       | L             | L             | L             | L           | L             | L                                  | A                               | L                        | L                        | L                        | L                        | L                        | L                        | L                        | L                        |
| Metals                                      |                   | L / W         | L / W       | L / W         | L / W   | L / W         | L / W         | L / W         | L / W       | L / W         | L / W                               | L                               | L                        | L                        | L                        | L                        | L                        | L                        | L                        | L                        | L                        |
| Oils and greases                            |                   | L / W         | L           | W             | W       | L             | L             | L             | L / W       | L             | L                                  | L                               | L                        | L                        | L                        | L                        | L                        | L                        | L                        | L                        | L                        | L                        | L
### Table 3: Summary of releases

<table>
<thead>
<tr>
<th>Source</th>
<th>Offset printing</th>
<th>Flexography</th>
<th>Screen printing</th>
<th>Gravure</th>
<th>Print finishing</th>
<th>Coating general</th>
<th>Coating of paper</th>
<th>Film coating</th>
<th>Adhesive coating</th>
<th>Coating / printing of metal packaging</th>
<th>Paint application in vehicle manufacture</th>
<th>Coating of winding wire</th>
<th>Surface cleaning of substrates</th>
<th>Machine cleaning in situ</th>
<th>Mixing and blending operations</th>
<th>Storage and handling operations</th>
<th>Solvent recovery plant</th>
<th>Cooling operations</th>
<th>Heating, engines and turbines</th>
<th>Drying</th>
<th>Oxidation plant</th>
<th>Effluent plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acid vapours</td>
<td>A</td>
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</tr>
<tr>
<td>Odour</td>
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<tr>
<td>Noise</td>
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</tr>
</tbody>
</table>

**Note:** A = Release to Air, W = Release to Water, L = Release to Land, * = Potential for noise, * = Potential for odour

Substances include their compounds, except where separate reference to the compound is made.

Releases to air may also be released to land or water, depending upon the abatement technology employed, e.g. via collected dusts, sludges or liquors.

Some releases are specific to a particular binder system (Table 4 and Table 6).
# Emission limits and other provisions

2.1 This section contains emission limits, mass release rates and other provisions that are judged for the generality of the activities within the sector to represent BAT.

## Emissions to air associated with the use of BAT

### Table 4: Emissions to air associated with BAT

<table>
<thead>
<tr>
<th>Row</th>
<th>Total particulate matter</th>
<th>Emission limit / provision</th>
<th>Monitoring (subject to paragraph 3.240)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shot blasting, fettling and other finishing operations.</td>
<td>20mg/m³</td>
<td>Continuously recorded indicative monitoring Plus once a year extractive monitoring</td>
</tr>
<tr>
<td>2</td>
<td>Paint spraying vehicle bodies emissions</td>
<td>5 mg/m³</td>
<td>Once year extractive monitoring</td>
</tr>
<tr>
<td>3</td>
<td>Other paint spraying operations</td>
<td>50 mg/m³</td>
<td>Once year extractive monitoring</td>
</tr>
<tr>
<td>4</td>
<td>All other contained sources (except gas fired oxidisers)</td>
<td>50 mg/m³</td>
<td>Continuously recorded indicative monitoring Plus once a year extractive monitoring</td>
</tr>
<tr>
<td>5</td>
<td>Visible emissions combustion plant</td>
<td>Ringlemann shade 1</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>From abatement plant Nitrogen containing coatings 300 mg/m³</td>
<td>Non-nitrogen containing coatings 100 mg/m³</td>
<td>Once a year extractive monitoring</td>
</tr>
<tr>
<td>7</td>
<td>From winding wire machines operating on: • Polyester imide enamel • Polyurethane enamel • Polyester imide with polyamide imide or polyamide • Polyimide Target value 0.1g/kg of coated wire 0.1g/kg of coated wire 5g/kg of coated wire 9g/kg of coated wire</td>
<td></td>
<td>Once a year extractive monitoring</td>
</tr>
<tr>
<td>8</td>
<td>From abatement plant</td>
<td>100 mg/m³</td>
<td><strong>Where used as a surrogate measurement for VOC destruction:</strong> Continuously recorded indicative monitoring Plus once a year extractive monitoring. <strong>All other cases:</strong> Once a year extractive monitoring</td>
</tr>
<tr>
<td>Row</td>
<td>Sulphur dioxide</td>
<td>Emission limit / provision</td>
<td>Monitoring (subject to paragraph 3.240)</td>
</tr>
<tr>
<td>-----</td>
<td>-----------------</td>
<td>-----------------------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td>9</td>
<td>From fuel burnt in combustion plant. Sulphur content of fuel</td>
<td>When burning gas oil. Note 1 When burning other fuels</td>
<td>0.2% wt/ wt sulphur in fuel. 0.1% wt/ wt sulphur in fuel (from 01/01/2008) 1% wt/wt sulphur in fuel</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Row</th>
<th>Formaldehyde</th>
<th>Emission limit / provision</th>
<th>Monitoring (subject to paragraph 3.240)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Textile and fabric finishing</td>
<td>20 mg/m$^3$ (measured as formaldehyde)</td>
<td>Once a year extractive monitoring</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Row</th>
<th>Ammonia</th>
<th>Emission limit / provision</th>
<th>Monitoring (subject to paragraph 3.240)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Textile and fabric finishing</td>
<td>30 mg/m$^3$</td>
<td>Once a year extractive monitoring</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Row</th>
<th>Isocyanate</th>
<th>Emission limit / provision</th>
<th>Monitoring (subject to paragraph 3.240)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>All contained sources where isocyanate is used</td>
<td>0.1 mg/m$^3$ (averaged over a 2 hour period as total NCO group)</td>
<td>Once a year extractive monitoring</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Row</th>
<th>Fluoride</th>
<th>Emission limit / provision</th>
<th>Monitoring (subject to paragraph 3.240)</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>All contained sources where fluorine containing coating is used</td>
<td>5 mg/m$^3$ expressed as hydrogen fluoride</td>
<td>Once a year extractive monitoring</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Row</th>
<th>HCl</th>
<th>Emission limit / provision</th>
<th>Monitoring (subject to paragraph 3.240)</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>All contained sources where chlorine containing coating is used</td>
<td>10 mg/m$^3$</td>
<td>Once a year extractive monitoring</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Row</th>
<th>Halogenated VOC assigned a risk phrase R40</th>
<th>Emission limit / requirement</th>
<th>Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>All contained sources where R40 halogenated VOC are used</td>
<td>20 mg/m$^3$ expressed as the sum of the mass concentrations of the individual VOC concerned. Note 2</td>
<td>Once a year extractive monitoring</td>
</tr>
</tbody>
</table>
2.2 For other VOC emission limits only the installation must comply with either:
   • the emission limits and the fugitive limit; or
   • the reduction scheme; or
   • the total emission limit value where available

<table>
<thead>
<tr>
<th>Row</th>
<th>VOC assigned a risk phrase R45, R46, R49, R60, R61</th>
<th>Emission limit / requirement</th>
<th>Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>The sum of these risk phrase VOC from all contained sources where the total of the emission of all the risk phrase compounds causing the risk phrase labelling is greater than or equal to 10 g/hr.</td>
<td>2 mg/m³ expressed as the sum of the mass concentrations of the individual VOC concerned. Note 2</td>
<td>Once a year extractive monitoring</td>
</tr>
</tbody>
</table>

Note 1 Gas oil as defined in the Sulphur Content of Certain Liquid Fuels Directive (1992/32/EC)
Note 2 Limits are derived from the Solvent Emissions Directive (1999/13/EC) and are the mandatory minimum standard

2.2 For other VOC emission limits only the installation must comply with either:
   • the emission limits and the fugitive limit; or
   • the reduction scheme; or
   • the total emission limit value where available
### Table 5: Other VOC emission limits

<table>
<thead>
<tr>
<th>Row</th>
<th>Source</th>
<th>Emission limit</th>
<th>Fugitive limit</th>
<th>Target emission</th>
<th>Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Heatset web offset printing</td>
<td>20 mg/m³ Note 2</td>
<td>30% of solvent input Note 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Publication rotogravure</td>
<td>75 mg/m³ Notes 2 and 3</td>
<td>New plant 10% of solvent input Note 2</td>
<td>Mass of solvent = Total mass of solids x 1 Note 2, 7 and 8</td>
<td>Emission limits: from A) unabated releases. Once a year extractive monitoring (subject to paragraph 3.240) B) abated releases continuously recorded indicative monitoring Plus once a year extractive monitoring</td>
</tr>
<tr>
<td></td>
<td>Waste gases from oxidation plant used as abatement</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Any other waste gases from contained sources</td>
<td>75 mg/m³</td>
<td>Existing plant 15% of solvent input Note 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Rotogravure, flexography, laminating or varnishing</td>
<td>100 mg/m³ Notes 2 and 3</td>
<td>20% of solvent input Note 2</td>
<td>Mass of solvent = Total mass of solids x 0.37 Note 2, 7 and 8</td>
<td>Fugitive emission limits - In accordance with Appendix 2</td>
</tr>
<tr>
<td></td>
<td>Waste gases from oxidation plant used as abatement</td>
<td></td>
<td></td>
<td></td>
<td>Target emission - Annually in accordance with Appendix 2</td>
</tr>
<tr>
<td></td>
<td>Any other waste gases from contained sources</td>
<td>100 mg/m³ Note 2</td>
<td></td>
<td></td>
<td>Total emission limit - Annually in accordance with Appendix 2</td>
</tr>
<tr>
<td>4</td>
<td>Rotary screen printing</td>
<td>100 mg/m³ Notes 2 and 3</td>
<td>20% of solvent input Note 2</td>
<td>Mass of solvent = Total mass of solids x 0.38 Note 2, 7 and 8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Waste gases from oxidation plant used as abatement</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Any other waste gases from contained sources</td>
<td>100 mg/m³ Note 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Coating and printing of metal packaging</td>
<td>50 mg/m³ Note 2 20 mg/m³ Note 6</td>
<td>20% of solvent input Note 2</td>
<td>Food contact applications: Mass of solvent = Total mass of solids x 0.58 Note 2, 7 and 8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Waste gases from drying operations</td>
<td></td>
<td></td>
<td></td>
<td>Non-food contact applications: Mass of solvent = Total mass of solids x 0.38 Note 2, 7 and 8</td>
</tr>
<tr>
<td></td>
<td>Any other waste gases from contained sources</td>
<td>75 mg/m³ Note 2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 5: Other VOC emission limits

<table>
<thead>
<tr>
<th>Row</th>
<th>Source</th>
<th>Emission limit</th>
<th>Fugitive limit</th>
<th>Target emission</th>
<th>Monitoring</th>
</tr>
</thead>
</table>
| 6   | Textile and fabric coating and finishing  
   Paper coating  
   Film coating  
   Coating in flexible packaging | Waste gases from oxidation plant used as abatement  
   Waste gases from drying operations  
   Any other waste gases from contained sources | 50 mg/m³  
   Note 2  
   20 mg/m³  
   Note 6 | 20% of solvent input  
   Note 2 | Food contact applications: Mass of solvent = Total mass of solids x 0.58  
   Note 2, 7 and 8  
   Non-food contact applications: Mass of solvent = Total mass of solids x 0.25  
   Note 2, 7 and 8 | Emission limits:  
   from A) unabated releases.  
   Once a year extractive monitoring (subject to paragraph 3.240)  
   B) abated releases continuously recorded indicative monitoring Plus once ayear extractive monitoring |
| 7   | Coil coating | Waste gases from oxidation plant used as abatement  
   Waste gases from abatement techniques which allow recovery and re-use of recovered solvents  
   Any other waste gases from contained sources | 50 mg/m³  
   Note 2  
   20 mg/m³  
   Note 6 | New plant 5% of solvent input  
   Note 2 | New plant  
   Mass of solvent = Total mass of solids x 0.15  
   Note 2, 7 and 8  
   Existing plant 10% of solvent input  
   Note 2 | Fugitive emission limits -  
   In accordance with Appendix 2 |
| 8   | Adhesive coating of film | Waste gases from oxidation plant used as abatement  
   Waste gases from abatement techniques which allow recovery and re-use of recovered solvents  
   Any other waste gases from contained sources | 50 mg/m³  
   Note 2  
   20 mg/m³  
   Note 6 | 20% of solvent input  
   Note 2 | Mass of solvent = Total mass of solids x 0.3  
   Note 2, 7 and 8 | Target emission -  
   Annually in accordance with Appendix 2 |
| 9   | Coating of winding wire | All sources | Total emission limit  
   10g/kg of coated wire with an average diameter equal to or less than 0.1mm  
   Note 2  
   5g/kg of coated wire all other diameters of wire  
   Note 2 | | Total emission limit -  
   Annually in accordance with Appendix 2 |
| 10  | All other A2 coating e.g. coating of plastic and metal not covered elsewhere in this table | Waste gases from oxidation plant  
   Waste gases from drying operations  
   Any other waste gases from contained sources | 50 mg/m³  
   Note 2  
   20 mg/m³  
   Note 6 | 20% solvent input  
   Note 2 | Mass of solvent = Total mass of solids x 0.37  
   Note 2, 7 and 8 |
<table>
<thead>
<tr>
<th>Row</th>
<th>Source</th>
<th>Emission limit</th>
<th>Fugitive limit</th>
<th>Target emission</th>
<th>Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Vehicle coating</td>
<td>VOC from ovens and spray booth VOC abatement plant</td>
<td>50 mg/m³</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Coating new cars</td>
<td>Production thresholds&lt;br&gt;Note 3,&lt;5000&lt;br&gt;=&lt;5000 monocoque&lt;br&gt;[]3500 chassis built</td>
<td>Total emission limit&lt;br&gt;Note 8</td>
<td>New plant&lt;br&gt;45g/m² or 1.3kg/body +33g/m² Note 2</td>
<td>Existing plant&lt;br&gt;60g/m² or 1.9kg/body +41g/m² Note 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>90g/m² or 1.5kg/body + 70g/m²</td>
<td>90g/m² or 1.5kg/body + 70g/m²</td>
</tr>
<tr>
<td>13</td>
<td>Coating new truck cabins</td>
<td>&lt;=5000&lt;br&gt;=&gt;5000</td>
<td>65 g/m²&lt;br&gt;55 g/m²</td>
<td>85 g/m²&lt;br&gt;75 g/m²</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Coating new vans and trucks</td>
<td>&lt;=2500&lt;br&gt;=&gt;2500</td>
<td>90 g/m²&lt;br&gt;70 g/m²</td>
<td>120 g/m²&lt;br&gt;90 g/m²</td>
<td></td>
</tr>
</tbody>
</table>

**Table 5: Other VOC emission limits**
Emissions to water associated with the use of BAT

2.3 Limit values for water discharges will be specified in individual cases taking account of the receiving environment. Wastewater treatment systems can maximise the removal of metals using precipitation, sedimentation and possibly filtration. The reagents used for precipitation may be hydroxide, sulphide or a combination of both, depending on the mix of metals present. It is also practicable in many cases to re-use treated water. Table 6 provides information regarding achievable levels associated with the use of wastewater treatment systems.

2.4 In all cases the effluent discharged from the installation must not give rise to a potential breach of an EQS or an EAL for the final receiving water, when taken with compliance with any water company permit.
### Table 6: Emissions to water associated with the use of BAT

<table>
<thead>
<tr>
<th>Determinand</th>
<th>Concentration, mg/litre</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOD</td>
<td>100</td>
</tr>
<tr>
<td>Total hydrocarbon oil</td>
<td>5</td>
</tr>
<tr>
<td>Total suspended solids</td>
<td>20</td>
</tr>
<tr>
<td>Metal packaging</td>
<td>500</td>
</tr>
<tr>
<td>Coil coating</td>
<td>500</td>
</tr>
<tr>
<td>Film coating</td>
<td>1000</td>
</tr>
<tr>
<td>Vehicle manufacturing</td>
<td>1000</td>
</tr>
<tr>
<td>Ammoniacal nitrogen expressed as N</td>
<td>15</td>
</tr>
<tr>
<td>Vehicle manufacturing</td>
<td>35</td>
</tr>
<tr>
<td>Dissolved iron</td>
<td>10</td>
</tr>
<tr>
<td>Total chromium</td>
<td>2</td>
</tr>
<tr>
<td>Vehicle manufacturing</td>
<td>3</td>
</tr>
<tr>
<td>Dissolved nickel</td>
<td>2</td>
</tr>
<tr>
<td>Vehicle manufacturing</td>
<td>10</td>
</tr>
<tr>
<td>pH</td>
<td>Metal packaging (2 piece draw and wall iron (DWI) can manufacture)</td>
</tr>
<tr>
<td></td>
<td>Metal packaging extruded aluminium tube manufacture</td>
</tr>
<tr>
<td></td>
<td>Coil coating</td>
</tr>
<tr>
<td></td>
<td>Film coating</td>
</tr>
<tr>
<td></td>
<td>Vehicle manufacturing</td>
</tr>
<tr>
<td>COD</td>
<td>Metal packaging (2 piece draw and wall iron (DWI) can manufacture)</td>
</tr>
<tr>
<td></td>
<td>Metal packaging extruded aluminium tube manufacture</td>
</tr>
<tr>
<td></td>
<td>Coil coating</td>
</tr>
<tr>
<td></td>
<td>Film coating</td>
</tr>
<tr>
<td></td>
<td>Vehicle manufacturing</td>
</tr>
<tr>
<td>Cyanide and cyanogen compounds</td>
<td>1</td>
</tr>
<tr>
<td>Metal packaging (2 piece draw and wall iron (DWI) can manufacture)</td>
<td></td>
</tr>
<tr>
<td>Sulphate as SO(_4)</td>
<td>1000</td>
</tr>
<tr>
<td>Metal packaging (2 piece draw and wall iron (DWI) can manufacture)</td>
<td></td>
</tr>
<tr>
<td>Vehicle manufacturing</td>
<td>2500</td>
</tr>
<tr>
<td>Copper coil coating</td>
<td>0.05</td>
</tr>
<tr>
<td>Copper vehicle manufacturing</td>
<td>3</td>
</tr>
<tr>
<td>Lead coil coating</td>
<td>0.1</td>
</tr>
</tbody>
</table>
Table 6: Emissions to water associated with the use of BAT

<table>
<thead>
<tr>
<th>Determinand</th>
<th>Concentration, mg/litre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead vehicle manufacturing</td>
<td>3</td>
</tr>
<tr>
<td>Cadmium coil coating</td>
<td>0.1</td>
</tr>
<tr>
<td>Cadmium vehicle manufacturing</td>
<td>0.2</td>
</tr>
<tr>
<td>Zinc coil coating</td>
<td>4</td>
</tr>
<tr>
<td>Zinc</td>
<td>2</td>
</tr>
<tr>
<td>Zinc vehicle manufacturing</td>
<td>5</td>
</tr>
</tbody>
</table>
3 Techniques for pollution control

3.1 This section summarises, in the outlined BAT boxes, what BAT should be in most circumstances. The boxes should not be taken as the only source of permit conditions; compliance with emission limits and other provisions contained in this guidance note together with any relevant case-specific considerations will also need to be taken into account.

3.2 The standards cover the techniques and measures which, in combination with those in the relevant previous (LAPC/IPC/Waste) guidance, have been identified as representing BAT in a general sense. They also cover the other requirements of the Pollution Prevention and Control (England and Wales) Regulations 2000 and requirements of other regulations, such as the Waste Management Licensing Regulations and the Groundwater Regulations insofar as they are relevant to an IPPC permit. For the sake of brevity these boxes simply use the term "BAT".

Process description and in-process controls

3.3 Where techniques or operating conditions are referred to in the BAT boxes below, provided that it is demonstrated to the satisfaction of the regulator that an equivalent or better level of control of environmental impacts will be achieved, then other techniques or operating conditions may be used.

Summary of activities

3.4 The meaning of “installation” and “directly associated activity” is addressed in chapter 2 of the General Guidance Manual.

Delivery, storage and handling of input (raw) materials

3.5 Operators of surface treatment installations, in which organic solvents are used, purchase either:
- the necessary surface treatment products (e.g. degreasers, surface cleaners, coatings, inks, thinners etc.), from third party suppliers, for use directly in the surface treatment or coating process; and/or
- components of such products, to manufacture these on-site, for subsequent use in the surface treatment or coating process. In some cases, such product manufacture may involve the preparation of intermediate materials or of a number of intermediate steps. Components purchased can include pigments and extenders, polymers and resins, solvents and additives. All these categories of component may be supplied as solids or liquids

3.6 Liquid products and components, many of which contain solvent, are delivered in a variety of unit quantities, typically ranging from five litres/kilos to 1000 litres/kilos, supplied in rigid metal or plastic containers, 205 litre drums and intermediate bulk containers (IBCs). Some solvents and liquid polymers may be delivered in bulk road tankers.
- bulk solvents and polymer deliveries are discharged to bulk storage tanks
- IBCs are off loaded by forklift and stored in designated storage areas
- drums are off loaded on pallets, using a drum lift, or vehicle tail lift, and stored in a designated storage areas
- smaller containers may be off loaded manually or on pallets and stored in designated storage areas

3.7 Solid or powder product components are usually delivered in 25 kilo paper or plastic bags, sacks or boxes. Some may be delivered in IBCs or bulk road tankers.
- bulk powder deliveries are discharged to silos
- IBCs are off loaded by fork-lift truck, and stored in designated storage areas
- bags, sacks and boxes are off-loaded manually or on pallets, and are stored in designated storage areas
3.8 For the prevention of accidents, the methods employed and the equipment used to ensure the correct handling and storage of flammable materials needs to be determined by trained personnel. There is HSE guidance available on this subject. \((\text{Ref 9}), (\text{Ref 10})\) and \((\text{Ref 11})\) Compliance with health and safety requirements should ensure that BAT 17 is met.

### Potential environmental impact

**Water:** Run off from solvent contaminated areas, contaminated bund water. Run off from dry powder contaminated areas.

**Land:** Spillage of solvent, during off loading, decanting, leakage from storage and process pipe work, accidental spillage. Spillage of dry powder materials during off loading, handling and transfer operations.

**Air:** VOC/odour release from spillage or vapour displacement, dust.

**Waste:** Pallets, drums, off specification materials, out of date product, spillages.

**Energy:** Not significant.

**Accidents:** Spillage of solvents, powders during handling operations. Leakage and containment failure of pipe work, drums, tanks etc. Fire within the storage and handling areas.

**Noise:** Vehicles and delivery operations may cause noise disturbance, especially if close to the site boundary. Blowing into silos from road tankers can create noise, disturbances such as pump noise, resonance in pipe work.

### BAT (Sheet 1 of 2)

1. The operator should ensure that deliveries are carried out in such a way so as to minimise noise, spillage, leaks and dusty emissions.

2. Storage areas should be under cover and protected from the elements to avoid or minimise environmental impact, except where stored materials are in suitable weather proof containers.

3. Storage areas should be hard surfaced.

4. Bulk storage tanks for solvents and solvent-containing liquids should wherever practicable be back vented to the delivery tank during filling. Where this is impracticable, for example: due to long pipe runs, back pressure, or contractual agreements over deliveries, then, displaced air vents should be sited in such a way as to prevent the arising of offensive odour beyond the site boundary.

5. Bulk storage tanks for solvent storage should normally be light coloured, in order to reduce thermal increase as a resulting from sunlight. (planning restrictions may apply)

6. All new static bulk solvent storage tanks containing solvent with a composite vapour pressure that is likely to exceed 0.4kPa at 20°C (293K) should be fitted with pressure vacuum relief valves. Pressure vacuum relief valves should be examined at a minimum of at least once every six months for signs of contamination, incorrect seating and should be cleaned and/or corrected as required.

7. Delivery connections to bulk storage tanks should be located within a bunded/contained area, fixed and locked when not in use.

8. All fixed storage tanks should be fitted with audible and/or visual high-level alarms or volume indicators to warn of overfilling. Where practicable in relation to the viscosity of the material being handled or pumping system used, the filling systems should be interlocked to the alarm system to prevent overfilling.

9. Dusty or potentially dusty materials should be stored in silos, or in confined storage areas within buildings, or in fully enclosed containers / packaging.

10. Deliveries to bulk storage tanks should be supervised by appropriately trained personnel (including trained drivers) to avoid potential accidents and spillage.
Printing general

3.9 Printing is the reproduction of text and images in which with the use of an image carrier, ink is transferred onto whatever type of surface. It includes associated varnishing, coating and laminating techniques. Printed substrates include paper, card, foil, plastics, metal and similar substrates. The printing process is made up of a number of steps all of which maybe part of a single installation.

- image preparation
- proofing
- image carrier production
- printing
  - offset printing
  - gravure
  - publication gravure
  - flexography
  - screen printing
  - rotary screen printing
- finishing

Image preparation

3.10 Most printed material is made up of both words and pictures, which are usually handled differently at the pre-press stage. Typeset films (text) and Repros (illustrations in which the picture has been converted into a series of small dots) are mounted together as pages on a copy board of a camera and exposed to light to produce a film. In the case of colour, light of various colours is passed through to produce an image for each colour. Many of these processes are now done electronically, such that the complete image is made up on screen, including text, pictures, colour separation (magenta, cyan, yellow and black) colour correction, resizing, tints and border etc. before being committed to film, one for each colour.
Although different film types are used for each type of print method the processing of the materials is similar. The film consists of paper or plastic covered with a layer of gelatine embedded with silver halide. The film is exposed using a scanner, camera or exposure device leading to a reaction of the silver halide with light. The exposed film is then developed reducing the silver halide to black metallic silver, the residual unexposed silver halides are then removed by fixing. The fixed film is then rinsed to remove any residual chemicals left on the film.

### Potential environmental impact

**Water**: Discharges from film rinse tanks containing silver and gelatine residues.

**Land**: Not significant.

**Air**: Possible odours associated with the use of acetic acid and ammonia.

**Waste**: Waste chemicals from developing, fixing and rinsing tanks.

**Energy**: Not significant.

**Accidents**: Spillage of chemicals, leakage and containment failure of pipe work, drums, tanks etc. Fire within the film processing area.

**Noise**: Not significant.

### BAT

<table>
<thead>
<tr>
<th>18</th>
<th>Silver emissions from the developing process should be reduced by:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• daily inspection and cleaning of the rollers between the fixing bath and the rinse bath</td>
</tr>
<tr>
<td></td>
<td>• replacing damaged or worn rollers</td>
</tr>
</tbody>
</table>

| 19 | An annual inspection of the developing machine should be carried out by the manufacturer or competent person, providing a written report and recommendations on the limitation of silver transfer from the fixing fluid to the rinse water bath. |

| 20 | In line silver recovery units should be fitted, to reduce the loss of silver to the rinse bath and extend the life of the fixing bath. |

| 21 | For very large developing machines (using more than 7000 litres of fixative a year), in line ion exchange systems for the treatment of the effluent of the rinse water should be installed. |

| 22 | The quality of the developed film should be checked, recorded and tracked to minimise the replacement of the developing and fixing bath solutions. |

| 23 | Automatic replenishment of fixing and developing baths with fresh chemicals should be employed to reduce the consumption of chemicals and the production of waste. |

| 24 | Where possible non-chemical developing should be employed. e.g. if similar quality of product can be produced. |

| 25 | The water consumption on all machines should be reduced by automatically adapting water flow to the width of the developed film. |

| 26 | Double rinsing bath should be installed, where the first bath removes most of the fixative and silver and the second bath the remainder. The water from the second bath should be used to replenish the first bath. |

| 27 | Large developing machines should use cascade rinsing, where the water flows counter current to the film, clean water being added at the film exit, whilst contaminated water is removed from the film entry end. |
Proofing

Proofing is the operation of making a copy of the proposed printed image for checking. A number of different proofing systems exist:

- computer printouts
- laser printouts
- colour monitors
- ink jet printing
- dryline printer (Blue Prints)
- dry toner systems
- liquid toner system
- colour foil systems

Potential environmental impact

Water: Not significant.

Land: Not significant.

Air: Possible odours associated with the use of ammonia in dryline printing.

Waste: Waste from dry toner, liquid toner and colour toner systems. Waste from cleaning of press machinery as a result of short runs and colour changes.

Energy: Not significant.

Accidents: Spillage of chemicals, leakage and containment failure of pipe work, drums, tanks etc.

Noise: Not significant.

<table>
<thead>
<tr>
<th>BAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>28</td>
</tr>
<tr>
<td>29</td>
</tr>
</tbody>
</table>

Image carrier production

Offset platemaking

3.12 A number of different types of offset plates exist:

- positive plates
- negative plates
- reverse plates
- electrophotographic plates
- silver salt diffusion plates
- waterless plates

All of which are purchased in a pre coated form.

3.13 The principal steps in the manufacture of plates using each method are similar, and consist of taking a coated plate which is then exposed, such that the exposed areas of the plate undergoes a change, the unexposed areas remain unchanged. The exposed plate is then developed to remove the unwanted areas of the image. The image is then fixed to stabilise the image. Finally, the plate is washed and small corrections on the plate are carried out. The releases from plate manufacture are mainly related to releases to water and waste from the developing and fixing processes.

3.14 Positive plates are made from aluminium coated with a resin and light sensitive materials such a o-diazoquinone. The plate is exposed such that the light passes through the transparent areas of the film (non-print areas). The exposed coating is then chemically removed from the plate leaving the exposed aluminium surface in a decoating process. This gives the two image
surfaces; the hydrophilic non print aluminium and the oleophilic printing area. The residual chemicals are then rinsed from the plate, prior to the application of gumming agents which protect and preserve the plate. Corrections to the plate may be carried out to remove undesirable elements from the image area. Baking of the plate in an oven at 200-300°C for a short time can increase the plate life by up to three times.

3.15 Negative plates are also made from aluminium but coated with diazo compound or low-molecular compounds which harden under the influence of light. The exposing light passes through the transparent image areas and initiates a cross-linking reaction resulting in the formation of hard polymers. The same reaction may be initiated by a laser beam in a computer to plate application. The unexposed areas of the plate remain unreacted and are removed in a de-coating process. Rinsing, gumming and corrections are carried out as on positive plate.

3.16 Reverse plate allows both positive and negative printing down of the image, however they are developed using the same techniques as those used for positive plates.

3.17 Electrophotographic plates are aluminium coated with an organic photo semi-conductor coating. The plate is exposed by charging it using a corona discharge, the plate is then exposed according to the light that is reflected from the image areas of the original, where the reflected light from the image areas reduces the decrease the charge on the plate. A laser may also carry out this process. The latent-charging pattern is then made visible by the use of toners. The toners are fixed by heating, prior to the removal of the coating in the non-image areas using special de-coating agents. Gumming is also carried out as in positive plate manufacture to preserve the plate.

3.18 Silver diffusion plates are generally made of plastic or paper. A photographic paper containing silver halide is exposed to the image, the paper is then placed in contact with the plate and passed through a special developer in a diffusion transfer processor. When the paper negative is peeled away from the plate, a positive image remains. The image areas are then treated to make them receptive to ink.

3.19 Waterless plates have a photopolymer underneath a silicone coating. On exposure of the plate a strong bond is created in the light permeable areas between the silicone and the photopolymer, resulting in a hardening of the coating. A pre-treatment agent is then used on the plate which causes the silicone coating in the unexposed areas of the plate to swell, rotating brushes are then used to remove the swollen silicone parts with water.

**Gravure cylinder making**

3.20 Gravure cylinders are made up of a steel core that is initially covered with an electro-deposited layer of nickel. A copper layer is then deposited on top, the depth of which can vary depending on the type of cylinder being made. The copper depth varies from 320-60 mm. The copper surface is then finished to provide a suitable surface for engraving or etching the cylinder. Once the image has been transferred to the cylinder and it is free of faults, it is chromed electrolytically before being used for printing.

3.21 Existing cylinders, which are no longer required, can be reused. The residual ink and other contaminates are removed from the cylinder. The chromed surface coating and some of the copper is then removed by different methods depending on the type of cylinder. The thinned cylinder can then be returned for re-deposition of the copper, prior to finishing and transfer of the image in a similar way to that for new cylinders.

3.22 The image data is now normally transferred to the cylinder by electro-mechanical or laser engraving methods. However, a minority of cylinders are still prepared using traditional photographic etching methods. Where the cylinder is covered with a light sensitive material, this is used to make a copy of the image, the image is then developed and etched into the copper surface with ferric chloride or copper chloride in a strong solution of hydrochloric acid. The etched cylinder is then cleaned with solvent to remove any residual material left on the cylinder prior to chrome plating.
Flexography plate making

3.23 There are three main types of flexo plate: rubber, photopolymer and laser-graved roller. The most common method of manufacture employs photopolymers in either solid sheets or viscous liquids of various thicknesses. The photopolymer plate is exposed through a negative from both the back and the face with ultraviolet light, which cause the photopolymer coating to polymerise. After exposure the unexposed, non-polymerised areas are washed out using solvent or water to leave the raised area that will transfer the image. A variation on this method uses plates that have a mask coating which is not transparent to ultraviolet light over the photopolymer. A digitally controlled laser is then used to remove the coating in the areas that form the image. The plate is then exposed and washed as normal.

3.24 The traditional method of making a flexo plate begins with the exposure of a metal plate through a negative and processing the exposed plate using an acid bath. The resulting metal engraving is used to mould a master using a bakelite board. The board, under pressure and heat, fills the engravings on the metal plate and, when cooled, becomes a master for moulding a rubber plate with a raised area that will transfer the graphics.

3.25 Engraving rubber flexo plates with a scanning high-powered laser makes laser-graved plates, after engraving no further processing is required.

Screen-print stencil manufacture

3.26 A frame with fine mesh fabric (polyester, nylon or stainless steel) tightly stretched is coated with a light sensitive emulsion. A positive film is fixed on the fabric and exposed to UV light, the exposed areas of the photo-emulsion are cured. The screen is washed to remove the non-cured areas with water manually or by automatic washers. Corrections are then carried out on the screen prior to use.

**Table 7: Potential environmental impacts of image carrier production**

<table>
<thead>
<tr>
<th>Environmental impact</th>
<th>Offset plate making</th>
<th>Gravure cylinder making</th>
<th>Flexo plate making</th>
<th>Stencil manufacture</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water</strong></td>
<td>Positive plates:</td>
<td></td>
<td>Rinse water from developing stencils contains reactive acrylate.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alkali hydroxide, sodium silicate and wetting agents from decoating.</td>
<td>After degreasing, deoxidation and during the polishing, rinse water is used. The wastewaters contain copper, chromium (III and VI) and sometimes nickel and has a low pH and some residual toluene and xylene.</td>
<td>Rinse water from washing out unexposed areas, containing cleaning agents and non-hardened prepolymer.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Negative plates:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alcohols, alkalis surfactants from decoating. Coating emulsion, acid alcohols and fluorides from correction.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Electrographic:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Monoethanolamines, alcohols, sodium hydroxide and surfactants from decoating.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Waterless plates:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>From developing coating residues containing silicones and photopolymers, pre-treatment chemicals propylene glycol, aminoalcohols and diethylene glycol</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Air</strong></td>
<td>Small amounts of VOC from alcohols in developers</td>
<td>Hydrochloric acid fumes and mist containing chromium VI from plating and deplating operations. Alcohol emissions from the development and drying of cylinders when etching is carried out</td>
<td>VOC release during wash out of non-hardened pre-polymers with solvents</td>
<td></td>
</tr>
</tbody>
</table>
### Table 7: Potential environmental impacts of image carrier production

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</tr>
</thead>
<tbody>
<tr>
<td><strong>Positive plates:</strong></td>
<td>Alkali hydroxide, sodium silicate and wetting agents from exhausted decoating agents.</td>
<td>Filters from copper bath.</td>
<td>Processed and unprocessed plates.</td>
<td>UV lamps.</td>
</tr>
<tr>
<td><strong>Negative plates:</strong></td>
<td>Alcohols, alkali surfactants from exhausted decoating agents.</td>
<td>Alkaline degreasing agent.</td>
<td>Rinse fluid spent perchloroethylene.</td>
<td>Solvents.</td>
</tr>
<tr>
<td><strong>Electrographic:</strong></td>
<td>Toner residues: iso paraffin, carbon black, polyacrylates</td>
<td>Metal hydroxide sludge.</td>
<td>Unhardened photopolymer.</td>
<td>Residues from stencil manufacture.</td>
</tr>
<tr>
<td><strong>Silver diffusion:</strong></td>
<td>Exhausted activator: hydroquinine, sodium thiosulphate, sodium carbonate, 2-methylaminoethanol and bromide.</td>
<td>Copper chromium metal from cylinder re-working.</td>
<td>Spent solvent wash out solution.</td>
<td></td>
</tr>
<tr>
<td><strong>Waterless plates:</strong></td>
<td>Pre-treatment agents: propylene glycol, aminoalcohols and diethylene glycol</td>
<td></td>
<td>Distillation sludge.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coating residues: silicones and photopolymers</td>
<td></td>
<td>Metal hydroxide sludge.</td>
<td></td>
</tr>
<tr>
<td>Land</td>
<td>No significant releases</td>
<td></td>
<td>UV lamps</td>
<td></td>
</tr>
<tr>
<td>Accidents</td>
<td>Spillage of chemicals, leakage and containment failure of pipe work, drums, tanks etc.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy</td>
<td>No significant releases</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**Tab (Sheet 1 of 3)**

**Offset plates positive, negative and reverse**

30 Plates should be developed in an automated developing machine. Hand and dip developing techniques should not be used.

31 The results from developing should be recorded and tracked to monitor the condition of the developer and ensure that it is completely exhausted when it is replaced.

32 For positive developed plates automatic filtration and replenishment of the developing bath should be used to reduce the consumption of developer.

**Silver containing offset plates and silver diffusion plates**

33 Silver emissions from the developing process can be reduced by:
   - carrying out daily inspections and cleaning of rollers between the fixing bath and the rinse.
   - replacing damaged or worn rollers.

34 An annual inspection of the developing machine should be carried out by the manufacturer or competent person, providing a written report and recommendations on limitation of silver transfer from the fixing fluid to the rinse water bath.
| 35 | In line silver recovery units should be fitted, this reduces the loss of silver to the rinse bath and extends the life of the fixing bath. |
| 36 | For very large developing machines (using more than 7000 litres of fixative a year), ion exchange systems for the effluent treatment of the rinse water should be considered. |
| 37 | The quality of the developed film should be checked, recorded and tracked to minimise the replacement of the developing and fixing bath solutions. |
| 38 | Automatic replenishment of fixing and developing baths with fresh chemicals should be employed to reduce the consumption of chemicals and the production of waste. |
| 39 | The water consumption on all machines should be reduced by automatically adapting water flow to the width of the developed film. |
| 40 | Double rinsing baths should be installed, where the first bath removes most of the fixative and silver and the second bath the remainder. The water from the second bath should be used to replenish the first bath. |
| 41 | Large developing machines should use cascade rinsing, where the water flows counter current to the plate, clean water being added at the film exit, whilst contaminated water is removed from the plate entry end. |
| **All offset plates** | |
| 42 | Offset plates made of aluminium should be recycled. |
| **Gravure cylinders** | |
| 43 | The demineralised water used for rinsing cylinders should be used to make up the evaporation losses from the copper and chromium plating baths. |
| 44 | Wastewaters from rinsing after the galvanic baths, degreasing, deoxidisation, pickling baths, cylinder correction and mechanical surface treatment of cylinders should be treated to meet the required standards. |
| 45 | Any possible accidental releases from the chromium bath should be directed to a low-level emergency tank, to prevent their release. |
| 46 | Suitable means should be available to isolate the plant sewage system from the main sewer, to prevent possible discharge that may damage the main sewer and subsequent treatment plant. |
| 47 | Only non-mercury containing solutions should be used for the separation of Ballard skins, to prevent the release of mercury from the site. |
| 48 | Treated wastewaters should be used as rinse water where possible. |
| 49 | Exhaust ventilation from the galvanic baths should be fitted with a baffle separator with an aerosol screen to prevent emissions of chromium VI. |
| 50 | Exhaust ventilation air from de-coppering baths containing ammonia should be scrubbed, prior to discharge, to meet the required emission limit. value |
| **Flexographic plates** | |
| 51 | Halogenated solvents should not be used for cleaning operations and washing out of the non-hardened prepolymer. |
| 52 | Where water wash out of the non-hardened prepolymer is carried out, filtering or sedimentation should be carried out on the effluent to remove prepolymers prior to discharge. |
3.27 Incorporates: printing by various methods including Lithographic, Heatset Web Offset, Cold Set, Sheet Feed Offset, Dry Offset and Waterless Lithographic Printing.

3.28 Offset lithographic is the most widely used printing process. The printing and non-printing surfaces of the lithographic printing plate are almost in the same plane. The different print areas of the plate are treated to accept "oily" printing ink, the image area, and reject the printing ink the hydrophilic non-image areas. The printing plate is dampened with a dampening solution (normally water and propan-2-ol (iso-propanol/iso-propyl alcohol(IPA)) plus additives) before inking. A thin film of ink is then applied via a roller to the image areas. The image to be printed is then transferred from the printing plate on to a rubber blanket cylinder and then on to the printing substrate, the film of ink is then dried. Offset is the term used to describe the double transfer of the image from the plate to the blanket roller to the substrate. Periodic cleaning of the blanket roller is required to remove build up of debris such as paper, dust and printing ink constituents. Cleaning is carried out using various organic solvents, either manually or automatically. At the end of each print run, cleaning of the inking rollers and ink ducts is carried out. The rollers are cleaned using various organic solvents whilst the inking ducts are usually cleaned using solutions similar to the blanket wash.

3.29 Heatset web offset printing is on a continuous reel "web". It is typically used for magazines and coated papers when printing large numbers of copies. It gives richer colours than cold set printing. In heat set web offset printing the ink dries in an oven. The exhaust gases from the heat set drying process contain VOC from inks, cleaning agents and propan-2-ol (iso-propanol/iso-propyl alcohol(IPA)). The exhaust gases are generally abated using thermal oxidation.

3.30 Cold set printing is on a continuous reel "web" and is typically used for newspapers printed on absorbent uncoated paper. The inks dry as a result of absorption by the substrate or oxidation. Cleaning of blanket rollers and print rollers is a more frequent requirement in coldset web offset.

3.31 Sheet fed offset

3.32 Dry offset is the printing process commonly used in the printing of metal packaging where it is not normally possible to register individual colours onto the surface to be printed. To overcome this problem, an intermediate surface (rubber blanket) is provided which picks up the colours in sequence from each of the printing heads to create the complete image in reverse on its surface. This blanket is then brought into contact with the surface to be printed allowing the...
complete image to be transferred in one step. The printing inks used are highly viscous and contain very a low percentage of solvent. Where this process is used for printing on metal or plastic surfaces, which are non-absorbent or may be required to withstand heat processing for food use, the inks are cured by thermal or UV processes.

**Waterless lithographic printing**

3.33 Waterless lithographic printing is similar to cold web offset lithographic but without the use of any damping water. The printing plate used is coated with an ink repellent silicone surface and following exposure to the image the unwanted silicone is removed by development to reveal the ink attractive layer below. Ink is readily accepted where the silicone has been removed and as a result no water is needed to keep the non-image areas free of ink. Solvent blanket washes are, however, still required.

**Gravure**

3.34 Gravure is an operation where the image lies recessed in the surface of the printing cylinder. The cylinder is flooded with ink and the surface scraped clean (using a doctor blade) to leave ink in the recessed image areas only. Low viscosity inks are mostly used in order to fill the recesses, the image is then transferred to the substrate. Dryers are used to evaporate the solvent phase and to dry the film. As a wide variety of solvents are used, it is common for the exhaust gases from the operation to be abated using a thermal oxidiser or bio-reactor. A very small proportion of water borne gravure printing inks which give rise to significantly lower VOC emissions, are used in some applications.

**Publication gravure**

3.35 Publication gravure is essentially the same as gravure printing, except, it is carried out on a substantially larger scale e.g. long runs such as magazines. The scale of the process means that a single solvent (toluene) system is employed to enable solvent recovery and reuse. The toluene-laden air from the ovens and often from the print line is passed through activated carbon beds where it is adsorbed. The toluene is then recovered from the activated carbon and either reused or sold back to the supplier.

**Flexography**

3.36 Flexographic printing involves sheet or web fed printing from a raised image on a printing plate made from either rubber or photo-polymers. Highly fluid quick drying inks are generally used. Ink is applied to the raised area of the printing plate from an engraved (anilox) roller, it is then transferred directly to the substrate. The ink must be heat dried prior to the printing of another colour. After the addition of the last colour all the residual solvents are removed in a final drying section. After finishing a printing run it is necessary to clean the printing plates, anilox roller etc. with solvent similar to those within the ink. As a result of the high solvent content and the variety of solvents used, abatement of the exhaust gases from the process, using a thermal oxidiser or bio-reactor, is common. Low viscosity water borne or organic solvents borne inks are used in approximately equal proportions, with a small usage of low organic solvent UV curable inks (note that ozone can be emitted from UV lamps and dryers), or water borne flexographic inks (for absorbent substrates).

**Screen printing**

3.37 Screen-printing is a form of stencilling where ink is forced through the clear elements of the stencil. Screen-printing is capable of putting down a heavier ink film than other processes, this enables printing on almost any surface or material. The material to be printed on, is positioned under the stencil screen in close contact, the frame supporting the screen is then loaded with ink which is forced through the clear parts of the screen by a squeegee. UV curing, solvent and water borne inks, are used in screen-printing. The use of solvent inks gives rise to VOC during printing, cleaning and drying operations. When oven drying is carried out the exhausted VOC can be collected. Water borne inks (most containing between 5-15% solvent) give rise to lower levels of VOC, however they have inferior adhesion to some substrates. UV curing inks avoid the use of solvents except for cleaning purposes, suitable UV curing inks are now available for most substrates.

Screens for long print runs may be provided with a protective lacquer coating which is hardened. After printing, screens, which have not been hardened, can be cleaned and used once more. Initially, any residual ink from the printing operation is removed, the screen is then placed in an
automatic screen-washing unit fitted with a distillation unit to recover and recycle the cleaning solvents. Once the screen has been cleaned the image is removed using an aqueous solution containing periodate then high-pressure washed.

Rotary screen printing

3.38 Rotary screen-printing is continuous web fed form of screen-printing.

Table 8: Potential environmental impacts of printing

<table>
<thead>
<tr>
<th>Environmental impact</th>
<th>Offset printing</th>
<th>Publication gravure</th>
<th>Flexographic and gravure</th>
<th>Screen printing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water</strong></td>
<td>During printing operations, waste water results only from the cleaning (emptying) of the damping solution ducts and/or damping solution preparation units (no damping solution is used in lithographic printing) and from manual cleaning of the blanket. The wastewater will be contaminated with hydrocarbon cleaning agents, paper and residual ink constituents.</td>
<td>The condensed steam from solvent recovery contains about 0.38-0.54g of toluene/litre. After stripping with air this is may be discharged to water.</td>
<td>Where water borne inks are used wastewater from cleaning operations containing residual ink constituents arise. Smaller quantities of wastewater are produced where solvent borne inks are used.</td>
<td>During printing no discharges to water occur. However during the cleaning of equipment contaminated wastewater is produced.</td>
</tr>
<tr>
<td><strong>Air</strong></td>
<td><strong>Sheet Fed Offset</strong> VOC are emitted from the use of propan-2-ol or ethanol from fountain solutions and other organic solvent used during cleaning. Ozone is also released when UV curing inks are used. <strong>Coldset Offset</strong> Emissions of different organic solvents occur during the cleaning of the press. <strong>Heatset Offset</strong> The gas from the heatset dryers is laden with mineral oil vapours and are normally directed to an oxidation unit, where they are burnt. Intermittent releases occur during cleaning operations.</td>
<td>Majority of organic solvent recovered from process. Process fugitive losses of solvent (normally toluene).</td>
<td>VOC releases normally directed to oxidation unit where they are burnt. Ozone releases from corona discharge lamps used for etching the surface of plastics and when using UV curing inks.</td>
<td>VOC releases during printing, cleaning etc. Ozone release from UV lamps used to cure UV curing inks.</td>
</tr>
<tr>
<td><strong>Land</strong></td>
<td>No significant releases</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Accidents</strong></td>
<td>Spillage of chemicals, leakage and containment failure of pipe work, drums, tanks etc. Fire within the printing area. Formation of an explosive atmosphere.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Energy</strong></td>
<td>Energy used as a result of incineration of off-gases.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Offset printing

57 For all Offset printing, where technically feasible non-dampening printing methods or physical or inorganic dampening aids should be used instead of propan-2-ol and other organic compounds.*

Where organic compounds are present in dampening:

- the proportion of organic compounds in dampening solutions should not exceed
  (i) 10% (by weight) in the case of existing presses, except where these are incapable of running at that level
  (ii) 5% (by weight) in the case of new presses

Cooling in order to reduce the evaporation of dampening solutions containing organic compounds should be installed.

58 For sheet fed offset, the composite vapour pressure at 20°C (293K) of the cleaning organic solvents used should be no greater than:

- 0.8kPa for low odour processes (such as to avoid tainting in food packaging)
- 1.6kPa for ultra violet curing processes
- 0.2 kPa for all other processes.

Specialist cleaning organic solvent products such as blanket reviver, which have a vapour pressure of greater than 0.1kPa should not contain more than 5% of organic solvent by weight.

Publication gravure

59 Waste cleaning organic solvents and waste inks should be distilled to recover their solvent content, which can then be recycled within the process.

60 Condensed steam that has been stripped of toluene should be reused as boiler feed water, or used as cooling water.

61 Where the condensed steam from the organic solvent recovery plant can not be reused it should be air stripped of toluene prior to discharge to sewer to meet the emission requirement.

Screen printing

62 Cleaning of screens with solvent to remove residual inks should be carried out in separate areas to any activities that may produce wastewater, to ensure each waste stream can be treated adequately.
63 Where practicable monthly organic solvent balances should be carried out. Discrepancies between the sum of the monthly organic solvent balance and the annual organic solvent balance should be investigated.

64 Where practicable programmable scales should be used, during the mixing and preparation of quantities of inks/coatings or when mixing is infrequent, to reduce organic solvent usage. In cases where wide ranges of colours are used (Flexographic and Gravure) colour computers with photospectrometers should be used.

65 Cleaning operations should be reviewed annually to identify cleaning steps that can be eliminated.

Application of cleaning organic solvents should be:
- from a contained device or automatic system when applied directly on to machine rollers
- dispensed by piston type dispenser or similar contained device, when used on wipes

66 When organic solvent is used on wipes
- pre-impregnated wipes should be held within an enclosed container prior to use

67 Where practicable organic solvent-free or organic solvent cleaning fluids with lower vapour pressures should be used (with or without the addition of mechanical, chemical or thermal enhancements).

68 Where there is a potential for static build during web printing the web should be treated to prevent static build up which may act as a source of ignition of an explosion.

69 Off-line cleaning should be carried out using enclosed cleaning systems, wherever technically possible. e.g. where machine parts can be removed for cleaning. Enclosed cleaning systems should be sealed to prevent emissions whilst in operation, except during purging at the end of the cleaning cycle. Where this is not practicable emissions should be contained and vented to abatement plant where necessary.

70 Residual ink/coating contained in parts of the press should be removed prior to cleaning.

71 Wherever technically possible returned ink from presses should be:
- kept and reused
- distilled to remove the organic solvent content which may then be used in cleaning operations

72 Where water borne products are used for printing their discharge should be minimised by:
- removing as much of the water borne product prior to cleaning:
- rinsing the equipment with the minimum amount of water. The water should then be treated, distilled or disposed of as waste (hazardous or non-hazardous).

73 Cleaning solvents containing halogenated hydrocarbons should be substituted. *

74 Emissions of ozone from corona discharges and UV curing systems should be captured and vented under suitable conditions to provide adequate dispersion.

75 Printing ink containing halogenated hydrocarbons should be substituted. (Those formulated in accordance with the CEPE (Consul Europeen de l’industrie Peinture des Encres d’imprimerie et des Couleurs d’Art) exclusion list for printing inks and related products should already comply. See also BAT 206)

76 Substitution of inks and pigments containing heavy metals (including lead, hexavalent chromium) should be reviewed annually.

* It should be borne in mind that the Health and Safety Executive will not wish to see substitutes being organic compounds with a Maximum Exposure Limit
Finishing processes

3.39 Finishing processes such as cutting trimming (both as part of the printing operation and after printing), spine buffing and gluing are carried out along side the printing operations.

Potential environmental impact

Water: Not significant.

Land: Not significant.

Air: Releases of paper from cutting trimming and buffing operations. Releases of VOC from gluing operations.


Energy: Not significant.

Accidents: Spillage of paper dust, leakage and containment failure of ducting systems.

Noise: Not significant.

Coating general

3.40 Coating is the single or multiple application of a continuous film of any preparation, used to provide a decorative, protective or other functional effect on the surface of a substrate, such as paper, card, foil, plastics, metal and similar materials. It also includes the coating of adhesives that are applied to a surface. Coating is carried out as part of a number of manufacturing processes:

- coil coating of sheet aluminium, steel and other metals
- textiles, textile coating and textile finishing
- film coating, coating of polyester film and similar substrates
- application of paint in vehicle manufacture
- coating of winding wire used in transformers and other electrical applications
- coating and printing of metal packaging
- wallpaper manufacture
- coating of plastic and metal components

3.41 Some coating installation will manufacture or carry out other operations e.g. mixing, milling and filtering to ensure that the coating has the required properties prior to application.
3.42 All product preparations are manufactured using a similar range of process steps. The manufacturing process is typically a batch process, which involves combining raw materials, in one or more steps, to produce the required formulation. Products are comprised of appropriate mixtures of four main raw material component categories:

- resins (organic (usually) or inorganic polymers)
- pigments primary (colours), extenders/fillers or activators (e.g. photochemicals)
- carriers (organic solvents, water, non-volatile liquids)
- fire retardants and antifungal/antimicrobial agents in the case of textile coating
- natural and synthetic rubbers
- additives (a wide range of specific materials, used in small quantities to provide particular properties during manufacture, in storage, during application, in service life etc.)
3.43 The products manufacturing stage rarely involves any chemical reaction processes, products being produced by mixing or blending usually at ambient temperatures.

3.44 Typical batch sizes can vary from 20 - 4000 Kg.

3.45 Products manufacture may involve up to 4 steps:
- pre-assembly and premixing
- pigment dispersing and grinding/milling
- final product assembly and viscosity adjustment
- product filtering and storage

Dispensing of raw material

3.46 Raw materials can be dispensed in various ways, depending on the size of the batch being manufactured and the scale of the process equipment, to the pre-dispersion plant. Whole bags of dry powders are assembled, typically on pallets, together with any part-bags and charged manually into the pre-dispersion equipment.

3.47 Large volume usage liquids can be piped via a ring main system to dispensing locations within the production plant or measured into intermediate containers for internal transport. Smaller volumes may be pumped from delivery barrels direct into the manufacturing stage, or may be measured into intermediate containers.

Premixing

3.48 In the premix step, liquid raw materials (e.g. organic solvents and carriers, resins and additives) are assembled and then blended in a suitable mixing container to form a viscous material. Pigments (and other extenders) are added and held in suspension in order to supply the dispersion equipment with a consistently mixed material. The premix stage results in the formation of an intermediate product.

3.49 Typical raw materials for solvent-borne products include resins, organic solvents, plasticizers, pigment, natural and synthetic rubbers and other specialty additives. Raw materials used for water-borne products include water, dispersants, pigments and specialty additives. Raw materials for UV cured products include acrylate polymers, monomers, initiators, and pigments.

3.50 The type of equipment used for premixing will depend on the batch size and the type of coating being produced. Drums equipped with a portable mixer may be used for small batches. These mixers normally have an impeller with three or four blades. Other materials made in portable mix tanks may be blended using larger, permanent high-speed dispersers or variable-speed mixers fitted with paddle, propeller, turbine, or disc-type agitators.

3.51 Product manufacturing facilities may use grinding equipment to accomplish the premix operations. This approach, common with water-borne products, eliminates the need to transfer the material to another type of equipment for the grinding/milling step described below.

Pigment dispersion and milling/grinding

3.52 Grinding or milling reduces the agglomerate particle size of the pigment to achieve a fine particle dispersion. This process can be classified into three stages wetting, dispersion and grinding.

3.53 In the wetting stage, various wetting agents may be used to displace the air, moisture, and gases that are adsorbed on the surface of the pigment particles. This is usually carried out at the same time as the dispersion stage. This results in the break up of the large aggregates of pigments into smaller agglomerates. Finally, milling (or grinding) is the mechanical break-up and separation of pigment clusters into individual particles and the distribution of the wetted pigment into the body of the liquid vehicle to produce a fine particle suspension. Milling usually involves the use of grinding media such as pebbles, balls, or beads to facilitate the break-up of the pigment agglomerates.
Wetting and dispersion

3.54 For many products, the first manufacturing step is the dispersion of powdered pigments in a resin/solvent blend. This is usually carried out using a high speed rotating disk (high speed dispersers) immersed in the powder/liquid mixture. The equipment can be fully enclosed - generally for large batches or long continuous runs - or commonly an open tank with a removable lid.

3.55 Where high volume production justifies it, the pre-dispersion can be diluted with extra resin solution/solvent, and pumped directly to the next stage of milling. More commonly, the pre-dispersion tank is mobile, and is mechanically transported to the mill.

Milling

3.56 As noted below, in some cases, dispersion can provide the required fineness of grind, but it is common to take the material from the dispersion stage, dilute it with extra resin solution/carrier, and to grind the pigment more finely in a mill. This dispersion stage generally involves pumping the paste through a mill, which may be enclosed or open, though in ball mills (now uncommon) the whole charge is held in the mill chamber during dispersion.

3.57 Wherever possible, enclosed mills are preferred, as they minimise any losses of volatile components (e.g. organic solvents).

3.58 A wide array of milling equipment is available. The choice is determined by a number of factors, including the resin system, the ease of dispersibility and type of pigments, the coating characteristics and the scale of production. More commonly used equipment includes the following: roller mills, ball and pebble mills, attritors, sand mills, bead and shot mills, high-speed stone and colloid mills, high-speed dispersers, high-speed impingement mills, and horizontal media mills. Roller and ball mills are somewhat outdated methods in current pigment dispersion technology.

3.59 Some products are manufactured entirely in one piece of equipment using high-speed, disk-type impellers. Because no grinding media are present in the mixing vessel, the pigment disperses through shearing forces acting in the bulk. Whilst high-speed disk milling may be appropriate for products such as thick film undercoats and primers, it will not be sufficient for products where a high degree of dispersion and fineness of pigment particle size is required.

3.60 When an acceptable degree of pigment particle size reduction and stability has been reached, either by dispersion alone, or by a combination of dispersion and milling, the batch is completed with viscosity and/or pH adjustment. This may occur with slow stirring.

3.61 These stages may be carried out in the same vessel, or finishing maybe completed in larger closed or fixed tanks, fitted with a stirrer or other form of agitation, with hatches that can be opened to make additions and to take samples. They may also be fitted, optionally, with piped supplies of solvent or resin solution.

Filtering/filling

3.62 The final step in the manufacturing process is the product filtering operation. The product is filtered to remove any oversize or undispersed particulate material and to enhance the quality and uniformity of the product.

3.63 A variety of filtering methods are used with the end use of the product determining the type of filtration required. Some products require only a cloth bag filter; other products require filtering equipment such as strainers or sieves. For high quality finishes, wound polypropylene or other resin cartridge filters are used.

3.64 The product is passed through the filter into the appropriate sized container (pails, drums, mobile tanks or other containers). Filling may be accomplished either manually or mechanically depending on the number and size of the containers to be filled.
Process equipment cleaning

3.65 Process equipment cleaning is a necessary stage in the manufacturing process and can be performed in situ or external to the manufacturing plant, depending on the equipment to be cleaned. Fixed process tanks and vessels and associated connecting pipes, pumps and filters can only be cleaned in situ. The range of cleaning equipment and method will vary according to the shape of the tanks, the product and resin systems concerned, the degree of cleanliness to be achieved and quality. Fixed tanks are often cleaned using static spray heads that can be fixed into position over the top of the tank or through a cleaning port. Usually organic solvent is used in such systems as the cleaning media and is sprayed at low pressure into the top of the vessel. Other cleaning methods may involve physical techniques using brushes instead of spray heads, and manual cleaning performed from outside or directly inside the tank. Cleaning media other than solvent may include caustic solutions, water-borne cleaners and abrasive impact techniques using inert particles.

3.66 Pipe lines connecting tanks are normally flushed and cleaned using organic solvent and typically a solvent compatible with the material in process or the next planned batch.

3.67 Process equipment that is mobile, such as portable tanks and IBCs, are usually cleaned external to the manufacturing plant. Portable tank cleaning methods are typically automated or semi-automated, using spray heads or brushes, and using one or a combination of solvent, water, and caustic solutions as the cleaning media. Often, it is difficult to find one machine that can clean all sizes and shapes of portable tanks and invariably, some manual cleaning will be carried out, normally the external shell of the tank and valves.

3.68 Small parts and tools used during the manufacturing process are cleaned either in situ manually or in small baths, which contain cleaning solutions, typically organic solvent. These baths are closed and can be interlocked to local exhaust ventilation. Tools are left to soak and then cleaned with brushes manually.

3.69 Filters are cleaned either in situ as part of the pipe flushing/pigging process or as an open manual process under local or general exhaust ventilation. The method of cleaning will depend on the type of filter. Filter cleaning can be avoided by using disposable filters, which are available for certain equipment and are suitable for certain products.

Waste

3.70 Waste is generated from all the above manufacturing steps, including indirect processes such as material delivery, unloading, warehousing and process equipment cleaning. Examples of wastes generated directly from the manufacturing processes include the following:

- preassembly and premixing will generate waste packaging (e.g. bags, drums, plastic wrap and pallets)
- grinding, milling and dispersing and product finishing and blending processes will also generate waste packaging as well as liquid samples from quality control; product residues; and spent equipment cleaning solvents
- product filling will generate dirty filters and packaging
Potential environmental impact

**Water**: Water may be used for cleaning vessels and emitted to effluent. High water usage may be associated with installations engaged in aqueous product formulations. In the case of textile coating some pigments (may contain cadmium), some fire retardants (may contain antimony), some stabilisers (may contain mercury), some antifungal/antimicrobial agents (may contain tributyl tin (TBT)) handle modifiers, organic solvents.

**Land**: Not significant.

**Air**: VOC from organic solvent transfer, mixing and blending operations. Dust from powder use. Isocyanate release when using reagents containing free isocyanate groups.

**Waste**: Generated from rejected material, cleaning organic solvents, filters.

**Energy**: Associated with disperser, pump and air handling equipment. Generally process specific. May be < 10% of site usage.

**Accidents**: Spillage of chemicals, leakage and containment failure of pipe work, drums, tanks, etc. Fire within organic solvent handling area. Failure of VOC extraction system or abatement plant.

**Noise**: Not significant.

<table>
<thead>
<tr>
<th>BAT</th>
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<tbody>
<tr>
<td>79</td>
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Coil coating

3.71 Coatings applied as a liquid may include epoxies, plastisols, organosols, vinyls, acrylics, alkyds, polyesters, silicone polyesters and fluorocarbons. They are applied smooth, however they may be embossed later in the process, in thicknesses of between 5 and 250 microns (Litho plate coatings are usually 0.5 to 2 microns). They may be applied to a variety of coiled metal substrate, e.g. Steel, Aluminium, Brass, Stainless Steel. A typical coil coating operation is made up of the following operation:

- entry end
- cleaning section
- pre-treatment
- coating
- post treatment
- exit end
3.72 The entry end consists of machinery, which uncoils the strip and prepares it for the continuous coating operation. Coils are all measured to ensure compliance with width and gauge requirements then any leading end damaged or out of specification material is trimmed and discarded, any damaged or out of specification trailing end material is similarly trimmed off and discarded.

3.73 The leading edge of the incoming strip is welded or stitched to the tail end of the outgoing strip thus presenting a continuous length of material to the process section. Accumulators at the entry and exit end of the line allow sufficient stop time for joining and separating the strip without stopping the coating operation.

3.74 The strip may be levelled to ensure good shape prior to coating.

Potential environmental impact

- **Water**: Not significant.
- **Land**: Not significant.
- **Air**: Not significant.
- **Waste**: Scrap metal from coils and bindings sent for recovery, packaging.
- **Energy**: Not significant.
- **Accidents**: Not significant.
- **Noise**: Not significant.

Cleaning Section

3.75 It is essential that the surface of the coil is free from impurities such as grease, oil, carbon or abraded iron fines to ensure that the entire surface is exposed to the coating product and strong adherence is achieved. Prior to coating, the strip is cleaned and degreased normally in an alkali cleaning section followed by hot and cold water rinses. This may be multi stage employing more than one bath or have electrolytic cleaning system to ensure an absolute level of cleanliness. A wringer "squeegee" roll set up is generally used to minimise carry over from the degreasing section.
Potential environmental impact

**Water:** Discharges of spent alkali cleaner contaminated with oils, grease, iron fines, aluminium and dirt. Rinse water from rinse operations

**Land:** Not significant.

**Air:** No significant releases. Water vapour is emitted from the extraction system

**Waste:** Solids from cleaning section, in-line filter elements

**Energy:** Not significant.

**Accidents:** Spillage of chemicals, leakage and containment failure of pipe work, drums, tanks, etc.

**Noise:** Not significant

### BAT

| 85 | The use of alkali cleaner should be used in a closed loop re-circulating system in order to minimise the use of raw materials |
| 86 | The effectiveness of the cleaning materials should be monitored, discharge of spent cleaning materials should only take place when they no longer give the required level of cleaning |
| 87 | Wherever technically possible and quality permits cascade rinse should be used along with squeegee rolls or knives to prevent carry over |
| 88 | Where possible the conductivity of the rinse waters should be measured and used to regulate the make-up and discharge of rinse water |
| 89 | Wastewaters from rinsing and cleaning should be treated to meet the required standards as appropriate. |
| 90 | Any possible accidental releases from the cleaning and rinsing operations should be contained e.g. by directing them to a low-level emergency tank, to prevent its release. |
| 91 | Suitable means should be available to isolate the plant sewage system from the main sewer, to prevent possible discharge that may damage the main sewer and subsequent treatment plant. |
| 92 | Only non mercury containing solutions should be used for the cleaning operations, to prevent the release of mercury from the site. |
| 93 | Treated wastewaters should be used as rinse water where technically possible to minimise raw water consumption. |
| 94 | Exhaust ventilation air from the cleaning and rinsing baths should be fitted with a baffle separator with an aerosol screen where there is a potential for the emissions of water droplets. |

### Pre-treatment

3.76 The strip is dried and treated with a conversion coat to improve the adhesion of the subsequent coating and to ensure enhanced corrosion resistance. The conversion coat normally applied is a chromate but others are available. Modern chromate solutions are applied using chemical roller coating machine, as these methods minimise potential releases, although other methods such as dipping or spraying may be used. In all cases coating is followed by oven stoving. This "dry-in-place" method of application removes the need for any additional treatment or rinsing.

3.77 For some specialist products such as lithographic plate, after cleaning, surface treatment of the coil may be carried out in the form of electrochemical graining and anodising to develop the required surface properties required of the final product.
Potential environmental impact

Water: Discharges of spent chromating, acidic electrolyte and acidic cleaning solutions.

Land: Not significant.

Air: No significant releases. Where spray application is used fumes are extracted and abated. Release of combustion products where oven drying is carried out.

Waste: Solids from chromating operations, in-line filter elements.

Energy: High energy input required for electrochemical processes.

Accidents: Spillage of chemicals, leakage and containment failure of pipe work, drums, tanks, etc.

Noise: Not significant.

| BAT |
|------|---|
| 95 | The use of “dry-in-place” application of chromate conversion coatings should be used wherever technically possible unless the quality of the product prevents this. |
| 96 | The effectiveness of the chromate conversion coating should be monitored, discharge of spent conversion coating solutions should only take place when they no longer give the specified coating requirements required for the product. |
| 97 | Any possible accidental releases from the application of the chromate conversion coating operations should be directed to a low-level emergency tank, to prevent its release. |
| 98 | Suitable means should be available to isolate the plant sewage system from the main sewer, to prevent possible discharge that may damage the main sewer and subsequent treatment plant. |
| 99 | Exhaust ventilation air from the chromate conversion coating should be abated to prevent emissions of the conversion solutions. |
| 100 | Emissions of acidic fumes (HCl) from the treatment tanks should be abated to meet the required standards. |

Coating

3.78 The coating process can comprise of a number of stages and be carried out by a number of different coating techniques i.e. roller coating, slot coating. Although the method of application and the type of coating may vary the general principles of operation of the coating machine are similar for all applications. As an example the coating of coil strip with a primer and finish coat on both sides is given. The strip passes through a roller coater machine, which applies a primer paint coat to both sides of the strip. The coaters are normally housed in enclosures to minimise the egress of organic solvent vapours to the bay atmosphere. The coater houses are ventilated by fan extraction to the outside of the building with a flow rate designed to maintain satisfactory working conditions at all times for the operators within the coater house.

3.79 After application of the prime paint/coating, the strip passes to an oven provided with convection heating by air recirculation to achieve the peak metal temperatures required for the curing of the coating. The oven is heated by recovered heat. After curing, in some processes the strip passes through a water spray quench tank and is dried by an air blower.

3.80 In some processes the strip continues through a second, finish-coating stage, which is similar to the prime coating process and after curing is again quenched and dried. However, for PVC plastic coated strip, the strip passes through an embossing roll, which imprints a pattern into the paint surface immediately prior to quenching.

3.81 When a laminated product is required the adhesive required for the production of the laminate can be applied within either of the two coating sections. It is then cured in the oven after the coater and then processed through a laminator.
3.82 Solvent and other organic fumes arising in the curing oven are extracted by a fan. The extraction system is designed to maintain a mass flow and pressure balance, which will prevent escape of fumes and will ensure that the level of organic vapour does not exceed 25% of the Lower Explosive Limit (LEL).

3.83 The fumes pass to abatement equipment, normally a thermal oxidiser (incinerator) designed to reduce the VOC’s and other organic’s to minimal levels before being discharged to atmosphere. The thermal oxidation systems used are designed to be thermally efficient utilising regenerative bed technology or recuperative technology or have secondary heat recovery attached.

Potential environmental impact

Water: Discharges of quench water and cooling water blowdown

Land: Not significant.

Air: VOC releases from extraction from coater house, VOC from curing ovens normally directed to oxidation unit where they are burnt. Water vapour from cooling towers

Waste: Waste coating, used wipes, in-line filter elements

Energy: Not significant.

Accidents: Spillage of chemicals, leakage and containment failure of pipe work, drums, tanks, etc.

Noise: Not significant.

BAT

101 Quench water should be minimised and reused where technically possible to reduce water usage.

102 Fan motors should be fitted with VSD controls to minimise energy usage wherever possible.

103 The use of heat recovery systems should be used to reduce primary energy

Post treatments

3.84 Post treatments such as wax coating, paper coating or a strippable film may be applied, dependent on customer requirements

Exit End

3.85 The finished product is normally inspected and is coiled on a coiler, on high production rate units there may be two coilers, coils are cut to size or weight according to customer requirements. For some specialist applications the coils may be converted on site to sheet prior to dispatch to the customer.

Potential environmental impact

Water: Not significant.

Land: Not significant.

Air: Not significant.

Waste: Scrap coil ends, swarf/edge trim, paper interleaving trim

Energy: Not significant.

Accidents: Not significant.

Noise: Not significant.
Figure 3.3: Flow diagram for a typical colour coat unwind and pre-treatment line
Textile coating and finishing

3.86 These types of processes include:
(i) Polymer coatings, including polyurethane, PVC, polyester and polyamide;
(ii) Anti-soiling and fire retardant finishes;
(iii) Fluorocarbon or silicone coatings for water repellence.

3.87 Under LA-IPPC, coating textiles with PVC is not considered to be in itself a coating process unless the PVC is applied from solution in organic solvents, or as a PVC plastisol.

- delivery, storage and handling of raw materials (See 3.5)
- mixing/ preparation
- coating/ application
- finishing
- cleaning
3.88 All textile coatings are made up of a number of process steps, which can most simply be categorised as

Figure 3.5: VOC releases to air
Figure 3.6: VOC releases to water

Figure 3.7: VOC releases to land
3.89 This is the preparation of the coating chemicals. In this process chemicals are dosed into a mixing vessel and blended/solvated to produce a homogeneous coating solution. Typical components that can be added are pigments (some contain cadmium), fire retardants (some contain antimony), stabilisers (some contain mercury), antifungal/antimicrobial agents (some contain tributyl tin (TBT)), handle modifiers, organic solvents etc.

Coating/application

3.90 The application of the coating either to a release medium or to a substrate, and the subsequent drying/curing processes give rise to specific environmental impacts depending on application process.

Coatings are usually applied as:
(i) Direct coating;
(ii) Transfer coating
(iii) Impregnation coating.

3.91 Direct coatings are mixed, applied by eg knife over plate, knife over air, or knife over roller. Anti-soiling, fire retardant, fluorocarbon and silicone coatings are also direct coatings and are often applied by immersion in a bath, or by pad or by knife over roller. The product is then dried or cured often in a oven. Some two component systems may require curing in order to react fully.

3.92 Transfer coatings are applied to a carrier, e.g. a release paper, and then dried. Some two component systems may require curing in order to react fully. Several layers may be built up before an adhesive layer is applied (another layer such as polyurethane, or polyester, or acrylic), the textile adhered, cured in an oven and the release paper removed. Two component polyurethane coatings as applied may contain isocyanates. Other emissions may include acid catalysts e.g. Para-toluene sulphonlic acid and formaldehyde formation from melamine systems.
3.93 Impregnation coatings are also known as coagulation coatings are mixed, and then applied directly to a substrate. This impregnated substrate contains organic solvents, often dimethyl formamide. The impregnated substrate is then run through a water bath, which removes the majority of the organic solvent from the substrate. The material is then dried and the result is a "cellular polymer" (often polyurethane) impregnated fabric. These are often further finished either by additional coating (often transfer), to produce artificial leathers, or abrading to produce imitation nubuck leather.

Table 9: Potential environmental impacts of textile coating application

<table>
<thead>
<tr>
<th>Environmental impact</th>
<th>Transfer coating</th>
<th>Direct coating</th>
<th>Impregnation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>Possible release of antimony from flame retardants, TBT from antifungal/antimicrobial agents, cadmium from pigments, mercury from stabilisers to effluent.</td>
<td>Possible release of antimony from flame retardants, TBT from antifungal/antimicrobial agents, cadmium from pigments, mercury from stabilisers to effluent.</td>
<td>Possible release of VOC and solvents with risk phrases into effluent dimethyl formamide (DMF) R61 is used in a number of processes.</td>
</tr>
<tr>
<td>Air</td>
<td>Large volumes of VOC are released from solvent based systems on drying. Risk phrase solvents, where used, may also be released to atmosphere. (DMF) is used in a number of processes.</td>
<td>Large volumes of VOC are released from solvent based systems on drying. Risk phrase solvents, where used, may also be released to atmosphere. (DMF) is used in a number of processes.</td>
<td>Large volumes of VOC are released from solvent based systems on drying. Risk phrase solvents, where used, may also be released to atmosphere. (DMF) is used in a number of processes.</td>
</tr>
<tr>
<td>Waste</td>
<td>Coating solution, or adhesive that is surplus to requirements.</td>
<td>Coating solution that is surplus to requirements.</td>
<td>Water / solvent mix from the coagulation bath.</td>
</tr>
<tr>
<td>Land</td>
<td>No significant release</td>
<td>No significant release</td>
<td>No significant release</td>
</tr>
<tr>
<td>Accidents</td>
<td>Spillage of solvent based solution. Leakage of pumps etc. Fire within the coating area.</td>
<td>Spillage of solvent based solution. Leakage of pumps etc. Fire within the coating area.</td>
<td>Spillage of solvent based coating solution Spillage of contaminated water from coagulation bath. Leakage of pumps etc. Fire within the coating area.</td>
</tr>
<tr>
<td>Energy</td>
<td>Large energy requirement if abatement is chosen route of compliance with the air emissions levels.</td>
<td>Large energy requirement if abatement is chosen route of compliance with the air emissions levels.</td>
<td></td>
</tr>
</tbody>
</table>
3.94 Finishing includes the examination of the finished items, and packing.

**Potential environmental impact**

- **Water**: Not significant
- **Land**: Not significant
- **Air**: Release of VOC to atmosphere or possible odours, associated with any residual organic solvents remaining in the goods.
- **Waste**: Landfill due to disposal of solid waste, including both goods, and packaging materials.
- **Energy**: Not significant
- **Accidents**: Fire within the processing area.
- **Noise**: Not significant

### Cleaning

3.95 Following application of the coating, cleaning of used equipment is carried out. Enclosed cleaning machines are available for some tasks in which the cleaning organic solvent may be recovered by distillation or by off-site recovery, however manual cleaning is still carried out in some instances.

**Potential environmental impact**

- **Water**: Water may be used for cleaning application equipment and emitted to effluent. Cleaning water may be contaminated with heavy metals and TBT
- **Land**: Contamination of land as a result of spillage of cleaning materials
- **Air**: VOC from organic solvent transfer, and fugitive emission during used.
- **Waste**: Generated from rejected material, cleaning organic solvents, filters, possible heavy metal contamination
- **Energy**: Associated with applicator equipment and room ventilation. Not significant.
- **Accidents**: Spillage of chemicals, leakage and containment failure of pipe work, drums, tanks, etc. Fire within application area.
- **Noise**: Not significant.

### BAT

104 Cleaning water should be minimised and reused where possible.
105 Fan motors should be fitted with VSD controls to minimise energy usage wherever technically possible.
106 The use of heat recovery systems should be used to reduce primary energy.
107 Where there is a potential for static build during web printing the web should be treated to prevent static build up which may act as a source of ignition of an explosion.
108 All goods must be sufficiently dried prior to examination to prevent the release of any residual VOC in the product.
109 Recycling should be maximised i.e. release paper, re use of the fabric tubes.
110 The minimum packaging possible should be used.
Film coating

3.96 Film coating includes the coating of polyester, PVC, polyethylene or similar substrates, by applicator roller, spray, slot extrusion and similar coating techniques, followed by oven curing or drying, prior to a final finishing processes such as cutting to size, laminating, interleaving, over-printing or application of adhesive strip.

The full process normally involves the following stages:
- acquisition and storage of materials (see 3.5)
- mixing/blending of chemical components into coating formulations (emulsions, solutions, dispersions, lacquers, adhesives, etc.)
- coating application to the substrate (including pre-treatment, back coating, coating methods)
- drying or curing
- laminating/interleaving etc. (optional)
- conversion/finishing (conversion to smaller units or sheets and packing)

3.97 The mixing stage may cover a variety of dispersion, blending and milling techniques involving complex mixtures of organic solvents of varying physical properties. The batch sizes may vary from 20 - 4000kg. Viscosity adjustments and filtration of coatings is also carried out during mixing. (see 3.42)

Coating Application

3.98 The application of the coating preparation may either be as a single layer or as multi layers in a single pass operation from different application heads. Multi layer in a single application head is not common. The coating supply and application process may give rise to fugitive emissions depending on the type of technique used.

Pre-treatment of substrate

3.99 Most coating applications require a pre-treatment coat, which may be a primer coating or corona treated to enhance adhesion or a release layer to facilitate product function (e.g. a transferable adhesive).

Back Coating

3.100 In some product application areas it is necessary for the 'reverse' side of the film to be treated. This is usually to confer special technical properties e.g. enhanced ink adhesion properties, antistatic, etc.
Coating methods

3.101 There are many variations to the type of coating application head. The following is a list of the main methods currently employed.

1. Knife Coating

A rigid knife is used to remove excess liquid which has been applied to the film base from a reservoir to produce a uniform coating of desired thickness on a continuously moving, rigidly supported web. The thickness of coating depends upon the gap (between knife and web), the geometry of the knife (angle, length) and physical properties of the liquid (viscosity, surface tension). In some applications the rigid knife may be replaced with an air knife in which compressed air is directed through a controlled slot towards the surface of the applied coating.

2. Dip or Meniscus Coating (Free Meniscus Coating)

In this technique the substrate is either immersed in the coating material or engages with the surface of the liquid, acquiring a coating through viscous drag. The coating is controlled either by drainage or withdrawal since the web exit angle is normally vertical. The method is used for low viscosity liquids and thicker coatings. The thickness of coating may be affected by angle of withdrawal, web speed, and viscosity.

3. Curtain Coating

A curtain of liquid is applied to the horizontal film base normally transverse to the curtain. The liquid falls from a height under gravity from a curtain die or cascade whilst the web is supported on a backing roller. This method is capable of achieving high web speeds and multilayer coatings.

4. Roller Coating

This is the most common method of application and essentially involves applying a coating to a surface using rotating rollers or coils. The fluid flow in the gap between adjacent rollers and their relative speeds is what controls the coating thickness. Roller coating may use rigid roll in which a roller rotates in the same direction as the film web held on a backing roller with the liquid supplied onto the roller from a reservoir. In Reverse rigid roll coating, the applicator roller rotates against the film web and the liquid may be contained in the nip between the two rollers mounted in the same horizontal plane.

Coating thickness is dependent on roller speed, web speed and liquid properties.

A development of roller application is triple roll coating where the third roller is metering the amount of liquid on the applicator roller to provide greater accuracy of application.

Non rigid roll coating is also carried out using deformable rolls or kiss coating, typically for waxes and hot melt applications.

5. Slot Coating

This method channels the coating formulation through a carefully designed slot die to provide a single layer application to the film web moving at an angle to the die. The liquid is fed into a coating die by a metering device such as a positive displacement pump. A further development of this technique is the extrusion slot coating technique in which the liquid bridge forms a short liquid curtain. The coated thickness is dependent on web speed and liquid flow rate. The method is used for photo resists and magnetic suspensions, and can cope with a wide range of viscosities.

6. Meter Rod Coating (Mayer Bar)

In this technique a wire wound bar is used to control the amount of liquid remaining on the web after application from a reservoir. The wire is usually a carefully selected gauge. The bar is normally rotated to prevent accumulated debris affecting coated quality. The method is suitable for thin coatings of low viscosity.
7. Gravure Coating

This method uses the principles of gravure printing. A roller with an engraved intaglio pattern rotates in the reservoir and excess surface liquid is removed by a doctor blade. The liquid held in the cells of the engraving is transferred by direct contact with the film web or in some cases may be offset to another roller for transfer. This method gives thin, accurate coatings for speciality application areas and is capable of high speed.

8. Slide Coating

Liquid flows through a series of slots formed from blocks mounted together on a base plate. Each slot delivers a controlled amount of liquid down an inclined slide (cascade) to provide a multilayer coating in contact with the film base held on a backing roller. This method is used for multiple layers, offering consistent uniformity of coating.

3.102 Following application of the coating, cleaning of used equipment is carried out. Enclosed cleaning machines are available for some tasks in which the cleaning organic solvent may be recovered by distillation or by off-site recovery, however, manual cleaning is still carried out in some instances.

**Potential environmental impact**

- **Water**: Water may be used for cleaning application equipment and emitted to effluent.
- **Land**: Not significant.
- **Air**: VOC from organic solvent transfer, and fugitive emission during application. Ozone may be generated from pre-treatment processes where applicable.
- **Waste**: Generated from rejected material, cleaning organic solvents, filters
- **Energy**: Associated with applicator equipment and room ventilation. Not significant.
- **Accidents**: Spillage of chemicals, leakage and containment failure of pipe work, drums, tanks, etc. Fire within application area.
- **Noise**:

### BAT

115 Cleaning water should be minimised and reused where possible.

116 When solvent is used on wipes they should be pre impregnated and held within an enclosed container prior to use. After use they should be stored in an enclosed container, prior to disposal in accordance with the waste regulations.

117 Where there is a potential for static build during web printing the web should be treated to prevent static build up which may act as a source of ignition of an explosion.

### Drying/curing process

3.103 The coating application process is followed by drying through organic solvent evaporation or curing of the applied layer. The capacity of the dryer is dependant on the weight of the coating applied and the evaporation rate of the volatile components. Air or nitrogen may be used and is normally heated by steam, heat exchanger (hot oil) or direct gas fired burner. Air volume flow is controlled either by dampers or VSD fans to ensure efficient evaporation of volatile components with due regard for safe concentrations of organic solvent / air mixtures. (Lower Explosive Limit). Heated air is usually passed through a nozzle system to increase the velocity of impact on the coating surface. Coated layers may also be dried (cured) by radiation. UV radiation is normally used.

3.104 Drying ovens may work with driven input air and/ or with driven exhaust air and may operate under positive or negative pressure for various technical reasons. Input air may be filtered for particulate removal. Organic solvent laden air has to be delivered to abatement technology at the specified condition for the satisfactory operation of the abatement technology.
3.105 UV curing systems are used for curing coatings consisting of curable oligomers and monomers. Ozone emissions may be associated with this technology.

### Potential environmental impact

**Water:** No significant impact. Water use associated with water borne coatings is evaporated to atmosphere at this stage. Where steam is raised for heating via boilers there will be boiler blow down.

**Land:** Not significant.

**Air:** VOC from organic solvent evaporation, oxides of nitrogen and carbon from gas burners and abatement technology. NOx may also arise from oxidation of nitrogen containing solvents. Ozone emissions may arise from UV curing lamps.

**Waste:** No significant impact.

**Energy:** Major use associated with web drive system for coating machinery, generation of heated air and operation of abatement technology.

**Accidents:** Fire or explosion from ignition of vapour exceeding LEL concentrations.

**Noise:** Not significant

### BAT

<p>| | |</p>
<table>
<thead>
<tr>
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<td>Cleaning water should be minimised and reused where technically possible.</td>
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<td>Fan motors should be fitted with VSD controls to minimise energy usage wherever possible.</td>
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<tr>
<td>120</td>
<td>Emissions of ozone from curing lamps should be captured and vented under suitable conditions to provide adequate dispersion. Low ozone lamps should be used where possible.</td>
</tr>
<tr>
<td>121</td>
<td>The use of heat recovery systems should be used to reduce primary energy.</td>
</tr>
</tbody>
</table>

### Laminating / Interleaving

3.106 Following rewinding of the dried coated material the product may be combined with other substrates for a variety of technical reasons. The coated material may be interleaved (with e.g. paper) to protect the coated layer or laminated to a release layer for transfer adhesive properties or other filmic material may be laminated for surface protection. There is minimal environmental impact from this process which may be carried out in-line (i.e. following drying) or off line as part of a conversion process.

### Conversion / Finishing

3.107 Dried product may be subjected to rewind inspection/trimming or a conversion operation on separate machinery. This operation is to trim unwanted coating from the finished product; i.e. edge effects or quality defects. The conversion also produces rolls of required length or sheets of required dimension. Converted product is contained in appropriate packaging. The process generates landfill waste, as there are no economic processes for recycling/reusing PET coated with other substances.
Environmental impact

**Water:** No significant impact.

**Land:** Conversion processes (particularly sheeting) generate significant quantities of coated film waste. Conventional disposal is to landfill.

**Air:** Insignificant effect. A residual amount of organic solvent may be present in finished product but technical requirements ensure that this is minimised.

**Waste:** Generated from rejected material, trim and sheeted waste areas. Conventional disposal is to landfill.

**Energy:** Associated with use of slitter and conversion machinery. May be significant but usually <25% of site total

**Accidents:** No significant environmental effect.

**Noise:** Not significant

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**BAT**

122 Bag filters or cyclone systems should be installed to dust extraction to ensure compliance with the required limit.

123 Where waste recovery is not economically or technically possible, opportunities for energy recovery on site or off-site from waste should be sought.

124 Finishing and converting equipment should be enclosed where technically possible to minimise fugitive emissions.

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**Application of paint in vehicle manufacture**

3.108 Coating of new steel or aluminium vehicle bodies may be continuous or discontinuous coating. Variations in the activity are greatest at the pretreatment and electrocoat stages. The following description is typical for continuous coating of steel car bodies, although, coating of car parts may be carried out as part of the activities within the installation.

3.109 In some cases vehicle parts painting (e.g. wheels, plastic parts, bumpers) which is a similar operation is technically connected and directly associated with the vehicle body coating. Where relevant, these operations can be fitted into the overall vehicle painting installation Figure 3.9. The operator should agree with the regulator whether to include any or all of the parts coating activities within the vehicle body mass calculation used in determining the VOC total emission limit.

**Pre-treatment**

3.110 The pre-treatment of car bodies is intended to clean and prepare the metal surface to improve corrosion resistance and the adhesion of subsequent paint coatings. The pre-treatment zones use aqueous cleaning solution and spray and/or dip tanks to remove contaminants. The cleaner zones are followed by water rinses.

3.111 The cleaned body is then subjected to phosphate treatment by spraying or dipping. The treated body is then rinsed with water. Sludge, formed as a by-product of the phosphate conversion process, is removed from the solution for disposal. The rinse waters from conversion zone are often discharged to an effluent treatment plant prior to discharge from the installation. The final rinse is carried out using demineralised water. The solids from the electrocoat rinse water are removed as filter cake from the effluent treatment process.

3.112 Some plants then use a passivation zone. This is followed by a water rinse, the final rinse being carried out using demineralised water.
Environmental impact

**Water:** Release of spent alkali cleaner from cleaning water rinses, release zinc, nickel and chromium from phosphate conversion and chromate rinse waters.

**Land:** Sludge from phosphate conversion is dispose of to landfill as is filter cake from the rinse water treatment.

**Air:** Insignificant effect. A small amount of moist air contaminated with cleaner and treatment chemicals may be released from local exhaust ventilation extraction.

**Waste:** Sludge from phosphate conversion, spent treatment chemicals during maintenance shut downs.

**Energy:** Not significant.

**Accidents:** Spillage of chemicals, leakage and containment failure of pipe work, drums, tanks, etc.

**Noise:** Not significant.

### BAT

125 Rinse water should be recycled to be used as make up water wherever technically possible to reduce raw water consumption.

126 Where possible the conductivity of the rinse waters should be measured and used to regulate the make-up and discharge of rinse water.

127 Wastewaters from rinsing and cleaning should be treated to meet the required standards of the permit.

128 Any possible accidental releases from the cleaning and rinsing operations should be directed to a low-level emergency tank, to prevent its release.

129 Suitable means should be available to isolate the plant sewage system from the main sewer, to prevent possible discharge that may damage the main sewer and subsequent treatment plant.

130 Non mercury containing solutions only should be used for the cleaning operations, to prevent the release of mercury from the site.

131 The effectiveness of the phosphate conversion coating, chromate rinse and passivation should be monitored to minimise raw materials usage and carry over of treatment solutions to the rinse system.

### Electrocoat

3.113 Electrocoat is a highly transfer efficient electrophoretic coating process for applying the first primer coat to enhance corrosion protection and adhesion of subsequent coatings. The body of the vehicle is dipped in to a tank containing a water borne coating. An electric current is passed through the paint between the vehicle body and the electrodes mounted within the tank. When the vehicle leaves the dip tank it is rinsed a number of times with water before final rinsing with demineralised water. The electrocoat is then stoved in an oven at around 180°C The rinse waters used are normally cascaded to minimise water usage and ensure that only the strongest effluent discharge to the effluent treatment plant. The treated effluent is normally discharged to sewer.
Environmental Impacts of electrocoating

Environmental impact

**Water:** Release of rinse waters contaminated with electrocoat primer (some electrocoats contain lead).

**Land:** Sludge deposits of electrocoat in dip tank and filter cake from the rinse water treatment are dispose of to landfill.

**Air:** Insignificant effect. A small amount of moist air contaminated with electrocoat may be released from local exhaust ventilation extraction. Combustion gases from stoving oven

**Waste:** Sludge deposits of electrocoat in dip tank,

**Energy:** The design of the stoving oven can have a considerable effect on the energy usage.

**Accidents:** Spillage of chemicals, leakage and containment failure of pipe work, drums, tanks, etc.

**Noise**: Not significant.

### BAT

<table>
<thead>
<tr>
<th>No.</th>
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</tr>
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<td>136</td>
<td>The effectiveness of the electrocoat coating should be monitored to minimise raw materials usage and carry over of treatment solutions to the rinse system.</td>
</tr>
<tr>
<td>137</td>
<td>Lead free electrocoats should be used wherever possible</td>
</tr>
</tbody>
</table>

### Sealing and Underseal

3.114 At this stage, holes used for pre-treatment and electrocoat material ingress and drainage can be sealed.

Seamsealant is applied to selected body panel joints to improve corrosion resistance and/or render the body watertight. A PVC based underseal is sometimes sprayed to coat areas of the body underside that are vulnerable to stone chip damage.

Any faults in the electrocoat are also sanded out at this stage the seam and under-sealant are later cured in the primer ovens

### Sound Deadening Material

3.115 Sound deadening material is applied on some areas of internal structure and floor panels. The sound deadening material is later cured in the primer oven.
Environmental impact

**Water**: Not significant

**Land**: Not significant.

**Air**: A small amount of VOC released from bonding and sealing and application of PVC underseal. Small amounts of dust from sanding operations

**Waste**: Waste sealant, bonding materials and cleaning materials which may contaminated with organic solvent.

**Accidents**: Not significant.

**Energy**: Not significant

**Noise**: Not significant

### BAT

| 138 | VOC releases should be minimised by the use of sealers and adhesives with a low VOC content wherever technically possible. |
| 139 | Dust emissions from sanding operations should abated where necessary to meet the emission limit. Refer to Table 4. |

#### Primer-Surfacer

3.116 Primer-surfacer materials are applied by a combination of air spray and electrostatic application equipment in a spray booth. The coatings have stone chip resistance properties and provide some smoothing of the substrate surface texture. This coating can be coloured similar to the intended topcoat. The coatings are oven cured.

#### Colour Coat

3.117 The colour coat is also applied by a combination of an air spray and electrostatic equipment in a spray booth. This coat improves the gloss and durability of the finished surface. The colour coat may be applied as a final coat or in combination with a subsequent clear coat (clear over base). Where clear over base is applied the coats may be dried by IR before oven curing.

3.118 Both the primer and colour coats (including clearcoat) are applied in a laminar flow paint booth, where the air from the spraying operations is drawn through a water abatement weir. The solids captured in the water are sometimes filtered out using ultra filtration techniques and recycled.

Environmental impact

**Water**: Small amount of blow down from the water system.

**Land**: Not significant.

**Air**: VOC released from spray coating operations. Release of combustion gases from oven abatement plant.

**Waste**: Contaminated cleaning materials. Sludge from ultra filtration system. Paint residues

**Energy**: Significant energy use in drying ovens.

**Accidents**: Spillage of chemicals, leakage and containment failure of pipe work, drums, tanks, etc.

**Noise**: Not significant.
3.119 The finished coat is inspected for defects and wet or dry sanding and/or polishing techniques are used to rectify defects.

Wax

3.120 Wax is injected into certain box sections and sometimes door inners to enhance corrosion resistance. In some plants the underside of the body may be spray coated in wax.

Paint Repair

3.121 In some cases certain defects may require some repainting to achieve acceptable customer standards. Spot repairs are dried with IR lamps.

Environmental impact

Water: Not significant.
Land: Not significant.
Air: VOC released from spray coating operations. Dust from sanding operations.
Waste: Contained cleaning materials. Paint residues.
Energy: Not significant.
Accidents: Spillage of chemicals, leakage and containment failure of pipe work, drums, etc.
Noise: Not significant.

BAT

140 Electrostatic spray techniques should be used on all automatic spray coating operations to obtain the highest transfer efficiency.

141 Where manual spraying is carried out the techniques used must have a transfer paint efficiency of at least 65% when used on flat panels; (for information prEN 13966-1 October 2000 is a draft European standard for the determination of the transfer efficiency for liquid coating materials. Part 1 concerns flat panels and should be sufficient for evaluating transfer efficiency for this paragraph).

142 Fan motors should be fitted with VSD controls to minimise energy usage wherever technically possible.

143 The use of heat recovery systems should be used to reduce primary energy
Figure 3.9: Process description - Potential releases from a typical application of paint in vehicle manufacturing

<table>
<thead>
<tr>
<th>Process description</th>
<th>Potential emission to atmosphere</th>
<th>Potential waste water discharge</th>
<th>Waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivery of coating materials</td>
<td>VOC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage of coating materials</td>
<td>VOC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>System fill / top up</td>
<td>VOC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrocoat: - Degrease - Pre-treatment - Electrophoretic</td>
<td>VOC</td>
<td>Wash water Metals Acid / Alkali COD Oils</td>
<td>Empty containers Cleaning waste Sludge</td>
</tr>
<tr>
<td>Drying / curing</td>
<td>Abatement</td>
<td>CO NO X CO</td>
<td>Empty containers Purged materials Rags Cleaning waste</td>
</tr>
<tr>
<td>Sealing and undercoat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drying / curing</td>
<td>Abatement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coating application: - Primer - Basecoat - Clearcoat</td>
<td>Abatement</td>
<td>Booth water chemicals Paint pigment Resin</td>
<td>Sludge Empty containers Cleaning waste Isocyanates</td>
</tr>
<tr>
<td>Drying / stoving</td>
<td>Abatement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repair: - Polishing - Sanding - Interior waxing</td>
<td></td>
<td>Cleaning waste</td>
<td></td>
</tr>
<tr>
<td>Cleaning and maintenance</td>
<td>Handling and storage of finished product</td>
<td>Water Booth water chemicals Paint pigment Resin</td>
<td>Cleaning chemicals waste &amp; equipment Redundant equipment Sludge Solvents</td>
</tr>
</tbody>
</table>
Figure 3.10: Process releases from typical small car parts coating application process

Potential release to atmosphere | Potential waste water discharge | Waste
--- | --- | ---
VOC | | Empty containers
VOC | | Empty containers
VOC Wash water Acid / Alkali COD Metals Oils | Empty containers Cleaning waste Sludge
VOC CO NOx PM CO2 | | Cleaning waste
VOC PM Water booth chemicals Paint pigment Resin | Empty containers Cleaning waste Sludge Isocyanates
VOC CO NOx PM CO2 | | Cleaning waste
VOC CO NOx PM CO2 | | Cleaning waste Empty containers
VOC PM Water booth chemicals Paint pigment Resin | Cleaning chemicals waste & equipment Redundant equip - ment Sludge Solvents
Winding wire coating

3.122 Wire winding involves the coating of a non-ferrous conductor (normally copper, although aluminium is sometimes used) with an enamel film carried in an organic solvent, typically not less than 10 layers are applied. The thickness other properties of film and are defined in international standards (IEC 60317)

3.123 The thickness of the film is very in proportion to the wire diameter and accounts for less than 1% of the total diameter of the wire. Having such a thin film allows very dense windings, which produce the high-density electromagnetic fields required in energy efficient transformers and electric motors.

3.124 The mechanical, electrical and chemical resistance of the film can only be achieved by using high specification polymers dissolved in organic solvents. Currently, water borne or organic solvent free systems cannot achieve the properties to allow operation in electrical products or to meet the above specifications.

The full process normally involves the following stages:
• drawing of the conductor to size and shape
• annealing
• application of the coating material
• drying/curing/stoving of the coating
• lubrication of finished product and storage

Figure 3.11: Winding wire manufacturing techniques

3.125 Copper wire is drawn out to the appropriate shape and size depending upon customer specification. This part of the process involves drawing the wire through a succession of appropriately shaped dies reducing the wire in size until it reaches the desired specification. The wire is then annealed in an annealing oven prior to coating.
Environmental impact

**Water:** Not significant

**Land:** Not significant.

**Air:** Not significant.

**Waste:** Scrap metal from coils and bindings sent for recovery, Packaging

**Energy:** Energy use in annealing ovens.

**Accidents:** Not significant

**Noise:** Not significant

3.126 The appropriately sized and shaped wire is then enamelled. This is carried out in either a vertical or horizontal (depending on the diameter of the wire) enamelling machine. Copper wire is drawn through a reservoir of enamel and then through oversized dies. This coats the wire with enamel. Following passage through the die, the coated wire passes into a heating chamber, which evaporates the organic solvent and cures the resin.

3.127 The cured enamel is then cooled and the enamelling process repeated a number of times to increase the thickness of the enamel layer. The final enamelled wire is either then wound onto reels for delivery or prior to winding and depending upon customers requirements passed over a wax impregnated pad which coats the wire and allows for closer winding.

3.128 The enamel coating areas are under negative pressure drawing any gasses into the heating chamber.

3.129 Organic solvent laden gasses generated during the enamelling process are exhausted from the enamelling chamber and pre heated in a heat exchanger where a large percentage of the organic solvent gasses are destroyed by thermal decomposition. Thereafter, further gasses are removed by passing the heated gasses through a precious metal catalyst. This gas is then returned to the enamelling oven where it will contribute to maintaining the temperature of the oven. A certain proportion of this air is continually vented to the atmosphere through another catalyst.

3.130 Stoving/curing. There are two basic schemes used dependant on the heating source.

- **Gas heating:** organic solvent laden air is passed directly into a gas burner, the design of the burner allows intimate mixing of the secondary air and oxidation occurs. Dilution air is required to ensure that the organic solvent concentration does not rise beyond the lower explosive limit. The air requirement is therefore greater than would normally be used on an equivalent steam boiler or air heating burner but is essential to prevent an explosion within the enamelling machine. The efficiency of oxidation is however sufficient to ensure that the emission control limit of 50mg/Nm³ is always achieved.

- **Electrical heating:** as the organic solvent laden air passes over heating elements it achieves a temperature in excess of 500ºC. this is generally sufficient to achieve complete oxidation. In all cases electrically heated machines have precious metal catalysts which ensure that the emission control limit of 50mg/Nm³ is always achieved.

- Recycling of a significant part of the air stream allows the machines to operate with minimum energy consumption. Irrespective of the heating method employed, approximately 50% of the heating requirement is derived from the combustion of the organic solvent.
Environmental impact

**Water:** From cooling baths contaminated with small amounts of lubricant emulsions from drawing operations

**Land:** Not significant.

**Air:** VOC releases from organic solvent borne enamels, carbon monoxide, and nitrogen oxides from curing/stoving operations. Isocyanate release where polyurethane wire enamels are applied. Some emissions may be odorous

**Waste:** Bare or coated copper wire that is an unavoidable part of the production during start-up and change of product. The metal has a high intrinsic value and is suitable for recycling to allow re-entry as a refined metal.

Waste enamel either as a liquid or a solid consisting of enamel contaminated filters, rags, and absorbent. The material is classified as hazardous waste.

**Energy:** Significant energy use in curing and stoving of coatings.

**Accidents:** Fire or explosion from ignition of vapour exceeding LEL concentrations. Spillage of chemicals, leakage and containment failure of pipe work, drums, tanks, etc.

**Noise:** Fans associated with air movement are a potential source of environmental noise

### BAT

146 Cleaning water should be minimised and reused where technically possible to reduce raw water consumption.

147 Fan motors should be fitted with VSD controls to minimise energy usage wherever technically possible.

148 The use of heat recovery systems should be used to reduce primary energy.

149 The enamelling chamber should be maintained under negative pressure to allow capture of fugitive emissions from the die bar and to contain any degradation products or products of combustion from entering the workplace air.

150 Water borne wiredrawing lubricant emulsions should be filtered or centrifuged to remove contamination and prolong its working life.

151 Scrap bare copper should be kept separate from enamelled conductor to allow recycling by the most direct route to the casting plant without the need of further refining.

152 Combination of the airflows from the oven exhaust and the cooling zone may be used to increase the exit velocity of the final discharge of stacks to atmosphere.
Figure 3.12: Releases from winding wire

- Delivery of coating materials
- Storage of coating materials
- System fill / system top-up
- Annealing
- Application of coating material
- Drying / Stoving / Curing
- Coated product
- Lubrication
- Handling and storage of finished product

- Empty drums
- Facility cleaning
- Waste products

- VOC
- CO
- NO
- VOC
- VOC
- VOC
- VOC
- VOC
- VOC
- VOC
Coating and printing of metal packaging

3.131 There are five basic manufacturing processes which are carried out within this sector one or more of which may be carried out within a specific installation. These are:
- flat sheet coating and printing
- 3-piece can manufacture
- draw and wall Iron (DWI) can manufacture
- impact extruded aluminium tube (monobloc aerosols and collapsibles) manufacture
- end manufacture

Flat sheet coating and printing

3.132 The substrate materials used in the flat sheet printing and coating process are mainly tinplate, tin-free steel, blackplate, or aluminium. The material is received either as stillages of pre-cut sheets or as coils which have to be processed on site into the cut sheets.

3.133 Metal sheets may pass through the printing and coating lines several times as several coating and decorative application and curing passes are sometimes required. Internal can coatings, as required by the product being packed, are generally applied first. This can be followed by application of an external base coat, a printed design and an external varnish in various combinations as required by the finished product.

3.134 On the coating lines the material required for the design is pumped from a reservoir at the machine up to the application rollers. The subsequent excess material is collected and returned to the reservoir. The film weight is accurately set on the coating machine as required by quality standards and measurements.

3.135 On the printing lines ink is spooned onto the application rollers by hand. Any subsequent excess material is collected and returned to the container on completion of the production run. The application of the ink to the sheet is measured to ensure the minimal required application rate is applied to achieve the desired depth of colour. The printing techniques commonly used are offset lithographic, dry offset and in some cases a waterless lithographic process may be employed.

3.136 Periodic cleaning of the coating and print rollers is required to remove the build up of coating and ink constituents. Excess coating is removed from the bottom roller whilst the machine is running by a scraper, to prevent contamination of the underside of the sheet.

3.137 At changeovers, more thorough cleaning of the coating and printing machines is carried out using various organic solvents, including reclaimed solvents, either manually or automatically. The waste organic solvent is often distilled and reblended either on or off site.

3.138 The coated or printed sheet is then transferred to the thermal curing oven where it is heated to the required curing temperature.

3.139 VOC from the organic solvent used in the materials applied from the oven exhaust and machine hoods are collected in ductwork and exhausted by fans to atmosphere or to abatement equipment.

3.140 The cured sheet is then cooled by drawing outside ambient air through fans and ducts and blowing it over the sheets. This reduces sticking together of the materials as the stack of sheets is rebuilt on stillages for subsequent transfer to the next stage of the process.

3.141 Where UV curing inks and coatings are used UV lamps are used. This process does not release VOC but the lamps create a low level of ozone which is exhausted to atmosphere.
Environmental impact

**Water:** Small quantities of waste water contaminated with propan-2-ol (iso-propanol/iso-propyl alcohol/IPA) and residual coating constituents result from the cleaning (emptying) of the damping solution ducts and/or preparation units.

**Land:** Not significant.

**Air:** VOC releases during printing, cleaning etc. Ozone release from UV lamps used to cure UV-cured inks. Combustion products from curing ovens and oxidation unit where fitted.

**Waste:** Coating residues containing organic solvent. Rags contaminated with organic solvent and ink cleaning agents containing alkalis (caustic). Printed metal sheets.

**Energy:** Significant energy use in curing and compressed air used to power machinery.

**Accidents:** Fire or explosion from ignition of vapour exceeding LEL concentrations. Spillage of chemicals, leakage and containment failure of pipe work, drums, tanks, etc.

**Noise:** Not significant.

### BAT

| 153 | The weight of film applied should be monitored to minimise organic solvent usage and scrap. |

### Three piece can manufacture

3.142 3-piece can making process covers products as diverse as food cans, paint cans, oblongs, and aerosols.

3.143 Tinplate sheets coated and/or decorated, as described earlier under Flat Sheet Coating and Printing, are slit into individual body blanks. These body blanks are automatically fed into a welding machine that rolls the body blank into a tube and then welds it along its length to produce a straight-sided welded cylinder. During slitting excess tinplate is trimmed off and subsequently re-cycled. The welding rolls and welding head are water-cooled using chilled re-circulating water. To ensure a quality weld, copper wire is fed over the internal and external weld rolls such that the entire length of each weld is produced using fresh copper wire as the electrodes. The used copper wire is chopped-up, collected and returned to the manufacturers for re-casting. An alternative means of joining the side seam is by mechanical clinching. In some cases, the circular cylinders so formed can be reformed into other shapes such as rectangular.

3.144 Immediately after welding, and while still on the welding machine, the internal surface and external surface of the weld may have a protective coating applied depending on the specification of the 3-piece can being manufactured. This protective coating is called a side stripe and may either be a organic solvent-borne lacquer, water-borne lacquer or a powder coating depending on the intended end use of the container. In the case of side stripe lacquers, these are applied using rollers or airless spray guns and any overspray is collected and ducted to atmosphere. In the case of powder coatings these are applied electrostatically and any overspray is collected and re-cycled.

3.145 Following welding/ side stripe application, the cylinders pass through an oven to cure the applied side stripe. These ovens are generally either hot air or induction and apply a localised heat to the weld area of the cylinder. Emissions from the side stripe oven are emitted directly to atmosphere via exhaust stacks.

3.146 Following side stripe curing, some specifications of 3-piece cans (typically food cans) are then automatically fed into a beading machine so that strengthening beads can be fabricated into the body wall of the cylinder. This process is purely mechanical and requires no additional process materials. After beading or side stripe curing, depending on the can specification, the welded cylinders are automatically fed into either necking and flanging machines or just flanging machines so that both ends of the cylinder can be profiled ready to accept an end component. Again, necking and flanging are purely mechanical processes requiring no additional process materials.
3.147 The fabricated body is then automatically passed to an end seamer where an end component, previously manufactured, is fed and seamed onto one end of the fabricated cylinder. The seaming operation is also purely mechanical and does not require any additional process materials.

3.148 For some specifications, such as food cans, the 3-piece can is supplied to the user with only one end seamed on and in this case end seaming is followed by palletisation. However, with other 3-piece cans such as paint cans, oblong cans and aerosols the cans pass through a second seaming machine and a second end component is seamed on prior to palletisation.

**Environmental impact**

**Water**: Not significant.

**Land**: Not significant.

**Air**: VOC releases during internal and external side striping operations, particulate emissions from spray operations, combustion products from curing ovens and oxidation unit where fitted.

**Waste**: Coating residues containing organic solvent, rags contaminated with organic solvent and cleaning agents. Scrap tinplate, copper and packaging.

**Energy**: Significant energy use in curing, compressed air used to power machinery and welding.

**Accidents**: Fire or explosion from ignition of vapour exceeding LEL concentrations. Spillage of chemicals, leakage and containment failure of pipe work, drums, tanks, etc.

**Noise**: Potential noise release.

### BAT

<table>
<thead>
<tr>
<th>154</th>
<th>Trim and process scrap metal substrate and used copper welding wire should be segregated and stored prior to recycling off site.</th>
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</thead>
<tbody>
<tr>
<td>155</td>
<td>The sidestripe thickness and width should be monitored regularly to minimise the solvent usage.</td>
</tr>
<tr>
<td>156</td>
<td>A test pack should be used to control the sidestripe oven temperature profile and minimise scrap.</td>
</tr>
</tbody>
</table>

**Two-Piece Draw and Wall Iron (DWI) Can Manufacture**

3.149 This generic description covers the manufacture of both beverage cans, which normally carry an external printed design, and food cans, which are normally finished with a colourless clear external coating and not printed.

3.150 Aluminium or packaging steel is supplied in continuous coil strips and is fed automatically through a cupper, which produces cups by means of a mechanical press. The cups are then transferred automatically to the body maker machines where cans are formed by the wall ironing process using a power press. Excess metal is then trimmed off and reclaimed. These metal forming operations use a water-borne synthetic lubricant, plus a small amount of biocide, both subsequently removed in the washer. There is also the possibility of tramp hydraulic oil from the presses mixing with the metal forming lubricant.

3.151 The cans are automatically conveyed to the can washer where they are cleaned and etched in a multi-stage process using acid or alkaline aqueous solutions, rinsed with demineralised water and then passed through a drying oven, fired with natural gas. Emissions from the can washing and drying are emitted directly to atmosphere via exhaust stacks. Given the need for an ultraclean can to receive subsequent organic coatings, the deionised (DI) water stages are controlled for quality by conductivity in a closed loop system with the DI water regeneration plant. There is a natural carry-out of water via the wet cans entering the oven. Where cans are to be undecorated (the normal case for food cans), then a clear external protective coat is applied to the upturned can via a curtain coater, between the can washer and drying oven. The coated cans then have a period of drainage, before entering the oven to both dry them and cure the external coating. The external washcoat system is a recirculating system with the process designed to collect as much of the excess coating as possible. Effluent from the can washer, DI unit and the washcoat is treated prior to discharge.
3.152 After the dryer oven, the cans are then passed automatically for external decoration, which involves two similar operations; basecoating and printing. In base coating the cans are coated in either a coloured or clear organic solvent or water-borne coating and the can rim is varnished. Applicator rollers are enclosed and emissions ducted to atmosphere via exhaust stacks. Following coating, the cans pass into a thermal oven to cure the coatings. The cans first pass through a hot zone from which emissions are passed via exhaust stack and then through a cooling zone. These emissions are collected in ductwork and exhausted by fans to atmosphere or to abatement equipment.

3.153 After the basecoat curing process, the cans are automatically transferred to the printer where the required decorative logo is applied using inks and a series of rollers. The printed can is then cured in a thermal oven similar to that for the basecoating, with emissions exhausted to atmosphere or abatement from the curing oven and the cooling exhaust.

3.154 The cans are then sprayed internally with a coating and cured in a thermal oven. These emissions are collected in ductwork and exhausted by fans through the ducts. These ducts are then connected to a main collection duct, which transfers the emission to atmosphere or to abatement equipment. The sprayers for the internal coating, the can conveyor system and the curing oven inlet are all enclosed and any emissions from these systems are exhausted via a stack. Initially, the emissions from the internal sprayers are cleaned via a bag filter plant to remove particulate before being exhausted to atmosphere. The filter bags are shaken automatically and the particulate is collected in a container which, when full, is sealed and stored for disposal by a contractor.

3.155 Finally, the cans are automatically transferred to a machine, which finishes the necks of the cans to accept the ends, which may be supplied from alternative plants and are fitted by the filler. All the cans pass through a light tester prior to palletising, any with potential leaks are rejected and reclaimed.

Environmental impact

Water: Large volumes of water used in can washing process. Effluent from can washing process may contain metals, oils and greases, acid, alkali, fluoride, sulphate and detergents.

Land: Not significant.

Air: VOC releases from the coating, printing and internal lacquer spraying, combustion products from curing ovens and oxidation unit where fitted. Particulate matter from internal lacquer spraying.

Waste: Coating residues, waste materials contaminated with organic solvent, oil from drawing operations, scrap steel, aluminium and packaging, filter cake from effluent treatment.

Energy: Significant energy use in curing, compressed air used to power.

Accidents: Fire or explosion from ignition of vapour exceeding LEL concentrations. Spillage of chemicals, leakage and containment failure of pipe work, drums, tanks, etc.

Noise: Potential noise release

| BAT | 157 Deionised water should be regenerated and recycled within the process to minimise releases. |
Extruded Aluminium Tube Manufacture

3.156 Aluminium slug (99.5% pure aluminium) is lubricated then converted in a series of high impact drawing operations into a tube with a single open end. The open end is trimmed to produce an even cylinder and the trim collected for recycling. Further separate metal forming operations may inwardly dome the closed end for pressure resistance (aerosol), perforate it for later addition of a plastic screw thread and cap or further form into a screw thread (the latter two for collapsible tubes).

3.157 The formed article is then washed in a continuous washer to remove residual lubricant and to prepare the surface for application of organic coatings. The chemicals used in the wash and etch process comprise caustic-based anionic detergents. The contaminated washer water may be dispensed partly or totally to sewer under local consent and/or re-used to feed the caustic scrubber system described below as a means of fume abatement.

3.158 The cleaned cylinders are then transferred to a basecoater whereby a metered coating of clear or pigmented basecoat is applied by roller with the cylinder rotating. The coating material is contained in a reservoir in which the pick-up roller runs and excess material removed by the metering system is fed back into the reservoir. Typical basecoats are organic solvent-borne but water-borne coatings may also be used. The coating station is extracted by fan and generally ducted to atmosphere via high-stack chimneys. From the basecoater, the coated cans pass automatically into a drying/curing oven, the extract from which is collected and sent directly to atmosphere via a high-stack chimney or to abatement equipment.

3.159 The cured basecoat provides the key for the subsequent printed design, which is applied via a multicolour decorator using the dry offset process. Inks are hand-spooned to the reservoir rolls and a precision system of rolls accurately meters each colour separately onto the applicator roll, which picks up the colours in register and transfers the complete image to the workpiece. A protective overvarnish is applied as the final operation before the cylinder passes automatically into an oven for drying and curing. There is fume extraction at the decorator, which is ducted to atmosphere having passed through a caustic scrubber and separate ducting of the oven exhaust to atmosphere or abatement equipment.

3.160 For aerosol cans, the cylinder undergoes further reforming, with controlled application of a mineral lubricant, to ‘neck-in’ and curl the open end to accept the valve assembly which will be fitted subsequently to filling.

Environmental impact

Water: Effluent from washing process may contain metals, oils and greases, acid, alkali, fluoride, sulphate and detergents.

Land: Not significant.

Air: VOC releases from the coating, printing and internal lacquer spraying, combustion products from curing ovens and oxidation unit where fitted. Particulate matter from internal lacquer spraying.

Waste: Coating residues, waste materials contaminated with organic solvent, oil from drawing operations, scrap steel, aluminium and packaging.

Energy: Significant energy use in curing, compressed air used to power.

Accidents: Fire or explosion from ignition of vapour exceeding LEL concentrations. Spillage of chemicals, leakage and containment failure of pipe work, drums, tanks, etc.

Noise: Potential for noise release.

BAT

158 Wash water effluent should be recycled within the process wherever technically possible, to minimise raw water consumption.

159 Scrap aluminium derived from trim or defective production should be segregated and stored prior to recycling off-site.
End, Cap and Closure Manufacture

3.161 Manufacture is either from plain or precoated/decorated sheet or coil in aluminium or packaging steel. The metal may be pre-lubricated prior to fabrication.

3.162 The metal is fed to a stamping press where the initial forming is carried out. Additional forming operations are performed to complete the profile. The completed shell then proceeds to a lining machine where a sealant or gasket is applied. Organic solvents may be contained in the sealant.

3.163 Additionally for easy opening ends, once the shell has had the compound applied it proceeds on to a conversion press where the pull-tab is fabricated and fitted and a final pressing is carried out to complete the end. Sometimes, the end score will be repaired with a spray lacquer.

3.164 Some sealants and gaskets require passage through an oven for forced drying or curing

3.165 Once completed the can end is packed and palletised for despatch to customers.

Environmental impact

**Water**: Not significant.

**Land**: Not significant.

**Air**: VOC releases from the organic solvent borne sealant and gasket compounds, from sealant application nozzles doused with organic solvent, from tab forming lubricants containing organic solvents. Spray lacquer repair.

**Waste**: Small quantities of sealant and gasket compounds, lubricating oils, scrap packaging steel, aluminium and packaging.

**Energy**: Significant energy use in curing, compressed air used to power.

**Accidents**: Fire or explosion from ignition of vapour exceeding LEL concentrations. Spillage of chemicals, leakage and containment failure of pipe work, drums, tanks, etc.

**Noise**: Potential noise release.

**BAT**

160 Trim and process scrap metal substrate should be segregated and stored prior to recycling of site.

161 Low VOC content tab-forming lubricant should used to minimise VOC emissions.

*Figure 3.13: Generic processes for metal packaging manufacture*
Wallpaper manufacture

3.166 Wallpaper manufacture consists of a number of operations which may be carried on a base paper including:
- paper coating including PVC coating and pre-pasting
- printing using techniques such as gravure, flexographic and screen printing (see paragraphs 3.33-3.38)
- embossing
- finishing

3.167 Some or all of these operations may be utilised in the manufacture of a particular wallpaper design, or in a particular installation.

Paper coating

3.168 Base paper for non-vinyl wallpaper is normally bought in pre coated with a china clay finish from the paper manufacture ready for printing. Base papers for vinyl wallpaper is PVC coated and may be supplied pre-coated with PVC or coated on site. The PVC plastisol coating, which is a mixture of PVC, plasticisers, fillers, pigments and organic solvent with other additives that may include blowing agents, may be manufactured on site, or supplied ready for application to the base paper. The coating of the base paper with PVC to produce a vinyl wall covering is carried out by coating the base paper with a layer of PVC plastisol and then gelling and fusing the PVC by passing it though a heated oven. VOC from the process are abated generally using thermal oxidation techniques.

3.169 Both non-vinyl and vinyl wallpapers may be supplied pre-pasted or pasted on site. This may be carried out at the same time as PVC coating in the case of vinyl wallpaper. The process involves the coating of the back surface of the base paper with a water-activated adhesive. The adhesive can be either water or organic solvent based and is applied using a rotary screen-printing or air knife technique. The adhesive is then dried in an oven, the organic solvent which is driven off is normally abated by thermal oxidation.

Printing

3.170 Printing of both the vinyl and non-vinyl papers may be carried out as part of the wallpaper production process, print is carried out before or after pre-pasting. The printing techniques commonly used are: gravure, flexography, screen-printing.

3.171 The inks used in the printing operations are normally bought in as full strength coloured inks, consisting of pigment resin, organic solvent and filler, and in some cases water. These full strength inks are then blended and diluted on site with water or organic solvent prior to printing. Final viscosity adjustments of the ink with solvent are normally carried out at the printing station.

Embossing

3.172 Embossing involves the decoration of the surface of the wall covering by passing it through embossed rollers and may be carried out hot or cold. The hot emboss process is used on vinyl papers, the PVC coating on the paper is softened by a radiant heater or tunnel heater. Then a textured impression is transferred to the softened coating as it passes through the embossed rollers. The cold embossing process only involves pressure and is normally carried out on non-vinyl wall coverings. Duplex embossing is also used, this involves the sticking of two layers of paper with a water borne adhesive, cold embossing, then drying with hot air. Any solvent which may be driven during the hot embossing process is abated generally using thermal oxidation techniques.

Finishing operations

3.173 Finishing operations such as cutting and trimming can give rise to particulate releases in the form of dust. If significant dust is generated by these operations, extraction should be used to minimise the potential particulate release.
Cleaning operations

3.174 Cleaning of equipment takes place at the beginning and/or end of each print run or in some cases during runs, to remove debris and ink build up. Enclosed cleaning machines are used for detachable equipment such as screens, plates, drums, rollers and ink trays emissions from these machines may be contained or vented via suitable abatement equipment.

Emissions control

Point source emissions to air

3.175 The nature and source of the emissions to air expected from each activity are given in previous sections. In general they comprise:

- VOC from most surface treatment operations (including coating operations)
- particulate matter from the handling of powders or dusty materials and cutting and finishing operations
- "sticky" particulate matter from spray coating operations
- acidic vapours from pre-treatment operations
- odorous compounds from VOC and non VOC compounds and the thermal breakdown of compounds during drying operations
- combustion gases from heated processes

Dispersion and dilution of stack emissions

3.176 The basis upon which stack heights are calculated using HMIP Technical Guidance Note D1 (D1) (Ref 16) is that pollutants are dispersed and diluted in the atmosphere to ensure that they ground at concentrations that are harmless under the theoretical conditions of the D1 model. The emission limits in this sector note should be used as the basis for stack height calculation. The stack height so obtained is adjusted to take into account local meteorological data, local topography, nearby emissions and the influence of plant structure. It is necessary that the assessment also takes into account the relevant air quality standards that apply for the emitted pollutants.

The calculation procedure of D1 is usually used to calculate the required stack height but alternative dispersion models may be used in agreement with the regulator. D1 relies upon the unimpeded vertical emission of the pollutant. A cap or other restriction over the stack impedes the vertical emission and hinders dispersion. For this reason where dispersion is required such flow impeders should not be used. A cone may sometimes be useful to increase the efflux velocity and achieve greater dispersion.

Revised stack height calculations should not be required unless it is considered necessary because of a breach, or serious risk of breach, of an EC Directive limit value and because it is clear from the detailed review and assessment work that the Part A2 activity itself is a significant contributor to the problem.

An operator may chose to meet a tighter emission limit in order to reduce the required stack height.

3.177 Liquid condensation on internal surfaces of flues and exhaust ducts might lead to corrosion and ductwork failure or to droplet emission.

- adequate insulation should be provided to minimise the cooling of waste gases and prevent liquid condensation by keeping the temperature of the exhaust gases above the dewpoint
3.178 Unacceptable emissions of droplets could possibly occur as a result of entrainment from wet abatement plant where the linear velocity within the associated ductwork exceeds 9 m/s. The use of mist eliminators reduces the potential for droplet emissions.

- where a linear velocity of 9 m/s is exceeded in the ductwork of existing wet abatement plant, the linear velocity should be reduced, subject to health and safety considerations, to ensure that droplet fallout does not occur

3.179 The dispersion from all emission points to air can be impaired by low exit velocity at the point of discharge, or deflection of the discharge.

- flues and ductwork should be cleaned to prevent accumulation of materials, as part of the routine maintenance programme
- a minimum discharge velocity should be required in order to prevent the discharged plume being affected by aerodynamic down wash

<table>
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<tr>
<th>BAT (Sheet 1 of 2)</th>
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<tbody>
<tr>
<td>All releases to air</td>
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<td>The operator should:</td>
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</tbody>
</table>

162 Ensure that all operations which generate emissions to air are contained and adequately extracted to suitable abatement plant, where this is necessary to meet specified emission limits.

163 Ensure that emissions from combustion processes in normal operation are free from visible smoke and in any case do not exceed the equivalent of Ringelmann Shade 1 as described in British Standard BS 2742:1969.

<table>
<thead>
<tr>
<th>Vents and chimneys</th>
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<tr>
<td>The operator should:</td>
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</table>

164 Ensure that hot emissions take place from the minimum practicable number of stacks. This is particularly important when new plants are being designed or when changes are being made to existing processes. If practicable a multi-flue stack should be used.

165 Ensure that vent and stack heights are sufficient to ensure adequate dispersion under all normal operating conditions.

166 Ensure that the minimum vent height is 3 metres above roof ridge height of any building within a distance of 5 times the uncorrected vent height and in no circumstances should it be less than 8 metres above ground level. (Note: this provision does not apply to workplace dust extraction units)

167 Be able to demonstrate to the regulator that all reasonably practicable steps are taken during start-up and shut down, and changes of fuel or combustion load in order to minimise emissions.

168 Investigate the cause and nature of any persistent visible emissions and provide a report to the regulator.

169 Ensure that emissions of water vapour are free from droplet fallout.

170 Ensure that liquid entrainment in the duct of wet abatement, leading to droplet fallout, does not occur as a result of the linear flow rate within the duct exceeding 9 m/s.

171 Ensure that flues and ductwork are cleaned to prevent accumulation of materials, as part of the routine maintenance programme.

172 Ensure that exhaust gases discharged through a stack achieve an exit velocity greater than 15 m/sec during normal operating conditions to achieve adequate dispersion.

173 Ensure that stacks are not fitted with any restriction at the final opening such as a plate, cap or cowl, with the exception of a cone which may be necessary to increase the exit velocity of the emissions.
3.180 The nature and source of the emissions expected from each activity is given in previous sections. In general, wastewater can arise from storm water, from cooling water, from accidental emissions of raw materials, products or waste materials and from fire-fighting. In addition to the techniques below, guidance on cost-effective effluent treatment techniques can be found in ETBPP/Envirowise Guides (Ref 14).

3.181 The amounts of process water used in surface treatment and coating vary considerably depending on the type of activity being carried out. Where water washing and rinsing of the substrate is carried out or water borne surface treatment materials are used, water consumption may be high. Where only organic solvent borne materials are used without water borne cleaning of the substrate, consumption may be low. Discharges principally comprise:

- discharges from image and image carrier manufacture
- discharges from coating, inks, adhesives etc. preparation manufacture
- discharge from wet scrubbers
- discharges from bio scrubbers
- discharges of cleaning water
- discharges of cooling water, often-containing biocides and anti-oxidants
- discharges of boiler water blowdown
- discharges of site drainage and stormwater

3.182 The following general principles should be applied in sequence to control emissions to water:

- water use should be optimised and wastewater re-used or recycled
- contamination risk of process or surface water should be minimised
- wastewater treatment systems can maximise the removal of pollutants, for example metals, using precipitation, sedimentation and filtration. The mix of pollutants will define the methods and reagents used. Concentrated effluents should be pretreated as necessary before discharge into the final effluent treatment system
- ultimately, surplus water is likely to need treatment to meet the provisions of BAT (and statutory and non-statutory objectives). Generally, effluent streams should be kept separate as treatment will be more efficient. However, the properties of dissimilar waste streams should be used where possible to avoid adding further chemicals, e.g. neutralising waste acid and alkaline streams. Also, biological treatment can occasionally be inhibited by concentrated streams, while dilution, by mixing streams, can assist treatment
- systems should be engineered to avoid effluent by-passing the treatment plant

3.183 Minimising the use of water and minimising the level of pollutants in each water stream are the primary aims, followed by the recycling of waste water streams wherever possible.

3.184 The nature of the receiving water should be taken into account, with regard to any pollutant released to this media. Irrespective of the receiving water, the adequacy of the plant to minimise the emissions must be considered. Guidance on treatment of persistent substances can be found in References (Ref 14).

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**Point source emissions to surface water and sewer**

Where possible, ductwork should be sufficiently lagged to prevent condensation of liquids, in particular solvents, within the duct.

Combustion processes should use low NOX burners.
Local Authority Regulation

3.185 Regulation 13 of The Pollution Prevention and Control (England and Wales) Regulations 2000 states that:

- “(1) In the case of a Part A installation or Part A mobile plant in relation to which a local authority regulator exercises functions under these Regulations, the Environment Agency may, at any time, give notice to the local authority regulator specifying the emission limit values or conditions which it considers are appropriate in relation to preventing or reducing emissions into water.”
- “(3) Where a notice under paragraph (1) specifies conditions in relation to emissions into water from an installation or mobile plant, the permit authorising the operation of that installation or mobile plant, shall include those conditions or more onerous conditions dealing with the same matters as the local authority regulator considers to be appropriate.”

**Groundwater protection legislation**

3.186 The Groundwater Regulations for the UK came into force on 1 April 1999. If List I or List II substances are discharged to groundwater or may be discharged to groundwater then the Environment Agency will provide advice as part of their statutory consultation duties. For further guidance see chapter 31 in the General Guidance Manual.

<table>
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<tr>
<th>BAT</th>
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<tbody>
<tr>
<td>The operator should ensure that:</td>
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<tr>
<td>176 All emissions are controlled, as a minimum, to avoid a breach of water quality standards (Calculations and/or modelling to demonstrate this may required to be provide to the regulator).</td>
</tr>
<tr>
<td>177 Run-off from the installation should be controlled and managed and where necessary (given the nature of the run-off) treated before discharge in a suitable effluent treatment plant,</td>
</tr>
<tr>
<td>178 All interceptors:</td>
</tr>
<tr>
<td>- are impermeable</td>
</tr>
<tr>
<td>- are subject to visual inspection and any contamination removed at a frequency agreed with the regulator</td>
</tr>
<tr>
<td>- have an annual maintenance inspection; prior to inspection all contents should be removed.</td>
</tr>
<tr>
<td>179 Procedures for dealing with the discharges from bunds should be in place.</td>
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</tbody>
</table>

**Off site effluent treatment**

180 Where effluent is treated off-site at a sewage treatment works, it is demonstrated that:

- all appropriate measures have been taken to reduce effluent volume and pollutant concentration;
- the treatment provided at the sewage treatment works is as good as would be achieved if the emission was treated on-site, based on reduction of load (not concentration) of each substance to the receiving water;
- the probability of sewer bypass, via storm/emergency or combined sewer overflows or at intermediate sewage pumping stations, is acceptably low; and
- a suitable monitoring programme is in place for emissions to sewer, taking into consideration the potential inhibition of any downstream biological processes.
Control of fugitive emissions to air

3.187 Common sources of fugitive emissions are:

VOC and Particulate matter from:
- handling, mixing, use and storage of organic solvent borne surface cleaners, degreasers, coatings, inks, adhesives etc. and organic solvents
- storage, handling and use of powders and dusty materials
- storage areas (e.g. bays, stockpiles etc.)
- the loading and unloading of transport containers
- transferring material from one vessel to another (e.g. mixing vessels or storage vessels, silos)
- conveyor systems
- pipework and ductwork systems (e.g. pumps, valves, flanges, catchpots, drains, inspection hatches etc.)
- poor building containment and extraction
- potential for bypass of abatement equipment (to air)
- accidental loss of containment from failed plant and equipment including leakage e.g. from bunds and drains

3.188 Where there are opportunities for reductions in fugitive emissions, the Permit may require an updated inventory of fugitive emissions to be submitted on a regular basis, and normally at least once a year.
181 Operations should be controlled to minimise fugitive emissions.

182 **Dust** - The following general techniques should be employed where appropriate:
   (a) covering of skips and vessels;
   (b) avoidance of outdoor or uncovered stockpiles;
   (c) enclosed conveyors, pneumatic conveying (noting the higher energy needs), minimising drops;
   (d) regular housekeeping.

183 **VOC**
   (a) For VOC where the operator uses the Emission and Fugitive limits or the Total Emission Limit Value for compliance, the Fugitive VOC emissions must be determined in accordance with the Solvent Management Plan (Appendix 2). Once completed, it need not be done again until the equipment is modified in such a way as to effect the potential fugitive release of VOC.
   (b) When transferring volatile liquids, the following techniques should be employed - subsurface filling via filling pipes extended to the bottom of the container, the use of vapour balance lines that transfer the vapour from the container being filled to the one being emptied, or an enclosed system with extraction to suitable abatement plant where abatement is necessary to meet the emission limits.
   (c) Vent systems should be chosen to minimise breathing emissions (e.g. pressure/vacuum valves) and, where relevant, should be fitted with knock-out pots and appropriate abatement equipment.
   (d) Where possible the application of the coating should be carried out in contained conditions
   (e) Where pre impregnated wipes are used they should be held within a closed container prior to use.
   (f) Prior to removal from site, used wipes and other items contaminated with organic solvent should be placed in a suitably labelled metal bin fitted with a self-closing lid.
   (g) Bins should be emptied at least daily, as the contents not only present a fire hazard, but they may also undergo spontaneous combustion (especially if contaminated with certain types of coating residues).
   (h) For materials that may undergo spontaneous combustion, special bins that allow air to circulate beneath and around them to aid cooling should be used.
   (i) Application of cleaning organic solvents should be from a contained device or automatic system when applied directly.
   (j) Closed cleaning systems should be used wherever possible.
   (k) Ductwork should be enclosed and sealed to prevent fugitive loss of VOC.
   (l) All drying ovens should be operated under balanced or negative pressure to reduce VOC emissions at entry and exit point. All other apertures within the oven must be sealed sufficiently.
   (m) Drying systems should operate to maximise the drying efficiency. Complete drying reduces the fugitive emission level of organic solvents left in products.
Fugitive emissions to surface water, sewer and groundwater

184 For VOC where the operator uses the Emission and Fugitive limits or the Total Emission Limit Value for compliance, the Fugitive VOC emissions must be determined in accordance with the Solvent Management Plan (Appendix 2). Once completed, it need not be done again until the equipment is modified in such a way as to effect the potential fugitive release of VOC.

185 Connections to bulk storage tanks should be located within a contained area, fixed and locked when not in use.

186 The integrity of storage tanks should be inspected, recorded and documented particularly where corrosive substances are involved. These inspections should be included in the maintenance schedule.

187 With regard to subsurface structure, the operator should:

- establish and record the routing of all installation drains and subsurface pipework
- identify all subsurface sumps and storage vessels
- engineer systems to minimise leakages from pipes and ensure swift detection if they do occur, particularly where hazardous (i.e. listed) substances are involved
- provide, in particular, secondary containment and/or leakage detection for such subsurface pipework, sumps and storage vessels
- establish an inspection and maintenance programme for all subsurface structures, e.g. pressure tests, leak tests, material thickness checks or CCTV

188 For surfacing, the operator should:

- ensure that all operational areas are equipped with an impervious surface, spill containment kerbs, sealed construction joints, and connection to a sealed drainage system unless the operator justifies that this is not necessary to the satisfaction of the regulator.
- keep records of the design and condition of the surfacing of all operational areas - relevant information may include, as appropriate, capacities, thicknesses, falls, material, permeability, strength/reinforcement, and resistance to chemical attack
- have an inspection and maintenance programme of impervious surfaces and containment kerbs
- justify where operational areas have not been equipped with:
  - an impervious surface
  - spill containment kerbs
  - sealed construction joints
  - connection to a sealed drainage system

189 The operator should ensure that all tanks containing liquids whose spillage could be harmful to the environment are contained. The operator should ensure that all bunds:

- are impermeable and resistant to the stored materials
- have no outlet (that is, no drains or taps) and drain to a blind collection point
- have pipework routed within bunded areas with no penetration of contained surfaces
- are designed to catch leaks from tanks or fittings
- should be at least 110% of the largest tank *
- are visually inspected weekly and any contents pumped out or otherwise removed under manual control after checking for contamination
- where not frequently inspected, are fitted with a high-level probe and an alarm as appropriate
- have an annual maintenance inspection (normally visual but extending to water testing where structural integrity is in doubt)

* A Code of Practice on the use and storage of solvents is currently being drawn up and will be published on the Defra website. [www.defra.gov.uk/environment/water/ground/solvents/index](http://www.defra.gov.uk/environment/water/ground/solvents/index)

Where the Code, when published, contains anything more stringent as regards bunding, account should be taken of it.
Odour

3.189 Chapter 17 of the General Guidance Manual provides guidance on controlling odour from installations and the information required in an application.

3.190 The potential for odorous emissions varies according to the types of materials used, the operations carried out within the installation and the techniques used to control potential emissions. Both VOC and non-VOC compounds may give rise to odorous emissions as a result of handling, storage, and use within the installation, in particular thermal breakdown of compounds during drying may lead to odorous emissions. Abatement should be used to prevent offensive odorous emissions where necessary. Stacks should be designed to disperse and dilute odorous emissions. Where odorous emissions are not able to be contained other than by buildings, good ventilation and a rate of air change to ensure that fugitive emissions are quickly and efficiently dispersed are necessary.

3.191 Implementation of the best available techniques and the emission limit values and provisions of this note should ensure that offensive odours are not perceived beyond the site boundary, other than where unavoidable plume grounding occurs. It may be necessary to include additional controls to avoid offensive odours, for example, where local meteorological conditions frequently lead to poor dispersion conditions.

3.192 The locality will influence the assessment of the potential for odour impact, for example, where the site has a low odour impact due to its remoteness from sensitive receptors, the escape of offensive odour beyond the installation would be unlikely to cause harm. In these circumstances it is expected that the operations should be optimised to minimise odour emissions and also that effective process management is applied. Assessment of the potential for offensive odour beyond the site boundary should take account of all predicted wind directions and weather conditions, which are typical of the location in question.
Management

3.193 Within IPPC, an effective system of management is a key technique for ensuring that all appropriate pollution prevention and control techniques are delivered reliably and on an integrated basis.

3.194 An effective Environmental Management System (EMS) will help the operator to maintain compliance with regulatory requirements and to manage other significant environmental impacts.

Operations and maintenance

3.195 Maintenance - It is good practice to ensure:
- effective preventative maintenance on all aspects of the process the failure of which could impact on the environment
- clear written maintenance instructions for all relevant items are developed and maintained
- a method of reviewing maintenance needs, with demonstrable evidence that this process takes place

3.196 Responding to problems - The regulator needs to be notified about certain events and expects the operator to respond to problems which may have an effect on emissions to the environment. Such problems may arise within the process itself or, for example, with the abatement plant.

3.197 Contractors on site - It is important to be aware that in complying with their permit, operators will be responsible for work undertaken by contractors. Operators are advised to provide instructions to contractors regarding protecting the environment whilst working on site.
<table>
<thead>
<tr>
<th>Operations and maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>193 Effective operational and maintenance systems should be employed on all aspects of the installation whose failure could impact on the environment, in particular there should be:</td>
</tr>
<tr>
<td>• documented operational control procedures</td>
</tr>
<tr>
<td>• a documented preventative maintenance schedule, covering all plant whose failure could lead to impact on the environment, including major ‘non productive’ items such as tanks, pipework, retaining walls, bunds, ducts and filters; this should be reviewed and updated annually</td>
</tr>
<tr>
<td>• documented procedures for monitoring emissions</td>
</tr>
<tr>
<td>194 The regulator should be provided with a list of key process equipment and abatement equipment. Such equipment should be provided with alarms or other warning systems which indicate equipment malfunction or breakdown. Such warning systems should be maintained and checked to ensure continued correct operation, in accordance with the manufacturer's recommendations.</td>
</tr>
<tr>
<td>195 Essential spares and consumables should be held on site or be available at short notice from suppliers, so that plant breakdown can be rectified rapidly.</td>
</tr>
<tr>
<td>196 Records of breakdowns should be kept and analysed by the operator in order to eliminate common failure modes.</td>
</tr>
<tr>
<td>197 A competent person should be appointed to liaise with the regulator and the public with regard to complaints. The regulator should be informed of the designated individual.</td>
</tr>
<tr>
<td>198 A high standard of housekeeping should be maintained.</td>
</tr>
<tr>
<td>Audits</td>
</tr>
<tr>
<td>199 All audit records of raw materials usage, water usage, energy usage and waste production should be referenced to annual production.</td>
</tr>
<tr>
<td>Competence and training</td>
</tr>
<tr>
<td>200 Training systems, covering the following items, should be in place for all relevant staff:</td>
</tr>
<tr>
<td>• awareness of the regulatory implications of the permit</td>
</tr>
<tr>
<td>• awareness of all potential environmental impacts under normal and abnormal circumstances</td>
</tr>
<tr>
<td>• awareness of the procedures for dealing with a breach of the permit conditions</td>
</tr>
<tr>
<td>• prevention of accidental emissions and action to be taken when accidental emissions occur</td>
</tr>
<tr>
<td>• awareness of all operating procedures</td>
</tr>
<tr>
<td>201 The skills and competencies necessary for key posts (which may include contractors and those purchasing equipment and materials) should be documented and records of training needs and training received for these posts maintained.</td>
</tr>
<tr>
<td>202 The potential environmental risks posed by the work of contractors should be assessed and instructions provided to contractors about protecting the environment while working on site.</td>
</tr>
<tr>
<td>203 Consumption of organic solvents should be minimised through good process control, using the appropriate techniques for the system as described in Guidance Note GG 13, Cost Effective Management of solvents in the printing and coating industries (Ref 6), produced by the Environmental Technology Best Practice Programme.</td>
</tr>
<tr>
<td>Accidents/incidents/non conformance</td>
</tr>
<tr>
<td>204 There should be written procedures for investigating incidents, (and near misses) including identifying suitable corrective action and following up.</td>
</tr>
</tbody>
</table>
Raw Materials

3.198 This section covers the use of raw materials and water and the techniques for both optimising their use and minimising their impact by selection (Energy and fuels are covered under Energy).

3.199 As a general principal, the operator will need to demonstrate the measures taken to:
• reduce the use of chemicals and other materials (Waste minimisation (optimising the use of raw materials))
• substitute with materials presenting lower risks to the environment
• understand the fate of by-products and contaminants and their environmental impact

Raw materials selection

3.200 Generally operators purchase and use products for use directly in the process. Operators may manufacture some of the products used. Products purchased may include surface cleaners and degreasers, impregnating and waterproofing materials, surface coatings and printing inks. In all cases, the selection of the product will be determined by a combination of factors, including the specific application methods, the process line configuration, the substrate, and its fitness for purpose.

3.201 The availability and suitability of low organic solvent or organic solvent free products should be regularly reviewed. In the case of surface coatings and printing inks, low VOC-emitting alternatives include:
(i) water borne inks and coatings, (low organic solvent content)
(ii) higher solids content inks and coatings,
(iii) powder inks and coatings,
(iv) organic solvent free liquid inks and coatings,
(v) radiation cured inks and coatings (for example, ultra violet and electron beam).

3.202 The selection of cleaning materials used for both cleaning down machinery and the substrate can have an effect on the emissions from the installation.

3.203 The use of organic solvents or preparations containing VOC that are assigned risk phrases R45, R46, R49, R60 or R61 should be reviewed annually as these substance have carcinogenic mutagen and repro-toxic effects.
3.204 The following issues should be considered when selecting raw materials:

Table 10: Raw material selection

<table>
<thead>
<tr>
<th>Raw material</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solvents</td>
<td>• The vapour pressure, flammability, odour, Classification under the Montreal Protocol, CHIP risk phrase classification</td>
</tr>
</tbody>
</table>
| Inks, coatings, adhesives, surface cleaners etc.   | • Type and amount of solvent within ink, coating, adhesive, surface cleaner etc.  
                                                      | • Amount of solvent used per unit area covered  
                                                      | • Content of heavy metals in pigments |
| Water proofing materials Impregnation materials    | • Type and amount of solvent within preparation  
                                                      | • Amount of solvent used per unit area covered  
                                                      | • Content of heavy metals in pigments  
                                                      | • Fungicide/biocide within preparation |
| Water                                             | • Identify most sustainable source (consider recycled sources)                                                                            |
| Fuel oils                                          | • Sulphur content should be minimised. The maximum sulphur content of heavy fuel oil shall be 1% by weight *                                 |

* Sulphur in liquid fuels regulations, article 3 (3)(i)(b) states that combustion plant (other than new large combustion plant covered by the Large Combustion Plant Directive (LCPD) for which there is a separate provision) can burn heavy fuel oil with a sulphur content greater than 1% so long as the sulphur dioxide emissions from the plant are less than or equal to 1700m³ at 3% oxygen dry. DEFRA is the enforcing authority for these regulations.

BAT

205 The operator should:

• maintain an inventory covering the principal types of raw materials used
• annually review alternatives for the principal types of raw materials used with regard to their environmental impact
• have quality procedures to control the specification of raw materials used, in order to minimise any potential environmental impact
• complete any long term studies needed into the less polluting options and make any material substitutions identified within the review period

206 The operator shall for substances or preparations which, because of their content of VOC are assigned risk phrases R45, R46, R49, R60 or R61 must be replaced, as far as possible by less harmful substances and preparations within the shortest possible time.

207 A programme to monitor and record the consumption of surface treatment against product produced should be used to optimise the amount of organic ink/coatings/organic solvent used.
Waste minimisation (optimising the use of raw materials)

3.205 Waste minimisation can be defined simply as: “a systematic approach to the reduction of waste at source, by understanding and changing processes and activities to prevent and reduce waste”.

3.206 A variety of techniques can be classified under the term waste minimisation and they range from basic housekeeping techniques through statistical measurement techniques, to the application of clean technologies.

3.207 Key operational features of waste minimisation will be:
  - the ongoing identification and implementation of waste prevention opportunities
  - the active participation and commitment of staff at all levels including, for example, staff suggestion schemes
  - monitoring of materials’ usage and reporting against key performance measures

3.208 Using this information, opportunities for waste reduction, changes in process and improved efficiency should be generated and assessed, and an action plan prepared for the implementation of improvements.

3.209 The use and fate of all materials should be mapped onto a process flow diagram using data from the raw materials inventory and other company data as appropriate. Data should be incorporated for each principal stage of the operation in order to construct a mass balance for the installation. The mass balance can then be used to identify opportunities for improvements.

Water use

3.210 Water use should be minimised within the BAT criteria for the prevention or reduction of emissions and be commensurate with the prudent use of water as a natural resource.

3.211 Reducing water use may be a valid environmental and/or economic aim in itself, perhaps because of local supply constraints. Also, from the point of view of reducing polluting emissions, any water passing through an industrial process is degraded by the addition of pollutants, and there are distinct benefits to be gained from reducing the water used. These include:
  - reducing the size of (a new) treatment plant, thereby supporting the cost benefit BAT justification of better treatment
  - cost savings where water is purchased or disposed of to another party
  - associated benefits within the process such as reduced energy requirements for heating and pumping, and reduced dissolution of pollutants into the water leading to reduced sludge generation in the effluent treatment plant

The use of a simple mass balance for water use may help to reveal where reductions can be made.

Advice on cost-effective measures for minimising water use can be found in Ref 14.
3.212 The amount of water used in surface treatment using organic compounds varies considerably on the activities being carried out within the installation. Its main uses are as a coolant, as a wash medium in developing and image carrier manufacture, as a degreasing, cleaning and carrier for surface treatment substances in substrate preparation prior to coating. Water can also be used in general cleaning and housekeeping operations within the installation. Where water borne materials are used in the installation, water consumption may be significantly increased.

3.213 The following general principals should be applied in sequence to reduce emissions to water:
- water-efficient techniques should be used where possible
- water should be recycled within the process from which it issues, treating it first if necessary. Where this is not practicable, it should be recycled to another part of the process which has a lower water quality requirement

### Water use

<table>
<thead>
<tr>
<th>BAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>211 The operator should carry out a regular review of water use (water efficiency audit). Where one has not been carried out recently, an initial comprehensive audit should be carried out at the earliest opportunity, but at the latest within 2 years. Audits should be at least as frequent as the IPPC permit reviews.</td>
</tr>
<tr>
<td>212 Using this information, opportunities for reduction in water use should be assessed and, where appropriate, should be carried out in accordance with a timescale approved by the regulator.</td>
</tr>
<tr>
<td>213 The volume of mains and abstracted water used in the activities should be directly measured normally once a day, or at a frequency agreed with the regulator, when the installation is operating all measurements should be recorded and the records held on site.</td>
</tr>
<tr>
<td>214 When parts are removed for cleaning a two bath system should be used to minimise the use of cleaning water. The water from the second bath can then be used to replenish the first bath when this water is so soiled it must be disposed of.</td>
</tr>
<tr>
<td>215 When cleaning tanks and fixed vessels cleaning water should be minimised by using rotary spray nozzle heads and reused where possible.</td>
</tr>
</tbody>
</table>

### Waste handling

3.214 Good segregation of materials is essential to facilitate opportunities for recovery, recycling and re-use.

3.215 The most important wastes are:
- contaminated solvents
- residual surface treatment material
- wipes, rags and other organic solvent contaminated wastes
- sludges from degreasing and cleaning operations
- sludge from effluent treatment processes
- contaminated powders pigments, fillers etc.
- particulate matter collected in bag or cartridge filters
- scrubber liquors and sludges, and output from the effluent treatment plant
- refractory waste from incinerators, dryers and combustion chambers
- chemical and oil containers
- general non hazardous industrial waste.

Waste should be recovered wherever practicable.

3.216 Most organic solvent and organic solvent contaminated wastes can be beneficially re-used by third parties especially if some degree of segregation is carried out to prevent unsuitable materials contaminating the waste.
Waste re-use, recovery, recycling or disposal

3.217 Waste should be re-used, recovered or recycled unless the regulator has accepted a satisfactory BAT justification.

3.218 Table 11 summarises the routes of the various waste streams from a typical surface treating using organic solvents site. Whether re-use, recovery or recycling is possible at a particular site will depend on the particular fuels and raw materials being used, the products being made and the methods of operation employed.

223 The operator should carry out an annual review to demonstrate that the best environmental options are being used for dealing with all waste from the installation.
Table 11: Waste stream routes

<table>
<thead>
<tr>
<th>Process waste stream</th>
<th>Treatment options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solvents</td>
<td>Recovery and reuse of solvent on site</td>
</tr>
<tr>
<td></td>
<td>Recovery and reuse of solvent off site</td>
</tr>
<tr>
<td></td>
<td>Recovery as heat on-site</td>
</tr>
<tr>
<td></td>
<td>Off site recovery as heat substitute fuel</td>
</tr>
<tr>
<td></td>
<td>Incineration on-site or off site</td>
</tr>
<tr>
<td>Coatings and inks</td>
<td>Recovery and reuse on site and off-site disposal of residues</td>
</tr>
<tr>
<td></td>
<td>Recovery and reuse of solvent content on/off site</td>
</tr>
<tr>
<td></td>
<td>Incineration on-site or off site</td>
</tr>
<tr>
<td>Solid waste i.e. powders, fillers and pigments etc.</td>
<td>Recycling on site as a raw material or offsite as a feed into another process</td>
</tr>
<tr>
<td></td>
<td>Landfill - where suitable or incineration</td>
</tr>
<tr>
<td>Effluent treatment sludge</td>
<td>Recycling to remove heavy metal contamination</td>
</tr>
<tr>
<td></td>
<td>Landfill - not suitable for recycling and not containing List I or List II substances</td>
</tr>
<tr>
<td></td>
<td>Incineration on-site or off site</td>
</tr>
<tr>
<td>Contaminated wipes and rags</td>
<td>Recovery and reuse of solvent on/off</td>
</tr>
<tr>
<td></td>
<td>Laundering of wipes and rags</td>
</tr>
<tr>
<td></td>
<td>Incineration/landfill - not suitable for recycling.</td>
</tr>
<tr>
<td>Sludge from degreasing units using Risk Phase Compounds</td>
<td>Recovery and reuse of solvent on/off site</td>
</tr>
<tr>
<td></td>
<td>Incineration of residues</td>
</tr>
<tr>
<td>Particulate matter</td>
<td>Some may be suitable for recycling on site as a raw material or offsite as a feed into another process</td>
</tr>
<tr>
<td></td>
<td>Incineration / landfill - where not suitable for recycling.</td>
</tr>
<tr>
<td>Metallic waste</td>
<td>Recycle</td>
</tr>
<tr>
<td>Shot blasting waste</td>
<td>Recycled</td>
</tr>
<tr>
<td></td>
<td>Landfill - not suitable for recycling</td>
</tr>
<tr>
<td>Refractory waste</td>
<td>Landfill</td>
</tr>
<tr>
<td>Scrubber liquor and sludges</td>
<td>Minimised, then to incineration / landfill</td>
</tr>
</tbody>
</table>

**Note:** Suitable licenced contractors should be used to transport/handle waste

**Energy**

3.219 BAT for energy efficiency under the PPC Regulations will be satisfied provided the operator meets the following conditions:

- the operator meets the basic energy efficiency provisions below and is a participant to a Climate Change Agreement (CCA) or a Direct Participation Agreement (DPA) with the Government

- or

- the operator meets the basic energy efficiency provisions below and the additional energy efficiency provisions
Basic energy efficiency provisions

3.220 The provisions of this section are basic, low cost, energy standards that apply whether or not a CCA or DPA is in force for the installation.

**Additional energy efficiency provisions**

3.221 Within IPPC it is valid to consider both the emission of direct (heat and emissions from on-site generation) and indirect (emissions from a remote power station) pollution when considering options for energy efficiency.

**Energy efficiency techniques**

231 The following techniques should be considered:
- heat recovery from different parts of the processes
- minimisation of water use and closed circulating water systems
- good insulation
- plant layout to reduce pumping distances
- phase optimisation of electronic control motors
- optimised efficiency measures for combustion plant e.g. air/feedwater preheating, excess air etc.

**Energy supply techniques**

232 The following techniques should be considered:
- use of Combined Heat and Power (CHP)
- generation of energy from waste
- use of less polluting fuels
Accidents

3.222 For accident management, there are three particular components:
- **identification of the hazards** to the environment posed by the installation/activity
- **assessment of the risks** (hazard x probability) of accidents and their possible consequences
- implementation of **measures to reduce the risks** of accidents, and contingency plans for any accidents that occur

3.223 Further guidance can be found in chapter 20 of the General Guidance Manual.

3.224 Examples of potential hazards associated with installations using VOC for coating and surface treatment:
- the use for flammable materials on site and potential sources of ignition
- static (due to poor materials selection, inadequate earth bonding)
- spark (due to incorrect electrical zoning, mechanical movement)
- heat (due to flames, radiant heat, friction)
- explosive atmospheres inside process equipment ducts and abatement plant
- powder explosions due to incorrect design, operation, or failure of powder handling systems
- spillage and loss of containment of materials

3.225 For the prevention of accidents, the methods employed and the equipment used to ensure the correct handling and storage of flammable materials needs to be determined by trained personnel. There is HSE guidance available on this subject. (Ref 9), (Ref 10) and (Ref 11) Compliance with health and safety requirements should ensure that BAT 246 is met.

### BAT (Sheet 1 of 2)

**Accidents/incidents/non conformance**

233 There should be written procedures for investigating incidents and near misses, including identifying suitable corrective action and following up.

234 The operator should maintain an accident management plan that identifies the hazards, assesses the risks and identifies the measures required to reduce the risk of potential events or failures that might lead to an environmental impact. The plan should identify:
- the actions to be taken to minimise these potential occurrences; and
- the actions to deal with such occurrences so as to limit their consequences

235 In the case of abnormal emissions arising from an accident, such as a spillage for example, the operator should:
- investigate immediately and undertake remedial action as soon as practicable
- promptly record the events and actions taken
- ensure the regulator is made aware, as soon as practicable

236 Suitable solvent containment and spillage equipment should be readily available in all solvent handling areas.

237 Adequate provision to contain potential liquid and solid spillage should be provided.

238 Appropriate precautions should be taken to prevent ignition of flammable materials.

239 All spillages should be cleared as soon as possible; solids by vacuum cleaning, wet methods, or other appropriate techniques may be used, however, dry sweeping of dusty spillages should not be permitted.

240 The handling and use of flammable and explosive materials should be carried out in accordance with the requirements of the Dangerous substances and explosive atmosphere regulations SI2776 2002.
Identification of the hazards

3.226 In identifying the hazards particular areas to consider may include, but should not be limited to, the following:

- transfer of substances (e.g. loading or unloading from or to silos or storage tanks)
- overfilling of silos or tanks
- failure of plant and/or equipment (e.g. extraction fans or pumps, over-pressure of storage silos and pipework, blocked drains)
- failure of containment (e.g. bund and/or overfilling of drainage sumps)
- fires and problems arising from fighting fires such as failure to contain firewaters
- making the wrong connections in drains or other systems
- preventing incompatible substances coming into contact
- unwanted reactions and/or runaway reactions
- emission of an effluent before adequate checking of its composition has taken place
- steam main issues
- vandalism
- vehicle movements

Measures to reduce the risks (identified by risk assessment)

3.227 Risk reduction can be achieved by process management controls and preventative measures. The following techniques will be relevant to most installations, although this is not an exhaustive list.

Process management controls

- process design, alarms, trips and other failsafe control techniques to ensure the safe operation of the plant
- security systems to prevent unauthorised access
- records of all incidents, near-misses, changes to procedures, abnormal events and findings of maintenance inspections and procedures to learn from such incidents
- personnel suitably trained in accident management
- guidance for specific accident scenarios
- procedures to ensure good communication among operations staff during shift changes and maintenance or other engineering work
- safe shutdown procedures
- established communication routes with relevant authorities and emergency services

Areas where flammable organic solvents and organic solvent containing materials are handled or used should be suitably contained to minimise the potential spread for fire.

Operations working at above 25% of the organic solvent LEL must be controlled using suitable monitoring and control devices.

The autoignition temperature should not be exceeded in any organic solvent containing section of the process, with the exception of the combustion chamber of any thermal abatement plant.

Electrical zoning and static protection should be provided in all areas where flammable organic solvents are stored used or handled.

Controlled shutdown procedures should be in place for dealing with emergency such as organic solvent levels entering the combustion plant at greater than 25% LEL.

The storage, handling and use of flammable materials should be undertaken so as to prevent accidents and limit their consequences.
Preventative measures

- procedures to ensure that the composition of the contents of a bund / sump is checked before treatment or disposal
- drainage sumps equipped with a high-level alarm with automatic pump to storage (not to discharge)
- high-level alarms etc. (which should not be routinely used as the primary method of level control)
- adequate redundancy or standby plant with maintenance and testing to the same standards as the main plant
- sufficient storage to contain process waters, site drainage waters, emergency firewater, chemically contaminated waters and spillages of chemicals, which should be routed where necessary, having regard to a site-specific assessment of risks, to the effluent system
- provision to contain surges and storm-water flows, which should be treated where necessary, having regard to a site-specific assessment of risks, before emission to controlled waters or sewer
- spill contingency procedures to minimise the risk of accidental emission of raw materials, products and waste materials and to prevent their entry into water
- suitable barriers to prevent damage to equipment from the movement of vehicles, as appropriate, having regard to a site-specific assessment of risks
- where indicated by the site-specific assessment of risks, containment or abatement for accidental emissions from vents and safety relief valves/bursting discs should be provided. Where this may be inadvisable on safety grounds, attention should be focused on reducing the probability of the emission

Noise and Vibration

3.228 Within this section, “noise” should be taken to refer to noise and/or vibration as appropriate, detectable beyond the site boundary.

3.229 Further guidance can be found in chapter 16 of the General Guidance Manual.

3.230 Noise surveys, measurement, investigation (which can involve detailed assessment of sound power levels for individual items of plant) or modelling may be necessary for either new or existing installations depending upon the potential for noise problems. Operators may have a noise management plan as part of their management system. Where an installation poses no risk of noise related environmental impact because the activities undertaken are inherently quiet or remote from receptors, these measures would not normally be required.

3.231 Extract fans and ductwork may give rise to emissions of noise and vibration as a result of resonance, vibration or other mechanical noise.

BAT

247 The operator should employ basic good practice measures for the control of noise, in particular:
- identification of key plant and equipment with the potential to give rise to noise nuisance
- documented maintenance systems for the identified key plant and equipment

248 Where noise problems do occur as a result of fan and ductwork acoustics, housings and / or silencers should be used.
Monitoring

3.232 This section describes general monitoring and reporting provisions for emissions to all environmental media. Guidance is provided for the selection of the appropriate monitoring methodologies, frequency of monitoring, compliance assessment criteria and environmental monitoring. The specific monitoring provisions with respect to emissions to air are described in Table 4 and Table 5.

Standards for monitoring equipment and procedures

3.233 The Environment Agency has introduced its Monitoring Certification Scheme (MCERTS) to improve the quality of monitoring data and to ensure that the instrumentation and methodologies employed for monitoring are fit for purpose.

• operators should ensure their monitoring arrangements comply with the provisions of MCERTS where available, e.g. using certified instruments and equipment, and using a registered stack testing organisation etc.

See http://www.environment-agency.gov.uk for listing of MCERTS equipment.

Sampling and analysis standards

3.234 The analytical methods given in Table 4 and Table 5 and Appendix 1 should normally be used. In the event of other substances needing to be monitored, standards should normally be used in the following order of priority:

• Comité Européen de Normalisation (CEN)
• International Standardisation Organisation (ISO)
• British Standards Institution (BSI)
• United States Environmental Protection Agency (US EPA)
• American Society for Testing and Materials (ASTM)
• Deutsches Institut für Normung (DIN)
• Verein Deutcher Ingenieure (VDI)
• Association Française de Normalisation (AFNOR)

3.235 Further guidance on standards for monitoring gaseous releases relevant to IPPC is given in the Technical Guidance Note M4 (Monitoring) (Ref 19). A series of updated Guidance Notes covering this subject is currently in preparation. This guidance specifies manual methods of sampling and analysis, which will also be suitable for calibration of continuous emission monitoring instruments. Further guidance relevant to water and waste is available from the publications of the Standing Committee of Analysts. See http://dwi.gov.uk/regs/pdf/scabb202.pdf

3.236 If in doubt the operator should consult the regulator.

Monitoring and sampling protocols

3.237 Where monitoring is needed the operator should address the following:

• determinands to be monitored
• monitoring strategy and selection of monitoring points
• monitoring methods and procedures (selection of Standard Reference Methods)
• reference conditions and averaging periods
• measurement uncertainty of the proposed methods and the resultant overall uncertainty
• drift correction
• quality assurance (QA) and quality control (QC) protocols, equipment calibration and maintenance, sample storage and chain of custody/audit trail
• reporting procedures, data storage, interpretation and review of results, reporting format for the provision of information to the Regulator
• the accreditation held by samplers and laboratories or details of the people used and the training/competencies
Monitoring frequency

3.238 The frequency of testing should be increased, for example, as part of the commissioning of new or substantially changed activities, or where the emission levels are near to or approach the emission limit.

3.239 Emission flow rates must be consistent with good operating practice and meeting the requirements of the legislation relating to workplace safety.

3.240 Where non-continuous quantitative monitoring is required, the frequency may be varied. Where there is consistent compliance with emission limits, regulators may consider reducing the frequency. When determining ‘consistent compliance’ factors to consider include:

- the variability of monitoring results, for example, results which range from 15 - 45 mg/m³, against an emission limit of 50 mg/m³ might not qualify for a reduction in monitoring
- the margin between the results and the emission limit, for example, results which range from 45 - 50 mg/m³ when the limit is 50 mg/m³ might not qualify for a reduction in monitoring

3.241 Consistent compliance should be demonstrated using the results from at least three or more monitoring exercises within two years, or two or more monitoring exercises in one year supported by continuous monitoring. Any significant process changes which might have affected the results should be taken into account.

3.242 Where effective surrogates are available they may be used to minimise monitoring costs.

3.243 Where monitoring shows that substances are not emitted in significant quantities, consideration can be given to a reduced monitoring frequency.

Monitoring emissions to air

3.244 *The reference conditions of substances in releases to air from point sources are: temperature 273.15 K (0°C), pressure 101.3 kPa (1 atmosphere), measured wet, no correction for water vapour.* To convert measured values to reference conditions, see Technical Guidance Note M2 (Ref 19) for more information.

Monitoring emissions to water

3.245 The appropriateness of the emission benchmarks in Section 2 will vary depending upon the sensitivity of the receiving water and should be proportionate to the scale of the operations, nature of the discharge and receiving water. For each release point the following information is required:

- the specific volume flow from the process to sewer/controlled water
- the quality of the receiving water
- the volume of discharge compared to the percentage dry river flow of the receiving water

Environmental monitoring (beyond installation)

3.246 Environmental monitoring may be required, for example, when:

- there are vulnerable receptors
- the emissions are a significant contributor to an Environmental Quality Standard (EQS) which may be at risk
- the operator is looking for departures from standards based on lack of effect on the environment
- the operator is required to validate modelling work

Monitoring of process variables

3.248 Some process variables will have potential environmental impact and these should be identified and monitored where it has an environmental relevance. For the surface treatment activities examples of monitoring these variables include:

- keeping inventories of materials used and disposed of particularly organic solvents
- monitoring of contaminants in raw materials where contaminants are likely and there is inadequate supplier information
- monitoring temperature, pressure and flammability where relevant, example explosive limits on dryers
- plant efficiency monitoring, for example solvent reclamation plant efficiency

3.249 Construction of inventories of materials used and disposed of may involve the identification of individual organic solvents, or solids. This may give rise to an issue of commercial confidentiality. Information supplied must be placed on the public register, unless exclusion has been granted on the grounds of commercial confidentiality or national security.

### BAT

#### Monitoring and reporting

249 The need for and scope of testing and the frequency and time of sampling depend on local circumstances, operational practice, and the scale of operation. As part of proper supervision the operator should monitor emissions, make tests and inspections of the process and keep records, in particular the operator should keep records of audits, inspections, tests and monitoring, including all non-continuous monitoring, inspections and visual assessments. Monitoring may include process variables and operating conditions where relevant to emissions. In such cases:

- current records should be kept on site and be made available for the regulator to examine
- records should be kept by the operator for at least two years

250 The regulator needs to be informed of monitoring to be carried out and the results. The results should include process conditions at the time of monitoring.

251 The operator should notify the regulator at least 7 days before any periodic monitoring exercise to determine compliance with emission limit values. The operator should state the provisional time and date of monitoring, pollutants to be tested and the methods to be used

252 The results of non-continuous emission testing should be forwarded to the regulator within 8 weeks of the completion of the sampling.

253 Adverse results from any monitoring activity (both continuous and non-continuous) should be investigated immediately. The operator should ensure that:

- the cause has been identified and corrective action taken
- as much detail as possible is recorded regarding the cause and extent of the problem and the action taken to rectify the situation
- re-testing to demonstrate compliance is carried out as soon as possible, and
- the regulator is notified

254 The regulator needs to be notified about certain events and expects the operator to respond to problems which may have an effect on emissions to air. Such problems may arise within the process itself or with the abatement plant, for example.
In the case of abnormal emissions, malfunction or breakdown leading to abnormal emissions:

- investigation and remedial action should be undertaken immediately
- the process or activity should be adjusted to minimise those emissions; and
- the events and actions taken should be promptly recorded
- in the case of non-compliance causing immediate danger to human health, operation of the activity should be suspended

The regulator should be informed without delay:

- if there is an emission that is likely to have an effect on the local community; or
- in the event of the failure of key abatement plant, for example, bag filtration plant or scrubber units
- if continuous monitoring shows an emission concentration exceeding double the limit value

Care is needed in the design and location of sampling systems in order to obtain representative samples for all release points.

- sampling points on new plant should be designed to comply with the British or equivalent standards. e.g. BS ISO 9096: 2003, BS EN 13284-1 or BS ISO 12141:2002 for sampling particulate matter in stacks
- the operator should ensure that adequate facilities for sampling are provided on stacks or ducts
- where monitoring is not in accordance with the main procedural requirements of the relevant standard, deviations should be reported as well as an estimation of any error invoked

Continuous monitoring is normally expected for the main abated releases identified in Section 2. Where continuous monitoring is required by the permit it should be carried out as follows:

- all continuous monitoring readings should be on display to appropriately trained operating staff
- instruments should be fitted with audible and visual alarms, situated appropriately to warn the operator of arrestment plant failure or malfunction
- the activation of alarms should be automatically recorded
- all continuous monitors should be operated, maintained and calibrated (or referenced) in accordance with the manufacturers' instructions, which should be made available for inspection by the regulator. The relevant maintenance and calibration (or referencing) should be recorded
- all new continuous monitoring equipment should be designed for less than 5% downtime over any 3-month period

Monitoring and reporting of emissions to air

Exhaust flow rates of waste gases should be consistent with the efficient capture of emissions, good operating practice and meeting the requirements of the legislation relating to the workplace environment.

The introduction of dilution air to achieve emission concentration limits should not be permitted.

Dilution air may be added for waste gas cooling or improved dispersion where justified, but this should not be considered when determining the mass or concentration of the pollutant in the waste gases.

Periodic visual assessment of releases should be undertaken as required by the regulator to ensure that all final releases are colourless, free from persistent visible emissions and free from droplets.
263 Calibration and compliance monitoring should meet the following provisions as appropriate. No result should exceed the emission concentration limits specified, except where either:
(a) data is obtained over at least 5 sampling hours in increments of 15 minutes or less; or
(b) at least 20 results are obtained where sampling time increments of more than 15 minute are involved; AND in the case of (a) or (b)
(c) no daily mean of all 15-minute mean emission concentrations should exceed the specified emission concentration limits during normal operation (excluding start-up and shut-down); and
(d) no 15-minute mean emission concentration should exceed twice the specified emission concentration limits during normal operation (excluding start-up and shut-down).

264 Where continuous quantitative monitoring is undertaken, compliance with (c) and (d) above should be demonstrated on a daily basis.

265 For unabated releases of VOC calibration and compliance monitoring must meet the following provisions as appropriate: No result should exceed the emission concentration limits specified, except where:
- the average of all the emission readings taken during the periodic measurements does not exceed the emission limit
- none of the hourly averages of the emission readings exceed the emission limit by a factor of more than 1.5

266 No result should exceed the emission concentration limits specified.

267 Where continuous monitoring and recording is required to demonstrate compliance with the VOC provisions of the note.

268 Thermal oxidisers must have monitoring and recording for VOC expressed as total carbon excluding particulate matter. After sufficient monitoring data has been collected to clearly demonstrate adequate VOC destruction continuous monitoring of temperature and oxygen or temperature and carbon monoxide may be used as a surrogate measurement.

269 Catalytic oxidisers must have monitoring and recording for VOC expressed as total carbon excluding particulate matter. After sufficient monitoring data has been collected to clearly demonstrate adequate VOC destruction continuous monitoring of carbon monoxide and temperature may be used as a surrogate measurement.

270 Bio scrubbers and reactors must have monitoring and recording for VOC expressed as total carbon excluding particulate matter. After sufficient monitoring data has been collected to clearly demonstrate adequate VOC destruction continuous monitoring of the flow and pH of the re-circulating water, fan suction, exhaust temperature and pressure drop across the packing, coupled with daily monitoring of the nutrient may be used as a surrogate measurement.

271 Turbines, reciprocating engines, boilers or any other form of VOC abatement equipment must have continuous monitoring and recording for VOC expressed as total carbon excluding particulate matter.

272 Where abatement equipment is required to comply with the particulate matter provisions of the note.
- then the particulate matter emissions should be continuously monitored to indicate performance of the abatement plant (using techniques such as differential pressure across filter, water flow on wet backed booths, in duct/across duct particulate monitor)
Monitoring and reporting emissions to water and sewer

273 The appropriateness of the monitoring provisions will vary depending upon the sensitivity of the receiving water and should be proportionate to the scale of the operations, nature of the discharge and receiving water. For each release point the following information is required:
  • the specific volume flow from the process to sewer/controlled water
  • the quality of the receiving water
  • the volume of discharge compared to the percentage dry river flow of the receiving water

274 Increased monitoring should be carried out where substances to which the local environment may be susceptible could be released from the installation, e.g. where releases of common pesticides or heavy metals may occur.

275 A full analysis, to include the substances listed in Schedule 5 of the Regulations, should be carried out annually on a representative sample from each release point, unless it is agreed with the regulator that this is inappropriate.

Monitoring and reporting of waste

276 The following should be monitored and recorded:
  • the physical and chemical composition of the waste
  • its hazard characteristics
  • handling precautions and substances with which it cannot be mixed

Monitoring of VOC

277 The definitions provided must be used in all calculations relating to the Solvent Management Plan (SMP) (Appendix 2).

278 For all installations, the SMP should be used to determine the solvent consumption annually (Appendix 2).

279 For all installations using the emission and fugitive limits, the SMP should be used for determining the fugitive emissions (Appendix 2). Once completed, it need not be repeated until the equipment is modified.

280 For all installations using the reduction scheme, the SMP should be used to determine the actual emissions annually (Appendix 2).

281 For all installations using the total emission limit value the SMP must be used to determine the Total Emission and the Solvent Input annually. In addition, the SMP should be used for determining the fugitive emissions (Appendix 2). Once completed, it need not be repeated until the equipment is modified.
References

Environment Agency documents referred to below are available from the Environment Agency website [http://www.environment-agency.gov.uk](http://www.environment-agency.gov.uk). Many of the references below are being made available free of charge for viewing or download on the website. The same information can also be accessed via the SEPA website [http://www.sepa.org.uk](http://www.sepa.org.uk), or the NIEHS website [www.ehsni.gov.uk](http://www.ehsni.gov.uk)


Ref 4 The Control of Pollution (Oil Storage) (England) Regulations 2001, SI 2954.


Ref 6 Management system references:
- ETBPP GG124: Solvent Management in Practice
- ETBPP GG 354: Surface Cleaning and Preparation: Choosing the Best Option
- ETBPP GG251: Environmental Management Systems for the Plastics Industry
- ETBPP GG114: Reduce Cost by Tracking Solvents
- ETBPP GG13: Cost Effective Solvent Management
- ETBPP GG28: Good Housekeeping Measures for Solvents
- ETBPP GG163: Cost Effective Ink Management for Printers
- ETBPP GG231: Cost effective Management of Cleaning Materials for Printers
- ETBPP GG60: Practical Measures to Save Money in Screen Printing
- ETBPP GG143: Practical Measures to Save Money in Screen Cleaning and Reclamation
- ETBPP GG52: Cost Effective Paint and Powder Coating: Coating Materials

Ref 7 Releases to air references:
- ETBPP GG71: Cost Effective Reduction of Fugitive Solvent Emissions
- ETBPP GG203: Monitoring VOC Emissions Choosing the Best Option
- ETBPP GC34: Emission -Free Mixing Creates A Stir
- ETBPP GG12: Solvent Capture for Recovery and Re-use for Solvent Laden Gas Streams
- ETBPP FP9: Efficient Emission Free Mixing
- ETBPP GG100: Solvent Capture and Recovery In Practice

Ref 8 Code of practice for the use of solvents (draft) Defra

Ref 9 HSE HS(G) 51, The storage of flammable liquid containers (1990)

Ref 10 HSE HS(G) 140, The safe use and handling of flammable liquids (1996)

Ref 11 HSE HS(G) 176, Storage of flammable liquids in tanks (1998)

Ref 12 HSE HS(G) 52, The storage of flammable liquid in tanks (1990)


Ref 14 Water efficiency references:
- ETBPP, Simple measures restrict water costs, GC22
- ETBPP, Effluent costs eliminated by water treatment, GC24
- ETBPP, Saving money through waste minimisation: Reducing water use, GG26
- ETBPP (is now Envirowise) Helpline 0800 585794


Ref 16 HMIP Technical Guidance Note (Dispersion) D1, 1993 The Stationery Office ISBN 0 11 752794 7 (EA website)

Ref 17 BS 5908: Code of Practice for Fire Precautions in the Chemical and Allied Industries
Ref 18  *Environment Agency, Pollution Prevention Guidance Note* - Pollution prevention measures for the control of spillages and fire-fighting run-off, PPG 18, gives information on sizing firewater containment systems ([EA website](http://www.environment-agency.gov.uk/epns))

Ref 19 Monitoring Guidance ([EA website](http://www.environment-agency.gov.uk/epns))

- M1 *Sampling requirements for monitoring stack emissions to air from industrial installations*, Environment Agency July 2002
- M2 *Monitoring of stack emissions to air*, Environment Agency November 2002
- MCERTS approved equipment link via [http://www.environment-agency.gov.uk/epns](http://www.environment-agency.gov.uk/epns) "Guidance for Business and Industry"

Ref 20 "*Policy and Practice for the Protection of Groundwater*" (PPPG) ([EA website](http://www.environment-agency.gov.uk/epns))
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAT</td>
<td>Best Available Techniques – see IPPC General Guidance Manual or the Regulations for further definition</td>
</tr>
<tr>
<td>BOD</td>
<td>Biochemical Oxygen Demand</td>
</tr>
<tr>
<td>BREF</td>
<td>BAT Reference Document</td>
</tr>
<tr>
<td>CCA</td>
<td>Climate Change Agreement</td>
</tr>
<tr>
<td>CEM</td>
<td>Continuous Emissions Monitoring</td>
</tr>
<tr>
<td>CHP</td>
<td>Combined Heat and Power plant</td>
</tr>
<tr>
<td>CO₂</td>
<td>Carbon Dioxide</td>
</tr>
<tr>
<td>COD</td>
<td>Chemical Oxygen Demand</td>
</tr>
<tr>
<td>DI</td>
<td>De-Ionised</td>
</tr>
<tr>
<td>DMF</td>
<td>Dimethylformamide</td>
</tr>
<tr>
<td>DPA</td>
<td>Direct Participation Agreement</td>
</tr>
<tr>
<td>DWI</td>
<td>Draw and Wall Iron</td>
</tr>
<tr>
<td>EA</td>
<td>Environment Agency</td>
</tr>
<tr>
<td>EAL</td>
<td>Environmental Assessment Level</td>
</tr>
<tr>
<td>ELV</td>
<td>Emission Limit Value</td>
</tr>
<tr>
<td>EMS</td>
<td>Environmental Management System</td>
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<tr>
<td>ETP</td>
<td>Effluent Treatment Plant</td>
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<tr>
<td>EU</td>
<td>European Union</td>
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<tr>
<td>EQS</td>
<td>Environmental Quality Standard</td>
</tr>
<tr>
<td>HCl</td>
<td>Hydrogen Chloride</td>
</tr>
<tr>
<td>HSE</td>
<td>Health and Safety Executive</td>
</tr>
<tr>
<td>IBC</td>
<td>Intermediate Bulk Container</td>
</tr>
<tr>
<td>IEC</td>
<td>Inrenational Electrotechnical Commission</td>
</tr>
<tr>
<td>IPA</td>
<td>Iso-propyl alcohol</td>
</tr>
<tr>
<td>IR</td>
<td>Infra Red</td>
</tr>
<tr>
<td>ITEQ</td>
<td>International Toxicity Equivalents</td>
</tr>
<tr>
<td>LEL</td>
<td>Lower Explosive Limit</td>
</tr>
<tr>
<td>LFL</td>
<td>Lower Flammability Limit</td>
</tr>
<tr>
<td>MCERTS</td>
<td>Monitoring Certification Scheme</td>
</tr>
<tr>
<td>NIEHS</td>
<td>Northern Ireland Environment and Heritage Service</td>
</tr>
<tr>
<td>NOx</td>
<td>Nitrogen Oxide</td>
</tr>
<tr>
<td>PET</td>
<td>Polyethylene Terephthalate</td>
</tr>
<tr>
<td>PVC</td>
<td>Poly Vinyl Chloride</td>
</tr>
<tr>
<td>QA</td>
<td>Quality Assured</td>
</tr>
<tr>
<td>QC</td>
<td>Quality Control</td>
</tr>
<tr>
<td>SAC</td>
<td>Special Areas of Conservation</td>
</tr>
<tr>
<td>SECP</td>
<td>Specific Energy Consumption</td>
</tr>
<tr>
<td>SED</td>
<td>Solvent Emissions Directive 1999/13/EC</td>
</tr>
<tr>
<td>SEPA</td>
<td>Scottish Environment Protection Agency</td>
</tr>
<tr>
<td>SMP</td>
<td>Solvent Management Plan</td>
</tr>
<tr>
<td>SOx</td>
<td>Sulphur Oxide</td>
</tr>
<tr>
<td>SPA</td>
<td>Special Protection Area</td>
</tr>
<tr>
<td>TBT</td>
<td>Tri Butyl Tin</td>
</tr>
<tr>
<td>TSS</td>
<td>Total Suspended Solids</td>
</tr>
<tr>
<td>TOC</td>
<td>Total Organic Carbon</td>
</tr>
<tr>
<td>UV</td>
<td>Ultra Violet</td>
</tr>
<tr>
<td>VOC</td>
<td>Volatile Organic Compounds</td>
</tr>
<tr>
<td>VSD</td>
<td>Variable Speed Drive</td>
</tr>
<tr>
<td>CEPE</td>
<td>Consul Europeen de l’industrie Peinture des Encres d’imprimerie et des Couleurs d’Art</td>
</tr>
</tbody>
</table>
Definitions

**Adhesive** shall mean any preparation, including all the organic solvents or preparations containing organic solvents necessary for its proper application, which is used to adhere separate parts of a product;

**Application of continuous film of coating** shall mean the application of a film of coating to the surface of a substrate, by continuous methods such as dipping, spraying, air knife coating, application by roller etc, where no repeated pattern of breaks in the coating occur.

**Coating** shall mean any preparation, including all the organic solvents or preparations containing organic solvents necessary for its proper application, which is used to provide a decorative, protective or other functional effect on a surface;

**Coating activity** shall mean coating activity in which a single or multiple application of continuous film of a coating is applied. If the coating activity includes a step in which the same article is printed by whatever technique is used, that printing step is considered part of the coating activity.

**Contained conditions** shall mean conditions under which an installation is operated such that the VOC released from the activity are collected and discharged in a controlled way either via a stack or abatement equipment and are therefore not entirely fugitive.

**Food contact** shall mean a coating which needs to comply with the requirements of the food safety legislation (the materials and articles in contact with food regulations) and is applied to packaging for food which may be consumed by humans or animals.

**Fugitive VOC emissions** shall mean any emissions not in waste gases of VOC into air, soil and water as well as, unless otherwise stated in Annex IIA of the SED, solvents contained in any products. They include uncaptured emissions released to the outside environment via windows, doors, vents and similar openings;

**Halogenated organic solvent** shall mean an organic solvent which contains at least one atom of bromine, chlorine, fluoride or iodine. per molecule

**Ink** shall mean a preparation, including all the organic solvents or preparations containing organic solvents necessary for its proper application, which is used in a printing activity to impress text or images on to a surface;

**Input** shall mean the quantity of organic solvents and their quantity in preparations used when carrying out an activity, including the solvents recycled inside and outside the installation, and which are counted every time they are used to carry out the activity;

**Installation** shall have the same meaning as in the General Guidance Manual.

**Organic solvent** shall mean any VOC which is used alone or in combination with other agents, and without undergoing a chemical change, to dissolve raw materials, products or waste materials, or is used as a cleaning agent to dissolve contaminants, or as a dissolver, or as a dispersion medium, or as a viscosity adjuster, or as a surface tension adjuster, or a plasticiser, or as a preservative.

**Organic compound** shall mean any compound containing at least the element carbon and one or more of hydrogen, halogens, oxygen, sulphur, phosphorus, silicon or nitrogen, with the exception of carbon oxides and inorganic carbonates and bicarbonates;

**Oxidation** shall mean either thermal oxidation or catalytic oxidation

**Oxidation plant** means thermal or catalytic incineration plant

**Preparation** shall mean mixtures or solutions composed of two or more substances;

**Printing activity** shall mean any reproduction activity of text and/or images in which, with the use of an image carrier, ink is transferred onto whatever type of surface. Associated varnishing, coating, laminating techniques and cleaning of the equipment are included as part of the activity.
**Reuse of organic solvents** shall mean the use of organic solvents recovered from an installation for any technical or commercial purpose and including use as a fuel but excluding the final disposal of such recovered organic solvent as waste.

**Risk Phrase** shall mean the same as in Directive 67/548/EEC:
- R40 - limited evidence of a carcinogenic effect
- R45 - may cause cancer
- R46 - may cause heritable genetic damage
- R49 - may cause cancer by inhalation
- R60 - may impair fertility
- R61 - may cause harm to the unborn child

**Shortest possible time** shall have the same meaning as in DEFRA Guidance on the Implementation of Solvent Emissions Directive (1999/13/EC) March 2002

**Start-up and shutdown operations** shall mean operations whilst bringing an activity, an equipment item or a tank into or out of service or into or out of an idling state. Regularly oscillating activity phases are not to be considered as start-ups and shut-downs

**Site boundary** shall have the same meaning as GG4

**Standard conditions** shall mean a temperature of 273.15 K and a pressure of 101.3 kPa;

**Substances** shall mean any chemical element and its compounds, as they occur in the natural state or as produced by industry, whether in solid or liquid or gaseous form;

**Surface Cleaning** shall mean any activity except dry cleaning using organic solvents to remove contamination from the surface of material including degreasing

**Technically connected** shall have the same meaning as in Integrated Pollution Prevention and Control, A Practical Guide (Pages 69-71)

**Varnish** shall mean a transparent coating;

**Volatile Organic Compound (VOC)** shall mean any organic compound having at 293.15 K a vapour pressure of 0.01 kPa or more, or having a corresponding volatility under the particular conditions of use. For the purpose of the Solvents Directive, the fraction of creosote which exceeds this value of vapour pressure at 293.15 K shall be considered as a VOC;

**VOC total emissions** shall mean the sum of fugitive emissions and emissions in waste gases;

**VOC waste gases** shall mean the final gaseous discharge containing VOC or other pollutants, from a stack or abatement equipment into air. The volumetric flow rates shall be expressed in Nm3/h at standard conditions.
## Appendix 1: Some common monitoring and sampling methods

### Table 12: Measurement methods for common substances to water

<table>
<thead>
<tr>
<th>Determinand</th>
<th>Method</th>
<th>Detection limit uncertainty</th>
<th>Valid range mg/l</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspended solids</td>
<td>Filtration through glass fibre filters</td>
<td>1 mg/l 20%</td>
<td>10 - 40</td>
<td>ISO 11929:1997 EN872 Determination of suspended solids</td>
</tr>
<tr>
<td>COD</td>
<td>Oxidation with di-chromate</td>
<td>12 mg/l 20%</td>
<td>50 - 400</td>
<td>ISO 6060: 1989 Water Quality Determination of chemical oxygen demand</td>
</tr>
<tr>
<td>BODs</td>
<td>Seeding with microorganisms and measurement of oxygen content</td>
<td>2 mg/l 20%</td>
<td>5 - 30</td>
<td>ISO 5815: 1989 Water Quality Determination of BOD after 5 days, dilution and seeding method EN 1899 (BOD 2Parts)</td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td></td>
<td></td>
<td>SCA The measurement of electric conductivity and the determination of pH ISBN 0117514284</td>
</tr>
<tr>
<td>Flow rate</td>
<td>Mechanical ultrasonic or electromagnetic gauges</td>
<td></td>
<td></td>
<td>SCA Estimation of Flow and Load ISBN 011752364X</td>
</tr>
<tr>
<td>Metals</td>
<td></td>
<td></td>
<td></td>
<td>BS 6068: Section 2.60 1998 - Determination of 33 elements by inductively coupled plasma atomic emission spectroscopy</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td></td>
<td></td>
<td></td>
<td>SCA The determination of formaldehyde, other volatile aldehydes and alcohols in water</td>
</tr>
<tr>
<td>Ammonia</td>
<td></td>
<td></td>
<td></td>
<td>BS 6068: Section 2.11 1987 - Method for the determination of ammonium: automated spectrometric method</td>
</tr>
<tr>
<td>Grease and oils</td>
<td>IR absorption</td>
<td>0.06 mg/kg</td>
<td></td>
<td>SCA The determination of hydrocarbon oils in waters by solvent extraction IR absorption and gravimetry ISBN 011751 7283</td>
</tr>
</tbody>
</table>
Table 13: Measurement methods for air emissions

<table>
<thead>
<tr>
<th>Determinand</th>
<th>Method</th>
<th>Averaging time</th>
<th>Compliance criterion</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOC</td>
<td>Stationary source emissions - Determination of the mass concentration of total gaseous organic carbon in flue gases from solvent using processes - Continuous flame ionisation detector method. EN 13526</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VOC speciated</td>
<td>Stationary source emissions - Determination of mass concentration of individual gaseous organic compounds EN 13649</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrogen dioxide</td>
<td>In accordance with ISO10849</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>In accordance with ISO12039</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isocyanates</td>
<td>In accordance with HSE occupational method MDHS 25/3 or Draft US EPA method 207-1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxides of sulphur</td>
<td>UV fluorescence automatic analyser</td>
<td>1 hour</td>
<td>95% of hourly averages over a year below specified limit</td>
<td>ISO 7935 (BS6069 Section 4.4) Stationary source emissions-determination of mass concentrations of sulphur dioxide CEN Standard in preparation.</td>
</tr>
<tr>
<td></td>
<td>Wet sampling train ion chromatography</td>
<td>1 hour</td>
<td>Two samples taken. Each result below limit after subtraction of measurement uncertainty</td>
<td>ISO 7935 (BS6069 Section 4.1) Method for the determination of the mass concentration of sulphur dioxide-hydrogen peroxide/barium perchlorate method.</td>
</tr>
</tbody>
</table>

Appendix 2: VOC compliance methods

Solvent Management Plan

Definitions:

The following definitions provide a framework for the mass balance calculations used in determining compliance with the requirements of the Solvent Management Plan and the Reduction Scheme.

Inputs of Organic Solvent in the time frame over which the mass balance is being calculated (I)

I1 The quantity of organic solvents, or their quantity in preparations purchased which are used as input into the process/activity (including cleaning solvents).

I2 The quantity of organic solvents or their quantity in preparations recovered and reused as solvent input into the process/activity. (The recycled solvent is counted every time it is used to carry out the activity.)

Outputs of Organic Solvents in the time frame over which the mass balance is being calculated (O)

O1 Emissions in waste gases

O2 Organic solvents lost in water, if appropriate taking into account waste water treatment when calculating O5

O3 The quantity of organic solvents which remains as contamination or residue in products output from the process/activity.

O4 Uncaptured emissions of organic solvents to air. This includes the general ventilation of rooms, where air is released to the outside environment via windows, doors, vents and similar openings.

O5 Organic solvents and/or organic compounds lost due to chemical or physical reactions. (Including for example those which are destroyed, e.g. by thermal oxidation or other waste gas or waste water treatments, or captured, e.g. by adsorption, as long as they are not counted under O6, O7 or O8).

O6 Organic solvents contained in collected waste.

O7 Organic solvents, or organic solvents contained in preparations, which are sold or are intended to be sold as a commercially valuable product.

O8 Organic solvents contained in preparations ‘recovered for reuse but not as input into the process/activity, as long as not counted under O7.

O9 Organic solvents released in other ways.
Figure 3.14: Solvent management plan

Solvent Management Plan

Consumption = I1 - O8
Actual solvent emission = I1 - O5 - O6 - O7 - O8
Fugitive emission (F) = I1 - O1 - O5 - O6 - O7 - O8
OR
Fugitive emission (F) = O2 + O3 + O4 + O9

Solvent Emissions Directive Activities
Fugitive Emission Value = \[
\frac{F}{I1 + I2} \times 100\%
\]
Total emission = O1 + Fugitive emission (F)
Determination of Consumption

Consumption (C): means the total input of organic solvents into an installation in the last calendar year, or previous 12-month period (I1), less any VOC that are recovered for reuse (O8).

The total mass of Solvent Inputs and Outputs must be determined and submitted to the regulator annually, preferably to coincide with the operators stocktaking requirements, in the form of a mass balance in order to determine the annual actual consumption of solvent.

Where: \( C = I1 - O8 \)

\( I1 \) Total quantity of organic solvents, or their quantity in preparations purchased which are used as input into the process/activity

A calculation of the purchased Solvent Input (I1) to the process/activity, is carried out by recording:

The mass of solvent contained in inks, coatings, diluents and cleaners in the initial stock (IS) at the start of the accounting period, plus

The mass of solvent contained in inks, coatings, diluents and cleaners in the purchased stock (PS) during the accounting period.

Minus The mass of solvent contained in inks, coatings, diluents and cleaners in the final stock (FS) at the end of the accounting period.

\( \text{Total Solvent Input (I1)} = IS + PS - FS \)

Determination fugitive VOC emissions

To demonstrate compliance with fugitive emission values in Section 2 the operator must determine the fugitive emissions (F) from the installation using the following:

\( F = I1 - O1 - O5 - O6 - O7 - O8 \)

or

\( F = O2 + O3 + O4 + O9 \)

This quantity can be determined by direct measurement of the quantities. Alternatively, an equivalent calculation can be made by other means, for instance by using the capture efficiency of the process.

The Fugitive Emission value as a percentage of the Solvent Input (I) is determined by

\( \text{Fugitive Emission Value} = 100 \times \frac{F}{I} \)

Where the Solvent Input (I) = I1 + I2 (determined as part of the Solvent Management Plan)

Fugitive emission values must be determined for each installation, once completed, it need not be repeated until the equipment is modified.
Determination of compliance with the Reduction Scheme

Compliance with Reduction Scheme is achieved if the annual actual solvent emission is less than or equal to the Target Emission.

Where the annual actual solvent emission is:

\[ \text{annual actual solvent emission} = I1-O8-O7-O6 (-O5 \text{ if abatement has been used}) \]

(see Definitions above)

Where a coating activity includes both food and non-food contact coating, compliance with the reduction scheme should be determined for each operation separately. Compliance is achieved if the annual actual solvent emission for both the food contact and the non-food contact coating is less than or equal to the sum of the individual target emissions for food contact and non-food contact coating.

The solids content of coating inks etc. should be determined in accordance with ISO method ISO-3251:1993(E)

Determination of compliance with the Total Emission Limit Values

Compliance is achieved if the Total Emission from the activity expressed in solvent emissions per unit of product, or otherwise as stated is equal to or less than the Total Emission Limit Value,

Where Total Emission is equal to the mass of solvent released in waste gases Plus the fugitive emissions determined above

\[ \text{Total Emission} = O1 + \text{Fugitive} \] (See above)
Appendix 3: Extract from Solvent Emissions Directive

Extracts from the Solvent Emissions Directive 1999/13/EC

Article 1  Purpose and scope

The purpose of this Directive is to prevent or reduce the direct and indirect effects of emissions of VOC into the environment, mainly into air, and the potential risks to human health, by providing measures and procedures to be implemented for the activities defined in Annex I, in so far as they are operated above the solvent consumption thresholds listed in Annex IIA.

Article 4  Obligations applying to existing installations

Without prejudice to Directive 96/61/EC, Member States shall adopt the necessary measures to ensure that:

1. existing installations comply with Articles 5, 8 and 9 no later than 31 October 2007;
2. all existing installations must have been registered or authorised by 31 October 2007 at the latest;
3. those installations to be authorised or registered using the reduction scheme of Annex IIB notify this to the competent authorities by 31 October 2005 at the latest;
4. where an installation:
   - undergoes a substantial change, or
   - comes within the scope of this Directive for the first time following a substantial change,
   that part of the installation which undergoes the substantial change shall be treated either as a new installation or as an existing installation, provided that the total emissions of the whole installation do not exceed those that would have resulted had the substantially changed part been treated as a new installation.

Article 5  Requirements

2. All installations shall comply with:

(a) either the emission limit values in waste gases and the fugitive emission values, or the total emission limit values, and other requirements laid down in Annex IIA;

or

(b) the requirements of the reduction scheme specified in Annex IIB.

For fugitive emissions, Member States shall apply fugitive emission values to installations as an emission limit value. However, where it is demonstrated to the satisfaction of the competent authority that for an individual installation this value is not technically and economically feasible, the competent authority can make an exception for such an individual installation provided that significant risks to human health or the environment are not to be expected. For each derogation, the operator must demonstrate to the satisfaction of the competent authority that the best available technique is being used;

Activities which cannot be operated under contained conditions may be exempted from the controls of Annex IIA, when this possibility is explicitly mentioned in that Annex. The reduction scheme of Annex IIB is then to be used, unless it is demonstrated to the satisfaction of the competent authority that this option is not technically and economically feasible. In this case, the operator must demonstrate to the satisfaction of the competent authority that the best available technique is being used.

Member States shall report to the Commission on the derogation concerning paragraphs (a) and (b) in accordance with Article 11.
4. For installations not using the reduction scheme, any abatement equipment installed after the date on which this Directive is brought into effect shall meet all the requirements of Annex IIA.

5. Installations where two or more activities are carried out, each of which exceeds the thresholds in Annex IIA shall:

(a) as regards the substances specified in paragraphs 6, 7 and 8, meet the requirements of those paragraphs for each activity individually;

(b) as regards all other substances, either:

(i) meet the requirements of paragraph 2 for each activity individually; or

(ii) have total emissions not exceeding those that would have resulted had point (i) been applied.

6. Substances or preparations which, because of their content of VOC classified as carcinogens, mutagens, or toxic to reproduction under Directive 67/548/EEC (1), are assigned or need to carry the risk phrases R45, R46, R49, R60, R61, shall be replaced, as far as possible and by taking into account the guidance as mentioned in Article 7(1), by less harmful substances or preparations within the shortest possible time.

7. For discharges of the VOC referred to in paragraph 6, where the mass flow of the sum of the compounds causing the labelling referred to in that paragraph is greater than, or equal to, 10 g/h, an emission limit value of 2 mg/Nm³ shall be complied with. The emission limit value refers to the mass sum of the individual compounds.

8. For discharges of halogenated VOC which are assigned the risk phrase R40, where the mass flow of the sum of the compounds causing the labelling R40 is greater than, or equal to, 100 g/h, an emission limit value of 20 mg/Nm³ shall be complied with. The emission limit value refers to the mass sum of the individual compounds.

The discharge of VOC referred to in paragraphs 6 and 8 shall be controlled as emissions from an installation under contained conditions as far as technically and economically feasible to safeguard public health and the environment.

9. Discharges of those VOC which, after the entry into force of this Directive, are assigned or need to carry one of the risk phrases mentioned in paragraphs 6 and 8, shall have to comply with the emission limit values mentioned in paragraphs 7 and 8 respectively, within the shortest possible time.

10. All appropriate precautions shall be taken to minimise emissions during start-up and shut-down.

11. Existing installations which operate existing abatement equipment and comply with the following emission limit values:

-50 mg C/Nm³ in the case of incineration,

-150 mg C/Nm³ in the case of any other abatement equipment,

shall be exempt from the waste gases emission limit values in the table in Annex IIA for a period of 12 years after the date referred to in Article 15, provided the total emissions of the whole installation do not exceed those that would have resulted had all the requirements of the table been met.

12. Neither the reduction scheme nor the application of paragraph 11 nor Article 6 exempt installations discharging substances specified in paragraphs 6, 7 and 8 from fulfilling the requirements of those paragraphs.

Article 8 Monitoring

1. In the other cases, Member States shall ensure that either continuous or periodic measurements are carried out. For periodic measurements at least three readings shall be obtained during each measurement exercise.
Article 9 Compliance with emission limit values

1. Compliance with the following shall be demonstrated to the satisfaction of the competent authority:

- emission limit values in waste gases, fugitive emission values and total emission limit values,
- the requirements of the reduction scheme under Annex IIB,
- the provisions of Article 5(3).

Guidance is provided in Annex III on solvent management plans serving to demonstrate compliance with these parameters.

Gas volumes may be added to the waste gas for cooling or dilution purposes where technically justified but shall not be considered when determining the mass concentration of the pollutant in the waste gas.

2. Following a substantial change, compliance shall be reverified.

3. In the case of continuous measurements the emission limit values shall be considered to be complied with if:

(a) none of the averages over 24 hours of normal operation exceeds the emission limit values, and
(b) none of the hourly averages exceeds the emission limit values by more than a factor of 1.5.

4. In the case of periodic measurements the emission limit values shall be considered to be complied with if, in one monitoring exercise:

(a) the average of all the readings does not exceed the emission limit values, and
(b) none of the hourly averages exceeds the emission limit value by more than a factor of 1.5.

5. Compliance with the provisions of Article 5(7) and (8) shall be verified on the basis of the sum of the mass concentrations of the individual VOC concerned. For all other cases, compliance shall be verified on the basis of the total mass of organic carbon emitted unless otherwise specified in Annex IIA.

Article 10 Non-compliance

Member States shall take appropriate measures to ensure that, if it is found that the requirements of this Directive have been breached:

(a) the operator informs the competent authority and takes measures to ensure that compliance is restored within the shortest possible time;

in cases of non-compliance causing immediate danger to human health and as long as compliance is not restored under the conditions of paragraph (a), operation of the activity is suspended.