INTERGRAF

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BAT IN HEATSET: PRACTICAL AND LEGAL GUIDANCE

GUIDANCE DOCUMENT

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Disclaimer

Intergraf, the authors and editors have done everything reasonably possible to avoid mistakes and to ensure that the recommendations in this Intergraf Guidance to BAT in Heatset are correctly based upon the legal texts, commonly accepted interpretation of the legal texts and the most recent version of the applicable BAT Reference Documents. The reader is however reminded that the text of the Industrial Emissions Directive and the Commission Implementing Decision (EU) 2020/2009 are the only authentic legal references. Neither Intergraf nor the authors or editors are in any way liable for any incorrectness or incompleteness in this Intergraf Guidance to BAT in Heatset.

FOREWORD

Intergraf, the European trade association representing the graphical sector, has been actively involved in the Industrial Emissions Directive (IED) and its revisions. We have worked with the European Commission to ensure that any new measures are compatible with our industry.

The Industrial Emissions Directive is the EU instrument regulating emissions from industrial installations. The aim of the Directive is to regulate emissions through better application of Best Available Techniques (BAT). Around 50,000 installations are covered by the scope of the Directive, including printing plants consuming more than 200 tonnes of solvents per year - e.g. large heatset printers, flexography printers and gravure printers. These installations are required to operate in accordance with a permit granted by national authorities. These permits should follow the operating conditions and emission limit values as set in the Commission Implementing Decisions establishing BAT conclusions, which are extracted from the BAT Reference Documents, i.e. BREFs. The printing sector is covered by the Surface Treatment using organic Solvents (STS BREF).

Intergraf actively participated in the revision of the STS BREF from 2015 until 2020. The Commission Implementing Decision establishing BATs relevant for the printing industry was adopted in 2020 and will be applicable in 2024.

We have prepared this detailed guidance document to support printing companies in the compliance with the new permit conditions and also support authorities with the implementation of the new requirements for the heatset sector.

We are grateful to the author, Paul Verspoor, as well as to Intergraf member associations and companies who contributed to this work.

Beatrice

Beatrice Klose
Secretary General of Intergraf

GUIDANCE TO

Commission Implementing Decision (EU) 2020/2009

establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions, for surface treatment using organic solvents including preservation of wood and wood products with chemicals

BAT IN HEATSET

PART 1: PRACTICAL GUIDANCE

PART 2: LEGAL TEXT AND EXPLANATIONS

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PART 1
PRACTICAL GUIDANCE

1 INTRODUCTION

HEATSET GUIDANCE IN TWO PARTS

This Intergraf guidance note for BAT in Heatset consist of two parts.

- **Part 1** describes techniques that, when implemented in Heatset plants will result in an operation in accordance with the BAT conclusions in the Commission Implementing Decision (CID). The techniques are described in practical 'Heatset terms'.
- In **Part 2** the legal text of the Commission Implementing Decision is reproduced, insofar as relevant to Heatset, and annotated. The annotations clarify and substantiate the choices that were made for the conversion of this legal text into the Intergraf Guidance to BAT in Heatset.

Part 1 is a stand-alone document intended for both operators and competent authorities. This Heatset-specific set of techniques lists and describes only BATs that are applicable to heatset. Where necessary the techniques have been slightly adapted to fit better the practical situation in Heatset plants.

Part 2 is a background document with substantiation of the choices that were necessarily made to produce the practical guidance in Part 1. The clarifications and explanations ensure transparency of the manner in which the Commission Implementing Decision has been transposed into Heatset-specific techniques.

> In the Commission Implementing Decision, the BATs are listed in an order from the most general (*BAT1: Environmental management System*) to the most specific (*BAT 28: Heatset: Use of Low-IPA or IPA-free additives in dampening solutions, etc.*). This is however not the logical order in which to address the issue in Heatset plants, since the five BAT conclusions in BAT 28 for Heatset already cover several of the 'generally applicable' BATs. The approach taken for the purpose of this Part 1 of the Heatset Guidance was therefor to start with BAT 28 and after that consider the parts of the 'Generally applicable' BATs that are not yet covered but could apply to Heatset.

INDUSTRIAL EMISSIONS DIRECTIVE & ENVIRONMENTAL PERMITS

The Industrial Emissions Directive 2010/75/EU (IED) requires that environmental permits be issued to plants of certain industries if they surpass a certain size.

Heatset web offset is one of some fifteen different industrial sectors in the category of 'Surface Treatment of Substances, Objects or Products using organic solvents'. This category covers sectors as wide apart as the manufacture of ships or airplanes and the printing of magazines. In these 'STS' sectors the IED applies when the 'organic solvent consumption capacity' of a plant exceeds 200 t/a.

Under Article 21.3 of the Industrial Emissions Directive, the permit conditions should be reconsidered, and where necessary, updated within 4 years of publication of the BAT conclusions (i.e. late 2024). The reconsideration of the permit conditions must take into account the recently adopted BAT conclusions applicable to the installation. (i.e. the Commission Implementing Decision).

'ORGANIC SOLVENT CONSUMPTION CAPACITY'

In offset printing, the threshold of 200 t/a only applies to heatset web offset. The solvent consumption of sheet fed or cold set presses in the same installation does not count.

In Heatset the 'organic solvent consumption capacity' is generally close to the actual consumption. Where no Isopropanol is used, a consumption of 200 t/a is often reached with two 32-page presses working three shifts. Where Isopropanol is used, one 32-page press or two 16-page presses may surpass the threshold.

For calculation of the solvent consumption see Annex 6 (BAT 10: Solvent Mass Balance)

Where the actual consumption is lower than 200 t/a, but the 'capacity' could be regarded as being higher, a simple way to avoid applicability of the IED is to include a 200 t/a maximum consumption in the applicable permit.

BEST AVAILABLE TECHNIQUES (BAT)

To determine which are, for each of the many IED sectors, the 'Best Available Techniques', an 'information exchange' between Member States and industry is organised. This information exchange results in a 'BREF'; short for 'BAT-Reference Document'.

The STS-BREF, in which Heatset is addressed, has recently been revised. The 1.000page document can be downloaded at:

https://publications.jrc.ec.europa.eu/repository/bitstream/JRC122816/jrc122816_sts_2020_final.pdf

Based on this revised STS-BREF the European Commission has published the *Commission Implementing Decision (EU) 2020/2009 of 22 June 2020 establishing Best Available Techniques (BAT) conclusions, for Surface Treatment using Organic Solvents. This decision can be downloaded in full at:*

https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2020.414.01.0019.01.ENG&toc=OJ%3AL%3A2020%3A414%3ATOC

This Decision has been reproduced in Part 2 of the Intergraf Guidance note insofar as relevant to Heatset.

NOTE

The Commission Decision can be downloaded in different versions (PDF, HTML and 'Official Journal'). There is a difference between these versions regarding the numbering of the 'notes' that are provided with some of the tables and BAT-lists. For Part 2 of this Guidance Note, the HTML version was used. In this version all these notes are listed at the end of the document and numbered 1 to 53. In the PDF version and the Official Journal version however, the notes are listed and separately numbered underneath the applicable table or BAT-list. Where in this Guidance reference is made to one of these notes, a cross reference between the two possibilities is provided.

The Commission Implementing Decision provides a summary of each of the many Best Available Techniques applicable to the STS sectors. For some emissions it also provides the basis for Emission Limit Values for the environmental permits in the form of a 'BATAEL'.

Directive 2010/75/EU of 24 November 2010 on Industrial Emissions may be downloaded from:

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010L0075&from=EN

BATAEL AND BATAEPL

Where in the Commission Implementing Decision, BAT is expressed in a value, this is either as a 'BAT-AEL' or as a 'BAT-AEPL'. These are two very different units.

In the IED permit, the competent authority must set Emission Limit Values that ensure that the emissions will not exceed the BATAELs. (IED Art 15.3).

The IED definition of BATAEL is: 'emission levels associated with the best available techniques' means the range of emission levels obtained under normal operating conditions using a best available technique or a combination of best available techniques, as described in BAT conclusions, expressed as an average over a given period of time, under specified reference conditions.

BAT-AEPLs are 'Environmental performance levels associated with BAT'. They do not lead to Emission Limit Values in the IED permit, but they do indicate what result may be expected from the application of BAT. They may include:

- Emission levels
- Consumption levels
- Other levels (e.g. abatement efficiency)

The environmental performance levels associated with BAT are expressed as ranges.

HEATSET & BAT

Most Heatset web offset plants have technically a lot in common. The web offset process does not allow for widely differing technical approaches and there are only a limited number of manufacturers of presses, dryers, and oxidisers. This allows for the description of a comprehensive list of Heatset-specific Best Available Techniques that is valid for most European Heatset plants.

The Commission Implementing Decision lists some 150 techniques that are regarded as 'generally applicable' to all, or a number of, the STS-sectors. It lists only 5 techniques that apply to heatset only. The 'general' techniques are necessarily described in a rather 'general terms'. Their applicability in a Heatset-plant needed to be determined separately and a 'translation' into terms applicable to heatset plants was necessary.

EQUIVALENT LEVEL OF ENVIRONMENTAL PROTECTION

Under 'General Considerations' the Annex to the Commission Implementing Decision begins with the following statement:

> *'The techniques listed and described in these BAT conclusions are neither prescriptive nor exhaustive. Other techniques may be used that ensure at least an equivalent level of environmental protection.'*

Because; '*Other techniques may be used…*', Heatset plants need not exactly implement all the listed techniques. Occasionally preference may be given to another or simply a less elaborate technique. Of course, in such a case '*an equivalent level of environmental protection*' must be ensured.

For the purpose of this Guidance Note, this possibility has been used in a few cases. Each case has been clearly indicated and substantiated in the annotations in Part 2.

DEFINITIONS

Many of the terms used in the Commission Implementing Decision are clearly defined in that document. A few definitions warrant special attention.

Plant

In the Commission Implementing Decision the 'Plant' is <u>only</u> the part of the 'installation' (which is the whole factory) where heatset printing takes place, as well as 'any other directly associated activities which have an effect on consumption and/or emissions'. These 'directly associated activities' are obviously mixing and supply of the dampening solution, cleaning of the presses, drying and in-line folding and cutting. Other directly associated activities may include platemaking and, in very rare cases, the mixing of inks. Platemaking and mixing inks are not addressed in this guidance, because platemaking is no subject in the Commission Implementing Decision and mixing inks is extremely rare in Heatset web offset printing.

Certainly not ‘directly associated’ are sheet-fed or cold-set presses. They are therefore not part of the ‘Plant’.

Solvent Mass Balance

The ‘Solvent Mass Balance’ is the same as the ‘Solvent Management Plan’, that Heatset plants have been making annually since the Solvent Emissions Directive came into effect.

Volatile Organic Compound and Solvent

There are many different definitions of organic compounds, volatile organic compounds (VOC) and organic solvents. As a result, there are also borderline cases where a substance counts as a VOC under one definition and not under another. For the purpose of this Commission Implementing Decision only the definitions from IED art.3 apply. (These are the same as the definitions in the old Solvents Emissions Directive and have applied to the industry for many years).

The applicable definition for VOC is:

> ***‘volatile organic compound’*** *means any organic compound as well as the fraction of creosote, 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*

NOTE

The ‘Particular condition of use’ is the temperature at the point in the process where emissions to the environment may occur. In the case of the inks used in Heatset web offset, this is the temperature in the dryer.

It is recommended to always check if a supplier’s claims about their products being ‘solvent free’ are given in accordance with this definition.

2 HEATSET-SPECIFIC BAT

CONSIDERATIONS

The table below describes BAT in a Heatset plant. The following should be taken into consideration:

- The Heatset BAT table in the next section lists 24 different ‘Heatset Techniques’ that describe BAT in a way that is logical to the operator of the heatset plant. The techniques are numbered A to Wand titled in the left-hand column.
- Most of these ‘Heatset Techniques’ refer to one or more of the BAT’s listed in the Commission Implementing Decision (CID). This is indicated in the right-hand column.
- All but one of the BAT’s from the Commission Implementing Decision that are relevant to Heatset have been transposed into one of the ‘Heatset Techniques’. Only BAT 28.b ‘Waterless offset’ is not part of any Heatset Technique, since the Guidance is aimed at the vast majority of heatset web offset plants that have technically a lot in common. These plants all employ the traditional offset technique using a dampening solution. It is actually unknown whether any IED-size Heatset plants employ waterless offset in the EU.
- A few of the ‘Heatset Techniques’ address a subject that does not feature in the Commission Implementing Decision. In that case the Techniques are based upon what is considered Best Practice in the Heatset sector. These techniques are indicated by ‘not in CID’.
- In compiling the table, it had to be decided if and to what extent each of the 150 ‘General BATs’ in the Commission Implementing Decision are applicable to Heatset. Each of these decisions is substantiated in Part 2 of this guidance.
- In the table below, the description of the techniques is purposely kept short. Where necessary, an extended description is provided in chapter 3 of this Guidance Note Part 1. Also, for most Heatset-specific BAT’s the full description from the BREF has been annexed.
- A table with a cross reference between the ‘Heatset techniques’ and the BATs in the Commission Implementation Decision is provided in Annex 1.
- The table below mentions specific techniques. Deviations are however possible and permitted since other techniques may lead to the same ‘level of environmental protection’.

HEATSET BAT TABLE

The table below applies only to heatset web offset and not to other printing processes that may take place in the same plant. The same is true for the BATAEL and BATAEPL values mentioned.

HEATSET TECHNIQUE	**DESCRIPTION**	**COMM. DECISION**
VOC: EMISSION REDUCTION		
A. VOC: Waste Gas Emissions	Application of an oxidiser. Oxidisers to be designed for low NOx and CO emissions. (See Technique H) For the purpose of energy saving: In the case of 'New plants or major upgrades, where technically and economically possible: application of integrated dryer-oxidisers (i.e. in the case of new dryers and dryers that are replaced at the end of their economic or technical life). <u>See also</u>: • Section 3.1 for an extended description • Annex 2 for the BAT description regarding integrated dryer-oxidisers from the BREF	BAT 28d, 8, 14, 15, 17
B. VOC: Cleaning rubber blankets	Application of cleaning agents with low volatility VOC or non-VOC components. <u>See also</u>: • Section 3.2 for an extended description • Annex 3 for the BAT description from the BREF	BAT 28c, 2, 3, 4, 9
C. VOC: Manual cleaning	Predominantly cleaning agents with low volatility VOC. <u>See also</u>: • Section 3.2 for an extended description	BAT 2, 3, 4, 9
D. VOC: Dampening solution	Additives to dampening solution: predominantly avoid IPA. Other additives: low volatility. IPA is used only where necessary to attain very high-quality requirements. In that case average IPA in dampening solution concentration of max 3 - 5% w/w to attain the BATAEL for Fugitive Emissions. <u>See also</u>: • Annex 4 for the BAT description from the BREF	BAT 28.a, 2, 3, 4

E. VOC: Treatment of air from press room or press encapsulation	The dryer takes its air supply in part from the press room or the press encapsulation. This air contains evaporated solvents that are consequently abated in the oxidiser. See also: • Section 3.3 for an extended description • Annex 5 for the BAT description from the BREF	BAT 28e, 2
F. VOC: OTNOC (Other than normal operating conditions)	Integrated dryer-oxidisers are annually inspected and maintained thoroughly. (Where an integrated dryer/oxidiser fails, the press cannot be used) Stand-alone oxidisers are inspected and maintained in accordance with the manufacturer's instructions. Monitoring of OTNOC periods, duration, causes and if possible emissions during their occurrence.	BAT 13, 2
G. VOC: Odour	Where in Heatset oxidisers are employed answering to the IED emission limit value (20 mgC/Nm^3) or the BAT-AEL (15 mgC/Nm^3), there is no odour issue.	BAT 23

VOC TWO ALTERNATIVE LIMIT VALUES

Please note:

There are two alternative methods to express the BAT-AEL for VOC emissions from Heatset. As a consequence, there are also two different methods to express a VOC emission limit value in the IED permit.

- *Either: The total VOC emissions (i.e. waste gas emissions plus fugitive emissions) as a percentage of the weight of the ink that is used.*
- *Or: A combination of two separate values; the waste gas emissions expressed in mgC/Nm^3 and the fugitive emissions as a percentage of 'Input'. (i.e. the amount of VOC used).*

The two BAT-AEL values correspond to approximately the same amount of VOC emitted. The second method is the more usual in Heatset.

See also:

- Section 3.4 for an extended description

H. VOC: Oxidiser limits	BATAELs: VOC: 15 mgC/Nm^3, NOx: 130 mg/Nm^3 BATAEPL: CO 150 mg/Nm^3	BAT 28 BAT 17

	The BATAEL for NOx and BATAEPL for CO may not apply in the case of existing oxidisers. See also: • Section 3.5 for an extended description	Tables 1 & 27
I. VOC: Fugitive emission limit	< 10% of solvent input. Where no IPA is used, a lower % is possible.	BAT 28 Table 26
J. VOC: Total emission limit	< 0,04 kg/kg ink used. This is an alternative to the combination of oxidiser limit and fugitive limit value.	BAT 28 Table 25
VOC MONITORING		
K. VOC: Solvent Mass Balance	Annual solvent mass balance to show compliance with fugitive or total emission limit. See also: • Annex 6: Heatset specific SMB. • Corresponding template in Excel: https://www.intergraf.eu/images/documents/IntergrafGuidanceBATHeatset_SMP.xlsx	BAT 10
L. VOC: Oxidiser monitoring	Oxidiser outlet measured every three years for VOC, NOx, and CO. (Unless VOC emission from the oxidiser > 0,1 kg/h; than every year). The oxidation temperature is continuously monitored. See also: • Section 3.6 for an extended description	BAT 28, 11
ENERGY CONSUMPTION		
M. Energy: dryer-oxidiser	Application of integrated dryer-oxidisers in accordance with Heatset Technique A, rather than separate dryers and oxidisers. A reduction of the gas consumption by 50% is often possible. See also: • Heatset Technique A: Waste Gas Emissions	BAT 28.d, 2, 19

N. Energy: Other reduction measures	Implementation of an energy reduction program. For example, based on the results of the EMPSI project. (*EMPSI: Energy Management Standardization In Printing Industry*) or ISO 50001 See also: • Annex 7: List of EMPSI "energy reduction opportunities".	BAT 2, 19
O. Energy: Record keeping	Measuring and recording energy consumption. Distinction between gas and electricity. Clear boundaries around the Heatset process. No BAT-AEPL for energy consumption in Heatset. See also: • Section 3.7 for an extended description	BAT 19
WATER: CONSUMPTION AND EMISSIONS		
In Heatset printing the water consumption for the dampening solution may be considerable but this does not lead to any discharge of waste water: the water evaporates. The small amount of resulting waste water is disposed of as hazardous waste. *BAT 20: 'Waste water generation and BAT 21: 'Waste water treatment' are limited to aqueous processes such as cleaning the objects that are to be coated. There are no such processes in Heatset. As a result, water consumption and waste water discharges in Heatset are not addressed in the Commission Implementing Decision.* *Heatset techniques P, Q & R below however do address potential water emissions. They are included in this table because in the Heatset sector they are generally considered to be Best Practice.*		
P. Water: Emissions	No discharge of waste water from Heatset printing.	Not in CID
Q. Water: Dampening solution	Disposal of waste dampening solution as hazardous waste.	Not in CID
R. Water: Cleaning agents	Disposal of used cleaning agents as hazardous waste. (Cleaning agents for rubber blankets will contain water)	Not in CID
SOLVENT CONTAINING RAW MATERIALS		

<table>
<tr><td colspan="3">Heatset inks are not hazardous. At room temperature they are not liquid, do not contain solvents and are not flammable. Cleaning agents and dampening additives may be hazardous and may contain solvents. Most are however not flammable.

Selection and use of solvent containing materials is addressed in Heatset Techniques B, C and D.</td></tr>
<tr><td>S. Storage of solvent containing raw materials</td><td>In production area only quantities necessary for production. Larger amounts are stored separately.

Where necessary Bulk tanks are bunded with enough capacity and fitted with overflow alarm.</td><td>BAT 5</td></tr>
<tr><td>T. Pumping & handling of solvent containing raw materials</td><td>Suitable pumps and seals. Equipment and working methods to prevent and contain leakages and spillages.</td><td>BAT 5, 6</td></tr>
<tr><td colspan="2">DUST</td><td></td></tr>
<tr><td>U. Dust: Emissions</td><td>Cutting and folding in Heatset is enclosed. No paper dust is emitted.

(Paper dust in Heatset is not specifically addressed in the BAT conclusions.)</td><td>BAT 18</td></tr>
<tr><td colspan="3">SOLVENT CONTAINING WASTE</td></tr>
<tr><td>V. Monitoring of solvent containing waste</td><td>Monitoring of quantities. Solvent content determined by analysis or calculation.</td><td>BAT 22</td></tr>
<tr><td colspan="3">OTHER WASTE</td></tr>
<tr><td colspan="3">The main ‘other waste’ in Heatset is of course paper. The amount of waste paper can be considerable and valuable. The amount depends to a large extent on the characteristics of the product printed. These characteristics are outside the printers’ control.

All paper waste generated in a Heatset plant is collected, kept separate by quality, and sold for recycling. To a large extent, it is a much-appreciated raw material for the manufacture of high-quality graphic paper.</td></tr>
</table>

Paper is costly and minimizing waste paper is an integral part of the operation in a heatset plant. How to avoid unnecessary losses is a however complicated issue and the Commission Implementing Decision does not contain any practical advice on the topic.

Paper waste is not addressed in this Intergraf Guidance Note.

MANAGEMENT

W. General: Management system	Based on this Heatset BAT Table, list the necessary investments, changes in raw materials that are used or working methods. Decide if the existing management structure and working methods can bring these changes to a good end. Where necessary adapt. <u>See also</u>: • Extended description in section 3.8	BAT 1, 5, 19, 22

3 EXTENDED DESCRIPTIONS

HEATSET TECHNIQUE A: VOC, WASTE GAS EMISSIONS

Application of an oxidiser.

Oxidisers to be designed for low NOx and CO emissions. (See Technique H).

For the purpose of energy saving: where technically and economically possible, the application of integrated dryer-oxidisers in the case of 'New plants or major upgrades'. (I.e. new dryers and dryers that are replaced at the end of their economic or technical life).

Separate oxidisers, treating the exhaust air from multiple dryers, will destroy the VOC in waste gas emissions and may comply with the applicable Emission Limit Values

Integrated dryer-oxidisers are however preferred because of lower energy consumption. Where these integrated dryer-oxidisers are used, the gas consumption in a Heatset plant may be reduced by half.

It is not always possible to apply integrated dryer-oxidisers in existing situations. The remaining economical lifetime of the press in question may be too short to warrant the investment, even though considerable savings in energy can be obtained. There may also be technical limitations that make application of an integrated dryer-oxidiser impossible or disproportionally expensive. Such limitations may for instance be caused by the construction of the building, its roof and its foundation, the position of cables, the lay-out of the ventilation system, etc.

Heatset plants generally have multiple presses. Where one of the conventional dryers is replaced by an integrated dryer-oxidiser, the VOC laden airflow to the existing conventional oxidiser will be reduced. It should be checked if the existing conventional oxidiser will continue to operate as required with this reduced airflow and VOC load.

- See also: Annex 2 for the BAT description from the BREF

HEATSET TECHNIQUE B & C: VOC: CLEANING RUBBER BLANKETS &, MANUAL CLEANING

Rubber blankets: Application of cleaning agents with low volatility VOC or non-VOC components.

Manual Cleaning: Predominantly cleaning agents with low volatility VOC.

Rubber blankets

Application of low volatility or non-VOC components may increase the amount of paper waste. After cleaning the rubber blanket, it may take more press revolutions before a saleable product is printed. Also, more web breakages may occur.

Manual cleaning

In Heatset the working methods for manual cleaning are too different to determine a sector specific BAT. Volatile solvents must however be used sparsely.

To comply with the BATAEL for fugitive emissions or total emissions, it is necessary to use volatile solvents in manual cleaning modestly.

HEATSET TECHNIQUE E: TREATMENT OF AIR FROM PRESS ROOM OR PRESS ENCAPSULATION

The dryer takes its air supply in part from the press room or the press encapsulation. This air contains evaporated solvents that are consequently abated in the oxidiser.

It is not the intention that all the air extracted from the press room or enclosure should be routed through the dryer. The airflow through the dryer and oxidiser should be limited to what is necessary for the drying process. Both the stand-alone oxidiser and the integrated dryer-oxidiser would lose their energy efficiency if they were required to treat all the additional air that is extracted from the press room or encapsulations.

- See also: Annex 5 for the BAT description from the BREF.

ALTERNATIVE LIMIT VALUES

There are two alternative methods to express the BAT-AEL for VOC emissions from Heatset. As a consequence, there are also two different methods to express a VOC emission limit value in the IED permit.

- **Either**: The total VOC emissions (i.e. waste gas emissions plus fugitive emissions) as a percentage of the weight of the ink that is used.
- **Or**: A combination of two separate values; the waste gas emissions expressed in mgC/Nm^3 and the fugitive emissions as a percentage of 'Input'. (i.e. the amount of VOC used).

The two BAT-AEL values correspond to approximately the same amount of VOC emitted. The second method is the more usual in Heatset.

Total emission limit value

Although the second method (separate waste gas and fugitive emission limit values) is the usual in the heatset sector, there may be reasons to prefer a total emission limit value.

A total emission limit value allows a compensation of higher waste gas emissions with lower fugitive emissions (and vice versa). This can be useful for example where the waste gas abatement cannot comply with a limit value of 15 mgC/Nm^3. This may be the case with older existing oxidisers or where another technique for waste gas treatment is applied such as condensation of the VOCs in waste gasses.

Total emissions and the amount of VOC in waste gasses

Where a total emission limit value applies, the amount of VOC emitted in the waste gasses must be determined. No particular method is prescribed in the BREF.

Since the emissions in the waste gasses need to be expressed in in tonnes per year rather than mgC/Nm^3, simpler and less expensive methods may be used than those described in BAT 11. It is for instance possible to use calculations based upon design parameters.

For a suitable calculation-method for the waste gas emissions and the check against a total emission limit value, see the section added by Intergraf at the end of appendix 6: 'BAT 10: Solvent Mass Balance'. See also the Heatset specific SMB template in Excel that can be downloaded from https://www.intergraf.eu/images/documents/IntergrafGuidanceBATHeatset_SMP.xlsx.

HEATSET TECHNIQUE H: OXIDISER LIMITS

BATAELs: VOC: 15 mgC/Nm^3, NOx: 130 mg/Nm^3

BATAEPL: CO 150 mg/Nm^3

The BATAEL for NOx and BATAEPL for CO may not apply in the case of existing oxidisers

NOx and CO emissions from stand-alone oxidisers and integrated dryer-oxidisers

Most stand-alone oxidisers and integrated dryer-oxidisers as used in Heatset emit less NOx and CO than 130 and 150 mg/Nm^3, respectively. Out of 27 dryer-oxidisers for which data were collected for the STS BREF, only one did not comply with the BATAEL for NOx and five did not comply with the BATAEPL for CO. In none of these cases the non-compliance was excessive.

Existing plants: BATAEL for NOx and BATAEPL for CO may not apply

The BATAEL for NOx and BATAEPL for CO as given in the Table 1 are based on BAT 17. This BAT specifies a design for oxidisers and the application of low NOx burners.

The application of both techniques is BAT 17 is however subject to restrictions:

- BAT 17 a: 'Design applicability may be restricted for existing plants.'
- BAT 17 b: 'Applicability may be restricted at existing plants by design and/or operational constraints.'

As a result, where an existing stand-alone oxidiser or integrated dryer-oxidiser cannot meet the BATAEL for NOx or the BATAEPL for CO, and their design does not allow technical changes that would reduce the NOx or CO emissions sufficiently, the BATAEL for NOx and the BATAEPL for CO do not apply.

It must be noted that integrated dryer-oxidisers as described in BAT 28.a must answer to many more design restrictions than separate dryers and oxidisers as generally used in other industries. (Space limitations, built in safety, automatic operation, to name but a few).

HEATSET TECHNIQUE L: OXIDISER MONITORING

Oxidiser outlet measured every three years for VOC, NOx and CO. (Unless VOC emission from the oxidiser > 0,1 kg/h; than every year).

Where appropriate the oxidation temperature is continuously monitored.

Frequency

The measurement frequency applicable in Heatset is determined by notes 7 & 12 in the HTML version of the Commission Decision. (In the PDF version: notes 2 & 7 of BAT 11). Note 7 refers to the VOC measurement and specifies that where the emission from a stack is less than 0,1 kgC/h the monitoring frequency is once per three years. Note 12 refers to the measurement of NOx and CO concentrations and ensures that their frequency is always equal to that of the VOC measurements.

Where in Heatset integrated dryer oxidisers are used, the amount of C emitted by these dryers will generally be less than 0,1 kg/h.

The airflow of a dryer oxidiser will often be between 5.000 and 10.000 m^3/h. With such airflows, the concentration C in the waste gasses should be below 20 or 10 mgC/Nm^3 to arrive at an hourly load inferior to 0,1 kg/h. Most dryer-oxidisers emit lower C concentrations. In the case of a larger airflow or higher concentration, the maximum of 0,1 kgC/h may be surpassed, in which case annual measurements are necessary.

Monitoring oxidation temperature

Note 8 in the HTML version of the decision (In PDF version note 3 of BAT 11) specifies that the temperature in the combustion chamber should be monitored continuously. This should be combined with an alarm system for temperatures falling outside the optimised temperature window.

This may not be the appropriate manner of monitoring the combustion process in integrated dryer-oxidisers. Where this is the case another method for monitoring the combustion process may need to be applied.

HEATSET TECHNIQUE O: ENERGY RECORD KEEPING

Measuring and recording energy consumption. Distinction between gas and electricity. Clear boundaries around the Heatset process.

No BATAEPL for energy consumption in Heatset.

Distinction between gas and electricity

Where each press has its own integrated dryer-oxidisers, the VOC concentrations resulting from the different dryers are not averaged out before entering an oxidiser. For safety reasons the integrated dryer oxidisers are designed to be able to cope with a 400% ink coverage on both sides of the web. The actual ink coverage in Heatset however varies with the product being printed; from less than 50% for magazines with a lot of text and few photographs, to well over 200% for certain brochures. In the case of a high ink coverage the integrated dryer oxidisers are almost autothermic, using very little gas. In the case of low ink coverage, a considerable amount of gas is added to maintain the temperatures required for the drying and the oxidation processes.

The annual average ink coverage and therefore the gas consumption in a Heatset plant varies with its product portfolio: where mostly magazines are printed, the gas consumption will be considerably higher than where mainly colourful door-to-door brochures are printed.

In the data collected for the STS BREF the gas consumption varied between 30 and 70% of the total energy consumption and might thus be half or double the electricity consumption. To be useful at all, the records for gas and electricity should be kept separate.

Clear boundaries

Clear boundaries are necessary both for both electricity and gas. This it is especially important in Heatset plants because these plants nearly always also employ other processes, often in the same building. (Such as computerised pre-press processes, platemaking, digital printing, sheet fed offset printing and finishing)

The following boundaries are recommended to ensure that the collected data are sufficiently comparable over time and that in the future benchmarking will be possible:

Electricity	Within the boundary are the heatset presses themselves, including their folders, cutting machines and reel unwinders, the ventilators for dryers and oxidisers and their supporting systems such as air compressors, water coolers and pumps for ink and the fountain solution. Where supporting systems are also used for other processes, their electricity consumption should be allocated pro rata. Not within the boundary are other production processes such as sheet fed offset, coldset, digital printing and finishing and the ventilation, heating, cooling, and

	lighting of the building.
Gas	Within the boundary are the dryers, stand-alone oxidisers, and integrated dryer-oxidisers. Not within the boundary are the gas consumption for heating or cooling of the plant.

No BATAEPL for energy consumption in Heatset

In the Commission Implementing Decision a BATAEPL for energy consumption in Heatset is given in table 3. The value is however confusing and not relevant where integrated dryer oxidisers are used. The BATAEPL is therefore not part of the BAT Guidance for Heatset.

For a substantiation of this choice see Part 2 of this Guidance, under BAT 19.

HEATSET TECHNIQUE W: MANAGEMENT SYSTEM

Based on this Heatset BAT Table, list the necessary investments, changes in raw materials that are used or working methods. Decide if the existing management structure and working methods can bring these changes to a good end. Where necessary, adapt management structure.

Implementing BAT in a Heatset plant generally implies the execution of a number of projects. For example: reduction of the IPA content in dampening solutions, increase of the energy efficiency, production of an annual Solvent Mass Balance, keeping track of the solvent content of waste, etc. etc. Although a full-fledged EMS is not necessary, there will be a need for adequate management attention, with clearly defined and allocated responsibilities.

Most modern Heatset plants will already have implemented a considerable part of the Heatset Techniques listed in this Guidance note. In Heatset it is therefore efficient to apply a practical ‘bottom up’ approach. This starts with the identification of all the projects that still need to be undertaken and then, where necessary, adapt the management structure such that the projects will be brought to a good end.

- In Heatset it is BAT, to list all the investments, and changes in raw material used and working methods that are still necessary. The list of necessary changes can be derived from the Heatset BAT Table in section 2.2.
- Based on this list it is BAT to evaluate the existing management structure and determine if, and to what extent, it can be expected to bring these changes to a good end. Where this is not the case, the structure should be adapted.

Checklists

It is helpful to use the descriptions of BAT 1 (Environmental System), BAT 5a (Prevention and control of leaks and spillages) and BAT 19a (Energy efficiency plan)) and BAT 22a (Waste management plan) from the Commission Implementing Decision as checklists when evaluating the existing management structure and working methods.

Ecolabels and Environmental Management Systems

The Commission Implementing Decision states that EMAS (EU eco-management and audit system) would be consistent with BAT 1 about Environmental Management Systems. This will also be the case with other Environmental Management Systems such as ISO 14001, and most national ecolabel systems.

Technique N: Energy 'Other reduction measures' is the least specific ´Heatset Technique´. Implementation of this Technique will therefore generally require more management attention than the other techniques. It may be decided that only this part of the implementation of BAT needs to be subject to a formal environmental management system. In that case ISO 500001 ´Energy Management´ can be used.

Where a Heatset plant participates in an ecolabel system it is recommended to check whether the criteria of the label in question adequately cover BAT in Heatset.

4 ANNEXES

LIST OF ANNEXES

ANNEX 1: CROSS REFERENCE TABLE

Below a cross reference between the table 'Heatset & BAT' and the BATs mentioned in the Commission Implementing Decision.

	BAT conclusions	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**8**	**9**	**10**	**11**	**13**	**14**	**15**	**17**	**18**	**19**	**22**	**23**	**28**
Heatset Technique		No BAT conclusion	EMS	Identify VOC and E-usage	Selection raw materials	non-VOC raw materials	Storage & handling raw mat.	Distribution raw materials	Drying & Curing	Cleaning	Solvent mass balance	Monitoring waste gasses	Reduction OTNOC	Abatement & ventilation	Abatement techniques	Abatement & NOx/CO	Dust emissions	Energy efficiency	Waste management	Odour	Heatset specific
A	VOC: Waste Gas Emissions			X					X					X	X	X					X
B	VOC: Cleaning Rubber Blankets			X	X	X				X											X
C	VOC: Manual Cleaning			X	X	X				X											
D	VOC: Dampening Solution			X	X	X															X
E	VOC Treatment of air from press room			X																	X
F	VOC: OTNOC			X									X								
G	VOC: Odour																			X	
H	VOC: Oxidiser Limits															X					X
I	VOC: Fugitive emissions Limit																				X
J	VOC: Total Emission Limit																				X
K	VOC: Solvent balance										X										
L	VOC: Oxidiser monitoring											X									X
M	Energy: Dryer Oxidiser			X														X			X
N	Energy: Other reduction measures			X														X			
O	Energy: Record Keeping																	X			
P	Waste water: Emissions	X																			
Q	Waste water: Dampening solutions	X																			
R	Waste water: Cleaning agents	X																			
S	Storage: solvent containing materials						X														
T	Pumping & handling solvents etc.						X	X													
U	Dust: Emissions																X				
V	Monitoring solvent containing waste																		X		
W	Management System		X				X											X	X		

BAT	**Not applicable Heatset:**
7	Coating Application
12	Monitoring waste water
16	Waste gas concentration
20	Water use and waste water generation
21	Emissions to water

ANNEX 2: BAT 28.D WEB OFFSET DRYER INTEGRATED WITH OFF-GAS TREATMENT

Description

A web offset dryer with an integrated off-gas treatment unit, enabling incoming dryer air to be mixed with a part of the waste gases returned from the off-gas thermal oxidation system.

Technical description

This technique consists of a hot air dryer for the printed web of heatset presses, where the incoming drying air is heated by mixing it with a part of the exhaust gases from the burner or burners that oxidise the VOC content of the outgoing drying air.

The outgoing drying air is fully fed to these burners. The part of the burner exhaust that is not recirculated and used for heating the incoming drying air is emitted.

The cool ingoing dryer air is used to cool the web where it exits the dryer and stop the evaporation of VOCs from the ink on the web. Cooling may also be achieved with the help of metal rollers that are internally cooled with water.

The maximum web temperature is adjustable and will generally be between 140 °C and 190 °C. There is a limit to the recirculation of the air from the oxidiser to the dryer part since the maximum temperature of the paper web is limited.

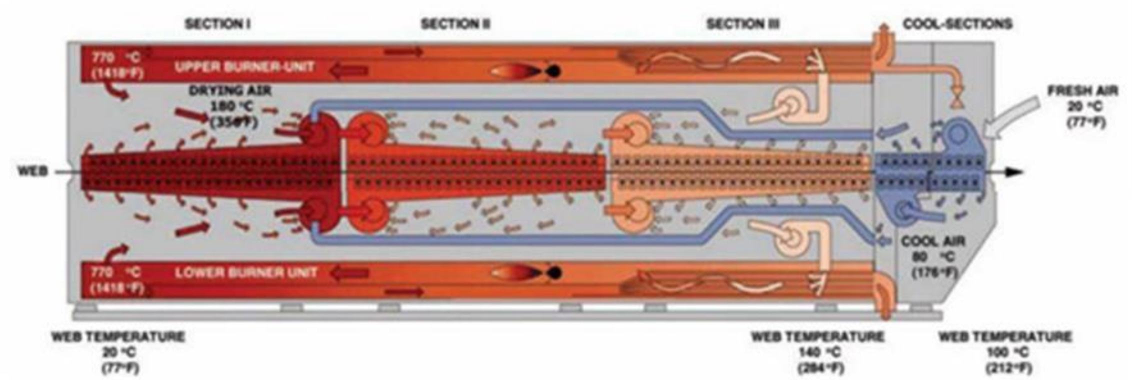

Figure 11.12: Integrated off-gas treatment at the dryer of the heatset web offset press

Achieved environmental benefits

The main benefit is the avoidance of VOC emissions from the drying of the mineral oils in the heatset inks.

In addition, malodorous smells are avoided. Untreated exhaust gases from heatset dryers are notoriously malodorous.

Energy consumption is considerably lower than in the case of separate dryers and oxidisers. The energy consumption of a separate dryer is saved and, due to the recirculation, the energy consumption of the oxidiser is reduced. This can be illustrated by the fact that the exhaust airflow from these integrated dryer-oxidisers is half the airflow of a separate dryer for the same press.

Environmental performance and operational data

Integrated dryer-oxidisers are generally capable of attaining values lower than the IED (Annex VII to Directive 2010/75/EU) emission limit value.

The destruction efficiency depends not only on the emission value, but also on the amount of mineral oil evaporated, which in turn depends on the ink coverage of the web and drying temperature.

Typically, the VOC concentration in the drying air is some 2 g VOCs/m3, and the emission value is well below 20 mg C/m3. As a result, the destruction efficiency will be over 99 %. Values of 99.9 % are also achievable.

Dryer-oxidisers are designed and produced by specialist companies experienced in supplying the heatset web offset printing market. Their dimensions depend on the width and speed of the press and the usual ink coverage of the web.

The reliability of these machines is outstanding. This is of course necessary because, in case of a defect, no further printing production is possible: the oxidiser cannot be bypassed.

Cross-media effects

No information provided.

Technical considerations relevant to applicability

In existing buildings, there may be restrictions to the applicability due to the size of the integrated dryer-oxidiser.

Replacement of existing dryers and their separate oxidisers without replacement of the press is not worth the savings in energy consumption.

Economics

No information provided.

Driving force for implementation

No information provided.

Example plants

Widely used.

Reference literature

[186, INTERGRAF, 2017]

ANNEX 3: BAT 28.C VOC-FREE OR LOW VOLATILITY SOLVENTS FOR AUTOMATIC BLANKET CLEANING

Description

Use of organic compounds which are not volatile or have a low volatility as cleaning agents for automatic blanket cleaning.

Technical description

Automatic blanket cleaning in heatset web offset printing concerns the cleaning of the rubber blanket cylinder during printing jobs. Paper fibres and ink stick to the rubber blanket and reduce the quality of the printed product. During production, the press is occasionally slowed down or stopped, according to the cleaning cycle for the rubber blankets, which are generally eight per heatset press (four colours on each side of the paper web). The cleaning agent consists of a solvent which is often mixed with water. Where water is used, it makes the paper fibres swell and the solvents detach both the fibres and the ink from the rubber blanket.

The length and frequency of the cleaning cycles vary widely, depending on the press, the paper, and the print job. The wrong length cleaning cycle may result in a web break. Cleaning cycles are reported to take generally between 15 and 40 seconds but may sometimes take up to 3 minutes. One cleaning cycle may use between 10 ml and 700 ml of cleaning agent.

Three types of automatic cleaning exist:

- Brush system: A brush wetted with the solvent-water mixture is briefly held against the blanket. The brush is wiped clean: some 10 % of the cleaning agent is collected together with the dirt removed and some 90 % is transferred to the paper web.
- Tissue system: Tissue is pressed against the rubber blanket a few times. Both the tissue and blanket cylinder are sprayed with cleaning agent. Some 20 % of the cleaning agent and the loosened dirt is absorbed by the tissue. The remainder of the cleaning agent is transferred to the paper web. In other cases, the tissue is pre-wetted with a cleaning agent.
- Spray system: The blanket cylinder is sprayed with cleaning agent. Cleaning agent and loosened dirt are transferred to the paper web.

In all three systems, the paper web transports all or almost all the cleaning agent to the dryer where it evaporates. The VOCs absorbed by the paper web are subsequently abated in the oxidiser. The remainder is collected and disposed of as waste. Therefore, the fugitive emissions are negligible.

Since most of the cleaning agents end up in the dryer, the whole system of cleaning method, cleaning agent, dryer and oxidiser must be designed and operated in such a way that no explosion risk can occur due to the temporary increase of the solvent concentration in the dryer and oxidiser during the cleaning cycle. The dryer manufacturer generally specifies limits within which the cleaning agents must fall. These limits may be expressed in different ways, (flammability, vapour pressure, LEL, etc.) but they always result in a very low vapour pressure for the solvents used.

Achieved environmental benefits

This technique results in the avoidance of fugitive emissions due to negligible evaporation of solvents from cleaning agents used for automatic cleaning. In addition, these automatic cleaning systems reduce the amount of manual cleaning and subsequently the use of more volatile solvents.

Environmental performance and operational data

The combination of low-volatility solvents that are used, the short duration of the cleaning cycle and the construction of the cleaning systems mean that almost all VOCs are either collected or absorbed in the paper web. As a result, no fugitive emissions worth mentioning result from automatic cleaning when only low-volatility solvents are used in the cleaning agent.

Cross-media effects

The amount of paper waste is influenced by the effectiveness of the cleaning agent used. In particular, VOC-free cleaning agents may be less effective than low-volatility cleaning agents. Where this is the case, the use of these VOC-free cleaning agents must be avoided to prevent an increase in paper losses.

Technical considerations relevant to applicability

All automatic cleaning systems used in large heatset web offset printing plants are suitable for the application of low-volatility solvents in cleaning agents.

Economics

There is no additional cost. All large modern heatset presses are equipped with automatic blanket cleaning systems.

Driving force for implementation

The main driving forces for implementation are economic advantages (faster cleaning, higher productivity, less manual cleaning), improved working conditions (less manual cleaning, lower exposure to solvent vapours) and increased safety (fewer flammable liquids in use).

Example plants

All plants that provided data.

Reference literature

[186, INTERGRAF, 2017]

ANNEX 4: BAT 28.A USE OF LOW-IPA OR IPA-FREE ADDITIVES IN DAMPENING SOLUTION

Description

Reduction or avoidance of isopropanol (IPA) as a wetting agent in dampening (fountain) solutions, through substitution by mixtures of other organic compounds which are not volatile or have a low volatility.

Technical description

To attain a print of acceptable quality in offset, it is necessary to fully wet all the hydrophilic parts of the plate, but with a minimal thickness of the water layer of approximately 2 µm. This needs to be a stable process, even where the press speed varies. A wetting agent is therefore necessary. The wetting agent reduces the surface tension of water and thus minimises the amount of water necessary for a perfect coverage of the hydrophilic parts of the plate.

The fountain solution also needs other additives such as acids to control the pH, plate conditioners to avoid corrosion and Arabic gum to further protect the offset plate. These other additives are not discussed here.

Traditionally, the most commonly used wetting agent is isopropanol (IPA). IPA is not only a good wetting agent, it is also ‘forgiving’ in the sense that imperfections in both press and paper web and changes in speed do not quickly lead to an interruption in the tightly controlled wetting process and the resulting immediate and severe problems with print quality. In the past, IPA was frequently employed in the fountain solutions in concentrations of 15 % w/w and more.

Where high-volatility VOCs like IPA are used as a wetting agent, a considerable part evaporates on its way to the plate and the rubber blanket and thus becomes a fugitive emission. The remaining part is absorbed by the paper web, quickly transported to the dryer, evaporated there, and destroyed in the oxidiser. In general terms, the lower the volatility of the wetting agents, the lower the proportion that evaporates as fugitive emissions and the lower the initial concentration needs to be. Also, other VOCs may not be as easily released from water as IPA is.

On today’s presses, with well-trained operators, good maintenance, and adequate quality control, it is often possible to substitute the IPA to a large extent or even completely by additives containing organic compounds that are not volatile or have a low volatility. On modern presses, in particularly demanding circumstances, reduction of the IPA concentration in the dampening solution to 3 % w/w can be achieved. On older presses, it should be possible to reduce the IPA concentration to 5 % w/w.

In all cases, the dampening solution must be cooled to approximately 10-15 °C to reduce the evaporation en route to the plate.

Achieved environmental benefits

Significant reduction of solvent evaporation from the fountain solution, resulting in a considerable reduction of fugitive emissions from the fountain solution.

Environmental performance and operational data

Compared to a situation with an IPA concentration of 15 % w/w, the fugitive emissions from the fountain solution are reduced by some 80 %.

Cross-media effects

Where the use of IPA in the fountain solution is avoided, there is a need to use biocides to prevent the growth of algae and other microorganisms in the dampening system. The biocide is however transported by the paper web to the oxidiser together with the other additives in the fountain solution.

Where occasionally a small amount of the fountain solution needs to be disposed of, this should be done as hazardous waste mainly because of this biocide content.

Technical considerations relevant to applicability

The applicability may be limited by technical and product quality requirements or specifications:

The water film brought onto the offset plate must be very thin (0.5-1 g/m2 or 0.5-1 µm). Where the film is too thin, it breaks and parts of the plate 'run dry'. Where the film is too thick, it is not removed adequately from the hydrophilic parts of the plate. In both cases, the result is an unrecognisably coloured and smudged paper web.

In order to reduce the IPA consumption and to apply additives that are not volatile or have a low volatility, the press must be properly equipped with for example ceramic, metal or hydrophilic distribution and plate rollers (see Section 11.4.2.2). The rollers must be adjusted with precision and the press must be well maintained. Temperature control is essential.

The required state of the press and operator training for successful reduction of the IPA to maximum 3 % w/w do not differ largely from what is necessary to apply only additives that are not volatile or have a low volatility.

In some cases, the complete avoidance of the use of IPA may have qualitative drawbacks. The use of substitutes increases the amount of water that needs to be brought onto the plate for adequate wetting by 30 % to 50 % compared to when IPA is the sole wetting agent. This unavoidably reduces the sharpness of the printed dots because of the less than perfect separation of the ink-water emulsion on the plate. As a result, there are limits to the achievable quality when printing without IPA, even on modern presses with well-trained operators, good maintenance, and adequate quality control.

In spite of the above, in most cases the print quality is still fit for purpose, but where these quality issues occur, this may become apparent in for example images with lots of detail (human faces, woodgrain), with large variation in the lighting of objects, very dark unsaturated colours or subtle grey balances. As a result, the use of isopropanol may be required for certain products that need a better than normal printing quality. Examples of these products are museum art catalogues and high-quality annual reports.

Economics

A learning curve applies to both the achievement of a low IPA concentration and the application of additives that are not volatile or have a low volatility. During the learning curve, production is down because of lower press speeds and quality problems. It may take several years to achieve a situation in which under all circumstances a low IPA concentration can be maintained, or the use of IPA can completely be avoided.

In the long run, a saving on the consumption of wetting agents is attained and also a saving occurs due to the avoidance of costs associated with the flammable properties of IPA.

No specification of the cost and savings is available.

Driving force for implementation

IPA use is generally reduced for reasons of worker exposure and to reduce fugitive emissions.

Example plants

All plants that submitted data.

Reference literature

[155, TWG 2016] [1, INTERGRAF and EGF, 1999] [186, INTERGRAF, 2017] [212, TWG, 2018]

ANNEX 5: BAT 28.C TREATMENT OF AIR FROM THE PRESS ROOM OR THE PRESS ENCAPSULATION

Description

Routing of extracted air from the press room or the press encapsulation to the dryer. As a result, a part of the solvents evaporated in the press room or press encapsulation are abated by the thermal oxidiser downstream of the dryer. This reduces the fugitive emissions.

Technical description

Heatset presses are often encapsulated for reasons of climate control and noise reduction and, where necessary, to avoid excessive exposure of personnel to solvent vapours. A stable offset printing process needs a constant temperature and low velocity of the air streams around the press. The noisy parts of the printing process are the print rollers, the dryer and the folding and cutting machine. These are often placed in an encapsulation together with the press itself.

In other cases, encapsulation is not applied for technical or economic reasons. This may for instance be the case where flying imprint units are used. These necessitate numerous plate changes and operator presence at the running press. In these cases, the press is not encapsulated but operated as much as possible from a separate control room.

Temperature-controlled air is fed into the press room or the encapsulation. The total press room ventilation flow is generally considerably larger (at least five times) than the dryer airflow. The inlet air for the dryer serves as a part of the exhaust air ventilation stream. A proportion of the air is thus not exhausted to the atmosphere, but to the dryer and the oxidiser. As a result, a part of the solvent vapours in the room or the encapsulation are treated. This reduces the fugitive emissions.

The airflow of modern dryers and integrated dryer-oxidisers is between 5 000 m3/h and 20 000 m3/h. The total airflow needed for controlling conditions inside the press room or the encapsulation depends on factors such as the number, the size and the speed of the presses and is generally larger than the amount evacuated by the dryers. Additional exhaust ventilation to the atmosphere is needed. The solvent concentration in the press room or encapsulation is low. Due to the low solvent concentration in the additionally ventilated air, its treatment is not economically viable. The highest concentrations will be found where isopropanol is used as an additive in the fountain solution. But even in those cases the concentration will, for health and safety reasons, be well below the occupational exposure limit for isopropanol (e.g. in Germany the maximum permissible concentration (MAK) is 200 mg/m3). As a result of this low concentration, it is not possible to increase the dryer airflow such that it alone could provide enough exhaust ventilation for the encapsulation.

Achieved environmental benefit

Reduction of fugitive emissions.

Environmental performance and operational data

An approximate calculation for the proportion of the solvent vapours in the encapsulation that are treated is given by the following formula:

$$\frac{\text{Airflow dryers (or integrated dryer-oxidiser)}}{\text{(Airflow dryers + additional exhaust ventilation)}}$$

Cross-media effect

No negative environmental effects.

Technical considerations relevant to applicability

Applicable in all heatset web offset printing plants.

Economics

No additional cost.

Driving force for implementation

Ventilation of the press room or the encapsulation is necessary for reasons of climate control and to avoid excessive exposure of personnel to solvents. Taking the inlet air for the dryers from the press room or the encapsulation aids this ventilation.

Example plants

All or almost all heatset web offset printing plants across Europe.

Reference literature

[155, TWG 2016] [186, INTERGRAF, 2017] [212, TWG, 2018]

ANNEX 6: BAT 10 SOLVENT MASS BALANCE

BAT 10: Solvent Mass Balance for the heatset web offset printing sector (STS-BREF annex 21.5.3)

Please note 1: A template for a Heatset SMB is available. It follows the description below. This template may be downloaded from https://www.intergraf.eu/images/documents/IntergrafGuidanceBATHeatset_SMP.xlsx

Please note 2: This Solvent Mass Balance is reproduced from the STS-BREF for calculation of the fugitive emissions.

Where a Total Emission Limit Value applies, the oxidiser emissions must also be quantified and expressed in tons/year, since the Total Emissions are equal to the sum of the fugitive emissions and the waste gas emissions.

For the calculation of the oxidiser emissions and the total emissions and for the check against a total emission limit value, see the section added by Intergraf at the end of this appendix.

Introduction

The SMP for heatset web offset printing sector (Heatset SMP) provides a method for the following:

a) Calculation of the annual input (expressed in t/a)
b) Reliable estimation of the fugitive emissions (expressed in t/a)
c) Calculation of the fugitive emissions as percentage of input.

The Heatset SMP described below aims to both simplify and standardize the making of SMP's in the heatset web offset printing sector. It does not describe how to monitor waste gas emissions or how to verify compliance of these waste gas emissions with their applicable emission limit value.

VOC emissions in heatset web offset printing

In heatset web offset printing the following sources of VOC emissions can be distinguished:

1. **Inks**

Offset inks contain oils that are not a VOC at room temperature. They however evaporate in the dryer and at the drying temperature they are considered VOC. After evaporation they are transported to the oxidizer, where they are destroyed to a very large extent. A small proportion may escape destruction in the oxidiser and will be emitted (waste gas emission).

A proportion of the oils remain in the ink on the paper web. The web is cooled, and the oils are no longer VOC's. The residue in the printed product is not considered part of the fugitive emissions (see also IED annex VII part 2, Heatset web offset printing, 'special provisions').

Evaporation of the VOC in inks takes place in the dryer. They do not contribute to the fugitive emissions. The quantity of these VOCs needs however to be known in order to determine the annual input and the percentage fugitive emissions.

Unless the ink supplier provides a different value, it may for the purpose of the Heatset SMP be assumed that the VOC content of heatset inks is 35 %.

2. Fountain solution additives

Fountain solutions contain wetting agents. These are in most cases VOCs. These VOC partly evaporate from the rollers on their way from the fountain to the paper web (fugitive emissions).

They are also partly absorbed in the paper web and transported to dryer. After evaporation they are destroyed in the oxidizer. A small proportion may escape destruction (waste gas emission).

3. Automatic cleaning

The cleaning agents used for automatic cleaning are often VOCs mixed with water. Both water and VOC partly evaporate on their way through the press (fugitive emissions).

Depending on the system used the remainder is either:

Absorbed in the paper web, transported to the dryer and after evaporation destroyed in the oxidiser. A small proportion may escape destruction (waste gas emissions), or

Collected as liquid waste (no emission) or

Absorbed in tissue which is disposed of as waste (no emission).

4. Manual cleaning

Manual cleaning is not very frequent since in heatset web offset printing no colour changes are necessary. Cleaning agents for manual cleaning contain VOCs.

During manual cleaning, a proportion of the VOC in the cleaning agents will evaporate (fugitive emission).

The remainder will be collected and disposed of as waste (no emission).

5. Press room air to off-gas treatment

The off-gasses from dryers are oxidised. The oxidation process is very effective. Only a very small amount of VOC escapes destruction and is emitted (waste gas emission).

Dryers take their inlet air from the press room. This air will contain fugitively evaporated VOCs from cleaning agents and dampening solution. The dryer air is transported to the oxidiser and the VOC contained in that air are destroyed. This reduces the actual fugitive emissions. Since the press room is also separately ventilated to the atmosphere, this concerns a limited percentage of the fugitive emissions.

Conservative simplification

Complicated parameters

Some of the parameters that would be necessary for an accurate SMP in heatset web offset printing are difficult to establish:

- The proportion of VOC in the waste of the cleaning agents. Some of the waste cleaning agents are mixed with water, some are contained in tissue and others in cleaning wipes.
- The proportion of the VOCs in the dampening solution and cleaning agents that is absorbed in the paper web, destroyed in the oxidiser, and therefore not emitted as fugitive emissions.
- The proportion of fugitively emitted VOCs that are transported to the oxidiser through the inlet air of the dryer.

Conservative sector parameters

Where the actual fugitive emissions are expected to be lower than the applicable fugitive emission limit, it may possibly be demonstrated compliance without measurements, substantiated estimates etc. For this purpose, the following conservative parameters can be used:

- Proportion VOC in waste: 0%
- Proportion of VOC in dampening solution emitted fugitively: 90%
- Proportion of cleaning agents emitted fugitively: 85%
- Proportion of fugitive emissions in dryer inlet air: 0%

Calculation method

The following procedure is recommended to determine the fugitive emissions and check compliance with the limit value. The method is designed to use, wherever possible, only information that is, or should be, readily available such as annual quantities used of inks, dampening additives and cleaning agents and information provided by suppliers on the VOC content of their products.

Determine annual input

The annual input is the sum of the VOC content of the inks, dampening additives and cleaning agents used in the applicable year.

For all these products their contribution to the input is calculated by multiplying the quantity of the product used by its VOC content percentage as provided by the supplier. For inks the VOC content at drying temperature may not be available. In that case the inks may be assumed to contain 35 % VOCs.

Conservative estimation of fugitive emissions

Calculate the fugitive emissions using the conservative parameters:

- Assume VOCs in waste: zero.
- Fugitive emissions from dampening solutions:
  - Multiply the amount of VOC in dampening additives by 90 %.
- Fugitive emissions from cleaning agents:
  - Multiply the amount of VOC in cleaning agents by 85 %.
- Assume no VOCs in dryer inlet air.

The total of these calculated emissions is a conservative estimate of the fugitive emissions.

Please note: since the oils in inks are not VOC at room temperature, there do not contribute to the fugitive emissions.

Check estimated fugitive emissions against ELV

Calculate the fugitive emissions as a percentage of annual input and check compliance against the applicable emission limit value. If the value is compliant; no further action is necessary, other than recording the calculations and possibly reporting the result.

Non-compliance and BAT

Where the estimated fugitive emissions are considerably higher (for example several percent of input) than the BAT-AEL, it is likely that BAT is not applied throughout the plant.

The main possible cause for excessive fugitive emissions in heatset web offset printing is the application of isopropanol (IPA) in a too high percentage in the dampening solution. Where the usual percentage IPA is more than 4 % or 5% (w/w) it is unlikely that fugitive emissions lower than the limit value can be obtained. Another possible cause is the application of cleaning agents with a high solvent content.

Where this is the case, it is recommended to first reduce or substitute the amount of IPA consumed or reduce the solvent content of the cleaning agents, before dedicating any effort to an increase of the accuracy of the SMP.

Non-compliance and improved accuracy

Where there is non-compliance of the fugitive emissions, but this non-compliance is not excessive, it is recommended to improve the accuracy of the estimated emissions. For recommendations to increase the accuracy, see below.

Increasing accuracy

Where compliance with the fugitive emission limit value cannot be demonstrated with the parameters used in the conservative simplification for the estimation of fugitive emissions, it will be necessary to measure or estimate some of the emission parameters. This will lead to a lower estimation of the fugitive emissions.

In the order of increasing difficulty, the parameters for which the accuracy may be increased are:

- VOCs in waste;
- VOCs transported to the oxidiser;
- VOCs emitted fugitively from dampening solution;
- VOCs emitted fugitively from cleaning agents.

Proportion VOC in waste

The VOC content of disposed waste is not considered to be emitted. Where an accurate estimation of the amount of VOC in waste is available, this may be subtracted from the fugitive emissions as determine with the conservative simplification. A considerable reduction of the estimation of the fugitive emissions may result.

A substantiated estimate of the VOC content of one or two of the largest waste streams can often be made. These will generally include the waste of cleaning agents for the rubber blanket. Information may be obtained from the company that treats the waste. Where the total weight of the waste stream is determined accurately, a substantiated estimation of the solvent content may be used.

It is recommended to focus on one or two large waste streams. It may be necessary to keep those streams separate from other streams for a considerable period of time in order to determine the total quantity and the VOC content with sufficient accuracy.

Where used cleaning agent is transported to the dryer by the paper web, there may not be a substantial amount of solvent containing waste and this method may not lead to a substantially lower estimation of the fugitive emissions.

Proportion of fugitively emitted VOC's that are transported to the oxidiser

A method for establishing the quantity of fugitive emissions transported to the oxidisers is described in Section 11.4.3.1 (Treatment of air extracted from press room or press encapsulation). It requires a thorough knowledge of the actual ventilation-system of the dryers, the press room, and the press encapsulation.

Proportion of VOC in dampening solution emitted fugitively

A considerable proportion of both the water and the additives in the dampening solution never reach the paper web. They evaporate during the process of producing an ever-thinner layer of water that can be emulgated into the ink or brought onto the plate directly.

Obviously, for the offset process to work, some of the dampening solution must attain the plate and therefore the paper web. It is however hardly known in what the proportion. Very little literature addresses this question. Therefore, the sector parameter of 90% evaporation can be assumed to be conservative. It will be difficult to substantiate any estimations that differ from this conservative parameter.

It may however be possible to estimate how much of the water in the dampening solution evaporates, by establishing the difference between the amount of water fed to the press and the increase in the humidity of the paper web during printing before the dryer. This difference must have evaporated.

If this amount is known, it must be also established to what extent the VOC content evaporates faster or slower than the water and in what concentration it reaches the paper web. With the amount of water reaching the paper web and the VOC concentration at that point, it can be calculated how much VOC has not evaporated and how much has been emitted as fugitive emission.

It will be important to take the temperature into account.

It is not known whether this estimation method has been attempted in practice.

Proportion of cleaning agents emitted fugitively

A distinction must be made between cleaning agents used while the press is running, and the cleaning agents used while the press is standing still.

When the press is standing still, no cleaning agents are transported to the paper web, evaporated in the dryer, and destroyed in the oxidiser. In this case the fugitive emissions are equal to the difference between the amount VOC used and the amount disposed of as waste.

Cleaning while the press is running may result in a proportion of the cleaning agents reaching the paper web, depending on the cleaning system used. Where the system is such that cleaning agents are evacuated by the paper web, an accurate estimation of the amount absorbed by the paper will be more difficult to be made than in the case of the dampening solution, since cleaning is an intermittent process.

Reference literature

- Assessment of printed product recyclability, European Recycled Paper Council, Issue 2 January 2017.
- Emission control Heatset web offset presses, VDI 2587, November 2001.
- Commission Implementing Decision of 16 August 2012 establishing the ecological criteria for the award of the EU Ecolabel for printed paper.

TOTAL EMISSIONS IN HEATSET

1. Accuracy issues when estimating oxidiser emissions

Where the oxidiser emissions need to be estimated a number of accuracy problems will be encountered that are difficult to solve. An approach using conservative default values is a solution. This is possible because generally the oxidiser emissions are but a small part of the total emissions and certainly very low compared to the BATAEL for Total Emissions (4% of the weight of inks used)

Some of the accuracy issues are:

- Measured waste gas concentration are generally not representative for the actual average concentration in the waste gasses. The oxidiser outlet concentration will vary over time, depending on the product being printed.
- The oxidiser outlet concentrations are expressed in mgC/Nm^3 and must be recalculated into mg solvent/Nm^3. This cannot be done accurately with a largely unknown mixture of VOCs as in the Heatset waste gasses. (The following default values may be used: 1 mgC/Nm^3 equals 1,32 mg VOC/Nm3 and 1 mg VOC/Nm^3 equals 0,76 mgC/Nm^3).
- In some calculations the average airflow through the oxidiser must be known. This is best limited to situations where the airflow is not variable. The average of a variable airflow is notoriously difficult to determine accurately.

2. Three different methods

The oxidiser emissions can be estimated in many different ways. The operator is free to employ a method that he considers best suited. In the Intergraf SMB template, three different methods are provided (Download at xxxxxxxx). All three methods can be used for both stand-alone oxidisers and integrated dryer-oxidisers.

<u>Method 1: Worst Case approach based on maximum design exhaust concentration</u>

This method assumes that whenever the press is running, the oxidiser emissions are equal to the Emission Limit Value (ELV). (Which in turn is assumed to be equal to the designed maximum emissions of the oxidiser). For example: 20 mgC/Nm^3. The actual emissions will be much lower since the concentration in the waste gasses only reaches the ELV when the ink coverage of the printed products is at its highest.

Method 2: Conservative approach based on design oxidation efficiency

For this method a conservative destruction efficiency of the oxidiser is estimated and used to calculate the emissions. The destruction efficiency is calculated on the basis of the design inlet and design outlet concentrations for the oxidiser. If these values are not known, conservative default values are provided.

For the default values it is assumed that the oxidiser is designed for the ELV and that the ELV is reached when the VOC concentration at the inlet of the oxidiser is some 2,5 gVOC/m^3, approximately 2.000 mgC/Nm^3. (Which is generally a low value). Under these assumptions, an ELV of 20 mgC/Nm^3 means that 1% of the VOC escapes destruction and will be emitted. If the emission limit value is higher or lower the estimated emissions change proportionally.

Method 3: Estimation based on average exhaust concentration

In this method the estimation of the emissions is based upon actually measured concentrations in the waste gasses of the oxidiser. The measured value is however not necessarily equal to the average value. The products printed during the measurements may not have been 'average' products. A correction factor is needed. This factor must be conservatively estimated by the operator, based upon the ink coverage during the measurements compared to the average ink coverage on the press. For example: if the ink coverage during measurements was 75% and the average ink coverage on the press is 125%, the correction factor 125/75 = 1,7.

2. Calculation of total emissions, check against Emission Limit Value

The total emissions are equal to the sum of the fugitive emissions and the waste has emissions.

The BATAEL for total VOC emissions in Heatset is 4% of ink weight. Where the VOC content of the inks is 525 t/a, the total ink consumption will be 1.500 t/a. The maximum total VOC emission is therefore 60 tonnes per year.

ANNEX 7: ENERGY SAVING OPPORTUNITIES

Opportunities catalogue from the EMPSI project

Please note: The 'opportunities' in this table are not specific for the heatset process. The investment figures and pay-back periods must be determined anew in each case.

RG-4.4.2 Opportunities catalogue

MEASURE	AREA	SAVINGS (%)	INVESTMENT	PAY-BACK (years)
Energy efficient press drive	Process - drying	2-10%	22-45 €/kW	3-5
Gas-heated (IR-) drying	Process - drying			3-7
Reusing residual warmth of dryer and/or linked-up equipment	Process - drying	30-45%	Capacity of 500 m3 air/h: 900 €	3-7
Optimize air household of dryers	Process - drying	10%	4.500 €	<3
Reuse of residual heat of vacuum pumps and compressors	Compressed air/vacuum	3%	Compressor of 32 kW: 1.400-2.800 €	3-7
Central system with cascade switching vacuum pumps and compressors	Compressed air/vacuum	15% electricity		3-7
Low-energy compressors	Compressed air	25% electricity		3-7
Suck in country air	Compressed air	5% electricity	140-180 €/m	3-7
Good Housekeeping compressed air	Compressed air	20% electricity consumption	Among other things a leakage caused by an opening with a diameter of 1 mm costs 30 Euros electricity costs a year, while an opening of 6 mm diameter quickly costs 900 € (with 6 bar overpressure and 8.760 company hours a year).	<1
Installing valve per user/user group	Compressed air	17.000 kWh per valve (diameter 6 mm, 6 bar)	70-225 €/valve	<2
Separate high and low net pressure	Compressed air			4-7
Optimizing pipe diameters and size buffer barrel	Compressed air	30% electricity reduction		3-7
Float-steered water divider (instead of time-steered)	Compressed air	1.500 kWh electricity	225 € (maximum)	<3
Good Housekeeping vacuum	Vacuum	Till 40% in energy consumption	A time switch with a weekly programme costs between 15 and 30 €.	<1
Insulation cold pipes	Cooled water	10% electricity	13mm insulation thickness: 45 €/m2 external pipe surface	<3

Use of free cooling	Cooled water	40% electricity		3-7
Low-energy refrigerators	Cooled water	25% electricity		3-7
Weather dependent control of cooled water	Cooled water	10% cooling energy		3-7
Good Housekeeping cooled water	Cooled water	25%		<3
Use of condenser heat	Cooled water			3-7
Optimization dust/shred exhaustion	Dust/shred exhaustion	8% gas		<5
Building orientation	Building			
Insulation	Building	15-20%	Windows: 150 - 210 €/m2	3-5
			Wall and roof: 10-30 €/m2	
Limiting sun radiation	Building	50%	100-150 €/m	<3
Optimizing ventilation	Building	20-25%		1-5
Frequency control ventilators	Ventilation	20%	700-1000 €/ventilator	3-7
Preventing loss of ventilation	Ventilation		850-1750€	<5
Heat recovery from ventilation air	Ventilation	5% (gas)	Heat wheel 10.000 m3/h: 7.000 €	3-7
Good Housekeeping heating	Heating	10% gas consumption	Minimal	
Controlling temperature per room	Heating	5% (gas)	50-100 €/thermostat	<5
			New buildings: 25 € of extra charges	
Support ventilators	Heating	1% gas consumption	250 €/100 m2 (floor area)	<5
Application of high efficiency air heaters	Heating	10% gas saving	In regard to conventional air heaters, extra investment: 20 €/kW	<5
Application of radiation heating	Heating	10% gas saving		<5
		40-50% in favourable cases		
Application of low temperature heating system	Heating	10%		<5
Hot-tap water production at tap point	Heating	10 % gas saving for		<5
		hot- water production		
High efficiency boiler or combination HE/IE boiler	Heating	10% gas	Compared with a conventional boiler or an improved efficiency boiler, extra investment: 32 €/kW, which is about 2300 € for a 70 kW high efficiency boiler	3-7
Weather dependent control	Heating	5% gas	10-30€/kW of the boiler capacity of extra investment, depending on the type of boiler	3-5
Optimizing unit	Heating	5-15% gas consumption	900 €	3-7
Cascade/ boiler order connection	Heating	5% gas consumption		3-5
Insulation pipes, valves, and appendages	Heating	3% gas	Insulation thickness of 25 mm: 7 €/m pipe	<3

Vaporization cooling	Cooling	100% on cool energy		3-7
Good Housekeeping space cooling	Cooling	10% on cool energy	Minimal	<3
Point exhaustion	Cooling			<5
Application low-energy humidifying system	Humidifying	5% electricity		
Good Housekeeping humidifying	Humidifying	0,4	Minimal	<3
Drawing up a lighting plan	Lighting	30-40% electricity consumption	It depends on the measures	3-7
Low-energy lighting, such as T-5 and T-8 fluorescent lamps, compact fluorescent lighting (CFL) or Light emitting diodes (LEDs)	Lighting	10-40% electricity consumption	Low-energy light bulbs: 4-10 €/bulb	3-7
Light control equipment (control of the daylight entering, occupancy sensors, task lighting)	Lighting	Occupancy sensors: 13-80% depending on the type of space. 50% (small offices) and 10-20% (open space offices) CFLs: 47%		CFLs: 2-3
Building Management System	Electricity/natural gas general	10%	7.000-40.000 €	3-7

PART 2
LEGAL TEXT AND EXPLANATIONS

1 INTRODUCTION

HEATSET GUIDANCE IN TWO PARTS

This Intergraf guidance note for BAT in Heatset consist of two parts.

- **Part 1** describes techniques that, when implemented in Heatset plants will result in an operation in accordance with the BAT conclusions in the Commission Implementing Decision (CID). The techniques are described in practical 'Heatset terms'.
- In **Part 2** the legal text of the Commission Implementing Decision is reproduced, insofar as relevant to Heatset, and annotated. The annotations clarify and substantiate the choices that were made for the conversion of this legal text into the Intergraf Guidance to BAT in Heatset.

From sector specific to general

The BAT conclusions in the CID start with the most general ('Environmental Management System') and end with the most specific ('BAT conclusions for heatset web offset printing'). From the point of view of practical implementation, this is not a logical order; especially since there is a considerable overlap between the general BATs and Heatset specific BAT's.

Therefore, for compiling the Intergraf Guidance in Part 1, the reversed order has been used. The Heatset specific techniques, as described under BAT 28, are used as the starting point and are at the heart of the guidance note. The general BATs are transposed into the Guidance to the extent that their subject is not already adequately covered by the Heatset specific techniques.

The BAT Conclusions that are part of the Guidance are coloured yellow.

Additions

The Commission Implementing Decision is extensive, but not comprehensive. In cases where, within an environmental subject addressed in the CID, one or more techniques were missing, these have been taken up in Part 1 as 'Industry Best Practice' (for example: disposal of aqueous waste from cleaning and dampening solutions).

Where environmental subjects or manufacturing processes are not addressed in the CID at all, they are also not addressed in the Guidance (for example: platemaking).

Both situations are clearly indicated.

Deviation

In a few cases, the Intergraf Heatset Guidance deviates from the CID. Where this is the case, this is made explicit, clarified and substantiated in Part 2. In each case, the deviation is based upon the General Considerations in the BAT conclusions, which start with the following:

> *The techniques listed and described in these BAT conclusions are neither prescriptive nor exhaustive. Other techniques may be used that ensure at least an equivalent level of environmental protection.*

Deviations have been avoided as much as possible. For each deviation, it is substantiated why the alternative ensures '*at least an equivalent level of environmental protection*'.

9.12.2020 EN Official Journal of the European Union L 414/19

COMMISSION IMPLEMENTING DECISION (EU) 2020/2009

of 22 June 2020

establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions, for surface treatment using organic solvents including preservation of wood and wood products with chemicals

(notified under document C(2020) 4050)

(Text with EEA relevance)

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) (1), and in particular Article 13(5) thereof,

Whereas:

(1) Best available techniques (BAT) conclusions are the reference for setting permit conditions for installations covered by Chapter II of Directive 2010/75/EU and competent authorities should set emission limit values which ensure that, under normal operating conditions, emissions do not exceed the emission levels associated with the best available techniques as laid down in the BAT conclusions.

(2) The forum composed of representatives of Member States, the industries concerned and non-governmental organisations promoting environmental protection, established by Commission Decision of 16 May 2011 (2), provided the Commission on 18 November 2019 with its opinion on the proposed content of the BAT reference document for surface treatment using organic solvents including preservation of wood and wood products with chemicals. That opinion is publicly available.

(3) The BAT conclusions set out in the Annex to this Decision are the key element of that BAT reference document.

(4) The measures provided for in this Decision are in accordance with the opinion of the Committee established by Article 75(1) of Directive 2010/75/EU,

HAS ADOPTED THIS DECISION:

Article 1

The best available techniques (BAT) conclusions for surface treatment using organic solvents including preservation of wood and wood products with chemicals, as set out in the Annex, are adopted.

Article 2

This Decision is addressed to the Member States.

Done at Brussels, 22 June 2020.

For the Commission
Virginijus SINKEVIČIUS
Member of the Commission

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(1) OJ L 334, 17.12.2010, p. 17.

(2) Commission Decision of 16 May 2011 establishing a forum for the exchange of information pursuant to Article 13 of Directive 2010/75/EU on industrial emissions (OJ C 146, 17.5.2011, p. 3).

ANNEX

Best available techniques (BAT) conclusions for surface treatment using organic solvents including preservation of wood and wood products with chemicals

SCOPE

These BAT conclusions concern the following activities specified in Annex I to Directive 2010/75/EU:

6.7:Surface treatment of substances, objects or products using organic solvents, in particular for dressing, printing, coating, degreasing, waterproofing, sizing, painting, cleaning or impregnating, with an organic solvent consumption capacity of more than 150 kg per hour or more than 200 tonnes per year.

6.10:Preservation of wood and wood products with chemicals with a production capacity exceeding 75 m^3 per day other than exclusively treating against sapstain.

6.11:Independently operated treatment of waste water not covered by Directive 91/271/EEC provided that the main pollutant load originates from activities specified in point 6.7 or 6.10 of Annex I to Directive 2010/75/EU.

These BAT conclusions also cover the combined treatment of waste water from different origins provided that the main pollutant load originates from the activities specified in point 6.7 or 6.10 of Annex I to Directive 2010/75/EU and that the waste water treatment is not covered by Council Directive 91/271/EEC ([1]).

These BAT conclusions do not address the following:

For surface treatment of substances, objects or products using organic solvents:
— Waterproofing of textiles by means other than the use of a solvent-based continuous film. This may be covered by the BAT conclusions for the textiles industry (TXT).
— Printing, sizing and impregnation of textiles. This may be covered by the BAT conclusions for the textiles industry (TXT).
— Lamination of wood-based panels.
— Conversion of rubber.
— Manufacturing of coating mixtures, varnishes, paints, inks, semiconductors, adhesives or pharmaceutical products.
— On-site combustion plants unless the hot gases generated are used for direct contact heating, drying or any other treatment of objects or materials. These may be covered by the BAT conclusions for large combustion plants (LCP) or by Directive 2015/2193/EU of the European Parliament and of the Council (2).

For preservation of wood and wood products with chemicals:
— Chemical modification and hydrophobisation (e.g. using resins) of wood and wood products.
— Sapstain treatment of wood and wood products.
— Ammonia treatment of wood and wood products.
— On-site combustion plants. These may be covered by the BAT conclusions for large combustion plants (LCP) or by Directive 2015/2193/EU.

Other BAT conclusions and reference documents which may be of relevance for the activities covered by these BAT conclusions are the following:
— Economics and Cross-Media Effects (ECM).
— Emissions from Storage (EFS).

— Energy Efficiency (ENE).
— Waste Treatment (WT).
— Large Combustion Plants (LCP).
— Surface Treatment of Metals and Plastics (STM).
— Monitoring of Emissions to Air and Water from IED Installations (ROM).

BAT IN HEATSET

For the Intergraf Guidance to BAT in Heatset it was not necessary to make use of other BAT conclusions then those in this Commission Implementing Decision.

It must be noted that Heatset web offset plants are among the smallest plants in scope of the IED. They are generally much smaller than those to which the BAT´s from the conclusion listed above apply; if not in manpower and finances than certainly in the size of their emissions.

DEFINITIONS

For the purposes of these BAT conclusions, the following definitions apply:

General terms	
Term used	**Definition**
Base coat	Paint which, when applied to a substrate, determines the colour and the effect (e.g. metallic, pearlescent).
Batch discharge	Discharge of a discrete, contained volume of water.
Clear coat	Coating material which, when applied to a substrate, forms a solid transparent film with protective, decorative or specific technical properties.
Combiline	Combination of hot-dip galvanising and coil coating in the same process line.
Continuous measurement	Measurement using an automated measuring system permanently installed on site for continuous monitoring of emissions, according to EN 14181.
Direct discharge	Discharge to a receiving water body without further downstream waste water treatment.
Emission factors	Coefficients that can be multiplied by known data such as plant/process data or throughput data to estimate emissions.
Existing plant	A plant that is not a new plant.
Fugitive emissions	Fugitive emissions as defined in Article 57(3) of Directive 2010/75/EU.
Grade B or C creosote	Types of creosote for which specifications are given in EN 13991.
Indirect discharge	Discharge which is not a direct discharge.

Major plant upgrade	A major change in the design or technology of a plant with major adjustments or replacements of the process and/or abatement technique(s) and associated equipment.
New plant	A plant first permitted on the site of the installation following the publication of these BAT conclusions or a complete replacement of a plant following the publication of these BAT conclusions.
Off-gas	The gas extracted from a process, piece of equipment or area which is either directed to treatment or discharged directly to air through a stack.
Organic compound	Organic compound as defined in Article 3(44) of Directive 2010/75/EU.
Organic solvent	Organic solvent as defined in Article 3(46) of Directive 2010/75/EU.
Plant	All parts of an installation that carry out an activity listed in point 6.7 or 6.10 of Annex I to Directive 2010/75/EU and any other directly associated activities which have an effect on consumption and/or emissions. Plants may be new plants or existing plants.
Primer coat	Paint formulated for use as a layer on a prepared surface, to provide good adhesion, protection of any layers below and filling of surface irregularities.
Sector	Any of the surface treatment activities that are part of activities listed in point 6.7 of Annex I to Directive 2010/75/EU and are referred to in Section 1 of these BAT conclusions.
Sensitive receptor	Area which needs special protection, such as: — residential areas, — areas where human activities are carried out (e.g. neighbouring workplaces, schools, day-care centres, recreational areas, hospitals or nursing homes).
Solid mass input	The total mass of solids used as defined in Part 5, 3(a)(i) of Annex VII to Directive 2010/75/EU.
Solvent	‘Solvent’ refers to ‘organic solvent’.
Solvent input	The total quantity of organic solvents used as defined in Part 7, 3(b) of Annex VII to Directive 2010/75/EU.
Solvent-based (SB)	Type of paint, ink or other coating material using solvent(s) as the carrier. For the preservation of wood and wood products, it refers to the type of treatment chemicals.
Solvent-based-mix (SB-mix)	Solvent-based coating where one of the coating layers is water-based (WB).
Solvent mass balance (SMB)	A mass balance exercise conducted at least once every year according to Part 7 of Annex VII to Directive 2010/75/EU.
Surface run-off water	Water from precipitation that flows over land or impervious surfaces, such as paved streets and storage areas, rooftops, etc. and does not soak into the ground.
Total emissions	The sum of fugitive emissions and emissions in waste gases as defined in Article 57(4) of Directive 2010/75/EU.
Treatment chemicals	Chemicals used in wood and wood products preservation such as biocides, chemicals used for waterproofing (e.g. oils, emulsions) and flame retardants. This also includes the carrier of active substances (e.g. water, solvent).

Valid hourly/half-hourly average	An hourly/half-hourly average is considered valid when there is no maintenance or malfunction of the automated measuring system.
Waste gases	Waste gases as defined in Article 57(2) of Directive 2010/75/EU.
Water-based (WB)	Type of paint, ink or other coating material in which water replaces all or part of the solvent content. For the preservation of wood and wood products, it refers to the type of treatment chemicals.
Wood preservation	Activities whose purpose is to protect wood and wood products from the damaging effects of fungi, bacteria, insects, water, weather or fire; to provide long-term conservation of structural integrity; and to improve the resistance of wood and wood products.

Pollutants and parameters	
Term used	**Definition**
AOX	Adsorbable organically bound halogens, expressed as Cl, include adsorbable organically bound chlorine, bromine and iodine.
CO	Carbon monoxide.
COD	Chemical oxygen demand. Amount of oxygen needed for the total chemical oxidation of the organic matter to carbon dioxide using dichromate. COD is an indicator for the mass concentration of organic compounds.
Chromium	Chromium, expressed as Cr, includes all inorganic and organic chromium compounds, dissolved or bound to particles.
DMF	*N*,*N*-Dimethylformamide.
Dust	Total particulate matter (in air).
F^-	Fluoride.
Hexavalent chromium	Hexavalent chromium, expressed as Cr(VI), includes all chromium compounds where the chromium is in the oxidation state +6 (dissolved or bound to particles).
HOI	Hydrocarbon oil index. The sum of compounds extractable with a hydrocarbon solvent (including long-chain or branched aliphatic, alicyclic, aromatic or alkyl-substituted aromatic hydrocarbons).
IPA	Isopropyl alcohol: propan-2-ol (also called isopropanol).
Nickel	Nickel, expressed as Ni, includes all inorganic and organic nickel compounds, dissolved or bound to particles.
NO_X	The sum of nitrogen monoxide (NO) and nitrogen dioxide (NO_2), expressed as NO_2.
PAHs	Polycyclic aromatic hydrocarbons.
TOC	Total organic carbon, expressed as C (in water).
TVOC	Total volatile organic carbon, expressed as C (in air).
TSS	Total suspended solids. Mass concentration of all suspended solids (in water), measured via filtration through glass fibre filters and gravimetry.
VOC	Volatile organic compound as defined in Article 3(45) of Directive 2010/75/EU.
Zinc	Zinc, expressed as Zn, includes all inorganic and organic zinc compounds, dissolved or bound to particles.

ACRONYMS

For the purposes of these BAT conclusions, the following acronyms apply:

Acronym	Definition
BPR	Biocidal Products Regulation (Regulation (EU) No 528/2012 of the European Parliament and of the Council of 22 May 2012 concerning the making available on the market and use of biocidal products, OJ L 167, 27.6.2012, p. 1).
DWI	Drawn and wall ironed (a type of can in the metal packaging industry).
EMS	Environmental management system.
IED	Industrial Emissions Directive (2010/75/EU).
IR	Infrared.
LEL	Lower explosive limit – the lowest concentration (percentage) of a gas or vapour in air capable of producing a flash of fire in the presence of an ignition source. Concentrations lower than LEL are 'too lean' to burn. Also called lower flammable limit (LFL).
OTNOC	Other than normal operating conditions.
STS	Surface treatment using organic solvents.
UV	Ultraviolet.
WPC	Preservation of wood and wood products with chemicals.

GENERAL CONSIDERATIONS

Best Available Techniques

The techniques listed and described in these BAT conclusions are neither prescriptive nor exhaustive. Other techniques may be used that ensure at least an equivalent level of environmental protection.

Unless otherwise stated, these BAT conclusions are generally applicable.

Emission levels associated with the best available techniques (BAT-AELs)

BAT-AELs for total and fugitive VOC emissions

For total VOC emissions, the emission levels associated with the best available techniques (BAT-AELs) are given in these BAT conclusions:

— as a specific emission load calculated as yearly averages by dividing the total emissions of VOCs (as calculated by the solvent mass balance) by a sector-dependent production input (or throughput) parameter; or

— as a percentage of the solvent input, calculated as yearly averages as per Part 7, 3(b)(i) of Annex VII to Directive 2010/75/EU.

For fugitive VOC emissions, the emission levels associated with the best available techniques (BAT-AELs) are given in these BAT conclusions as a percentage of the solvent input, calculated as yearly averages as per Part 7, 3(b)(i) of Annex VII to Directive 2010/75/EU.

BAT-AELs and indicative emission levels for emissions in waste gases

Emission levels associated with the best available techniques (BAT-AELs) and indicative emission levels for emissions in waste gases given in these BAT conclusions refer to concentrations, expressed as mass of emitted substance per volume of waste gas under the following standard conditions: dry gas, at a temperature of 273,15 K and a pressure of 101,3 kPa, without correction for oxygen content and expressed in mg/Nm^3.

For averaging periods of BAT-AELs and indicative emission levels for emissions in waste gases, the following definitions apply.

Type of measurement	Averaging period	Definition
Continuous	Daily average	Average over a period of one day based on valid hourly or half-hourly averages.
Periodic	Average over the sampling period	Average value of three consecutive measurements of at least 30 minutes each [3].

BAT-AELs for emissions to water

Emission levels associated with the best available techniques (BAT-AELs) for emissions to water given in these BAT conclusions refer to concentrations (mass of emitted substance per volume of water), expressed in mg/l.

Averaging periods associated with the BAT-AELs refer to either of the following two cases:
— in the case of continuous discharge, daily average values, i.e. 24-hour flow-proportional composite samples;
— in the case of batch discharge, average values over the release duration taken as flow-proportional composite samples.

Time-proportional composite samples can be used provided that sufficient flow stability is demonstrated. Alternatively, spot samples may be taken, provided that the effluent is appropriately mixed and homogeneous. Spot samples are taken if the sample is unstable with respect to the parameter to be measured. All BAT-AELs for emissions to water apply at the point where the emission leaves the plant.

Other environmental performance levels

Specific energy consumption (energy efficiency) levels associated with the best available techniques (BAT-AEPLs)

The environmental performance levels related to specific energy consumption refer to yearly averages calculated using the following equation:

$$\text{specific energy consumption} = \frac{\text{energy consumption}}{\text{activity rate}}$$

where:

energy consumption :the total amount of heat (generated by primary energy sources) and electricity consumed by the plant, as defined in the energy efficiency plan (see BAT 19 (a)), expressed in MWh/year;
activity rate :total amount of products processed by the plant or plant throughput, expressed in the appropriate unit depending on the sector (e.g. kg/year, m^2/year, vehicles coated/year).

Specific water consumption levels associated with the best available techniques (BAT-AEPLs)

The environmental performance levels related to specific water consumption refer to yearly averages calculated using the following equation:

$$\text{specific water consumption} = \frac{\text{water consumption}}{\text{activity rate}}$$

where:
water consumption :total amount of water consumed by the activities carried out in the plant excluding recycled and reused water, cooling water used in once-through cooling systems, as well as water for domestic-type usage, expressed in l/year or m^3/year;
activity rate :total amount of products processed by the plant or plant throughput expressed in the appropriate unit depending on the sector (e.g. m^2 of coated coil/year, vehicles coated/year, thousand cans/year).

Indicative levels for specific waste quantity sent off site

The indicative levels related to the specific quantity of waste sent off site refer to yearly averages calculated using the following equation:

$$\text{specific waste quantity sent off site} = \frac{\text{waste quantity sent off site}}{\text{activity rate}}$$

where:
waste quantity sent off site: :total amount of waste sent off site by the plant, expressed in kg/year;
activity rate :total amount of products processed by the plant or plant throughput expressed in vehicles coated/year.

1. BAT CONCLUSIONS FOR SURFACE TREATMENT USING ORGANIC SOLVENTS

1.1. General BAT conclusions

1.1.1. *Environmental Management Systems*

BAT 1. In order to improve the overall environmental performance, BAT is to elaborate and implement an Environmental Management System (EMS) that incorporates all of the following features:

BAT IN HEATSET

- BAT 1 is, to the extent necessary in Heatset, covered in Heatset Technique W: ‘Management System’
- In Heatset it is BAT to list the necessary investments, changes in raw materials that are used or working methods. The list of necessary changes can be derived from the Intergraf BAT Guidance Part 1.
- Based on this list it is to be decided if and to what extent the existing management structure can be expected to bring these changes to a good end. Where this is not the case, the structure is to be adapted.

An Environmental Management System is a powerful management tool. But it is also a considerable burden. Heatset plants are often Small or Medium Sized Enterprises with a headcount of less than 250. Implementing a full fledged EMS, incorporating all the features metioned in BAT 1, is a task that is much more time consuming and complicated than necessary to implement BAT in Heatset. In Heatset, an ‘equivalent level of environmental protection’ can be ensured without the implementation of such a full fledged EMS.

However, implementing BAT in a Heatset plant does generally imply a number of projects. For example: reduction of the IPA content in dampening solutions, increase of the energy efficiency, production of an annual Solvent Mass Balances, keeping track of the solvent content of waste, etc. Allthough a full fledged EMS is not necessayr, there is certainly a need for adequate management attention, with clearly defined and alocated responsibilities.

Most modern Heatset plants will already have implemented a considerable part of the techniques listed in Part 1 of the Guidance note. In Heatset it is therefore most efficient to apply a practical ‘bottom up’ approach. This starts with the identification of all the projects that still need to be undertaken and then, where necessary, adapt the management stucture in such a way that these projects will be brought to a good end.

(i) commitment, leadership, and accountability of the management, including senior management, for the implementation of an effective EMS;

(ii) an analysis that includes the determination of the organisation’s context, the identification of the needs and expectations of interested parties, the identification of characteristics of the installation that are associated with possible risks for the environment (or human health) as well as of the applicable legal requirements relating to the environment;

(iii) development of an environmental policy that includes the continuous improvement of the environmental performance of the installation;

(iv) establishing objectives and performance indicators in relation to significant environmental aspects, including safeguarding compliance with applicable legal requirements;

(v) planning and implementing the necessary procedures and actions (including corrective and preventive actions where needed), to achieve the environmental objectives and avoid environmental risks;

(vi) determination of structures, roles and responsibilities in relation to environmental aspects and objectives and provision of the financial and human resources needed;

(vii) ensuring the necessary competence and awareness of staff whose work may affect the environmental performance of the installation (e.g. by providing information and training);

(viii) internal and external communication;

(ix) fostering employee involvement in good environmental management practices;

(x) establishing and maintaining a management manual and written procedures to control activities with significant environmental impact as well as relevant records;

(xi) effective operational planning and process control;

(xii) implementation of appropriate maintenance programmes;

(xiii) emergency preparedness and response protocols, including the prevention and/or mitigation of the adverse (environmental) impacts of emergency situations;

(xiv) when (re)designing a (new) installation or a part thereof, consideration of its environmental impacts throughout its life, which includes construction, maintenance, operation and decommissioning;

(xv) implementation of a monitoring and measurement programme; if necessary, information can be found in the Reference Report on Monitoring of Emissions to Air and Water from IED Installations;

(xvi) application of sectoral benchmarking on a regular basis;

(xvii) periodic independent (as far as practicable) internal auditing and periodic independent external auditing in order to assess the environmental performance and to determine whether or not the EMS conforms to planned arrangements and has been properly implemented and maintained;

(xviii) evaluation of causes of nonconformities, implementation of corrective actions in response to nonconformities, review of the effectiveness of corrective actions, and determination of whether similar nonconformities exist or could potentially occur;

(xix) periodic review, by senior management, of the EMS and its continuing suitability, adequacy and effectiveness;

(xx) following and taking into account the development of cleaner techniques.

Specifically for surface treatment using organic solvents, BAT is also to incorporate the following features in the EMS:

(i) Interaction with quality control and assurance as well as health and safety considerations.

(ii) Planning to reduce the environmental footprint of an installation. In particular, this involves the following:

(a) assessing the overall environmental performance of the plant (see BAT 2);

(b) taking into account cross-media considerations, especially the maintenance of a proper balance between solvent emissions reduction and consumption of energy (see BAT 19), water (see BAT 20) and raw materials (see BAT 6);

(c) reducing VOC emissions from cleaning processes (see BAT 9).

(iii) The inclusion of:

(a) a plan for the prevention and control of leaks and spillages (see BAT 5 (a));

(b) a raw material evaluation system to use raw materials with low environmental impact and a plan to optimise the use of solvents in the process (see BAT 3);

(c) a solvent mass balance (see BAT 10);

(d) a maintenance programme to reduce the frequency and environmental consequences of OTNOC (see BAT 13);

(e) an energy efficiency plan (see BAT 19 (a));

(f) a water management plan (see BAT 20 (a));

(g) a waste management plan (see BAT 22 (a));

(h) an odour management plan (see BAT 23).

Note
Regulation (EC) No 1221/2009 establishes the European Union eco-management and audit scheme (EMAS), which is an example of an EMS consistent with this BAT.

Applicability
The level of detail and the degree of formalisation of the EMS will generally be related to the nature, scale and complexity of the installation, and the range of environmental impacts it may have.

1.1.2. *Overall environmental performance*

BAT 2. In order to improve the overall environmental performance of the plant, in particular concerning VOC emissions and energy consumption, BAT is to:

— identify the process areas/sections/steps that represent the greatest contribution to the VOC emissions and energy consumption and the greatest potential for improvement (see also BAT 1);
— identify and implement actions to minimise VOC emissions and energy consumption;
— regularly (at least once every year) update the situation and follow up the implementation of the identified actions.

BAT IN HEATSET

- BAT 2 regarding VOC emissions: This part of BAT 2 is adequately addressed in Heatset specific BAT 28 and in the corresponding Heatset Techniques A-F. There is no need for a separate study.
    - In Heatset the VOC emissions are caused by the drying of the inks, cleaning of the press and rubber blanket and the additives in the dampening solutions. Each of these sources of emissions and the corresponding method to reduce these emissions is adequately addressed in BAT 28 and the corresponding 'Heatset Techniques'.
- BAT 2 regarding Energy consumption: The single most important reduction in energy consumption is addressed in BAT 28.d and Heatset Techniques A: 'VOC: Waste Gas emissions' and M: Energy: Dryer oxidiser'. These technique concern the application of integrated dryer oxidisers, considerably reducing the gas consumption.
- Other possible reduction in energy consumption are covered by Heatset Technique N: 'Energy: Other reduction measures'.

1.1.3. *Selection of raw materials*

BAT 3. In order to prevent or reduce the environmental impact of the raw materials used, BAT is to use both of the techniques given below.

BAT IN HEATSET

- The selection of raw materials in order to reduce the environmental impact of Heatset is addressed in BAT 28 a & c and BAT 9.d and is part of Heatset Techniques B: 'VOC: Cleaning rubber blankets', C: 'VOC: Manual Cleaning' and D: 'VOC: Dampening solution'.

Technique		Description	Applicability
(a)	Use of raw materials with a low environmental impact	As part of the EMS (see BAT 1), systematic evaluation of the adverse environmental impacts of the materials used (in particular substances that are carcinogenic, mutagenic and toxic to reproduction as well as substances of very high concern) and substitution by others with no or lower environmental and health impacts where possible, taking into consideration the product quality requirements or specifications.	Generally applicable. The scope (e.g. level of detail) and nature of the evaluation will generally be related to the nature, scale and complexity of the plant and the range of environmental impacts it may have, as well as to the type and quantity of materials used.
(b)	Optimisation of the use of solvents in the process	Optimisation of the use of solvents in the process by a management plan (as part of the EMS (see BAT 1)) that aims to identify and implement necessary actions (e.g. colour batching, optimising spray pulverisation).	Generally applicable.

BAT 4. In order to reduce solvent consumption, VOC emissions and the overall environmental impact of the raw materials used, BAT is to use one or a combination of the techniques given below.

BAT IN HEATSET

- BAT 4.h is the only technique applicable in Heatset. This technique is fully covered by BAT 28 a & c and BAT 9.d and is part of Heatset Techniques B: 'VOC: Cleaning rubber blankets', C: 'VOC: Manual Cleaning' and D: 'VOC: Dampening solution'.

Technique		Description	Applicability
(a)	Use of high-solids solvent-based paints/coatings/varnishes/inks/adhesives	Use of paints, coatings, liquid inks, varnishes	The selection of the surface treatment techniques may be

		and adhesives containing a low amount of solvents and an increased solids content.	restricted by the activity type, the substrate type and shape, product quality requirements as well as the need to ensure that the materials used, coating application techniques, drying/curing techniques and off-gas treatment systems are mutually compatible.
(b)	Use of water-based paints/coatings/inks/varnishes/adhesives	Use of paints, coatings, liquid inks, varnishes and adhesives where organic solvent is partially replaced by water.	
(c)	Use of radiation-cured inks/coatings/paints/varnishes/adhesives	Use of paints, coatings, liquid inks, varnishes and adhesives suitable to be cured by the activation of specific chemical groups by UV or IR radiation, or fast electrons, without heat and without emission of VOCs.	
(d)	Use of solvent-free two-component adhesives	Use of solvent-free two-component adhesive materials consisting of a resin and a hardener.	
(e)	Use of hot-melt adhesives	Use of coating with adhesives made from the hot extrusion of synthetic rubbers, hydrocarbon resins and various additives. No solvents are used.	
(f)	Use of powder coatings	Use of solvent-free coating which is applied as a finely divided powder and cured in thermal ovens.	
(g)	Use of laminate film for web or coil coatings	Use of polymer films applied onto a coil or web in order to give aesthetic or functional properties, which reduces the number of coating layers needed.	
(h)	Use of substances which are not VOCs or are VOCs of a lower volatility	Substitution of high-volatility VOC substances with others	

		containing organic compounds that are non-VOCs or VOCs of a lower volatility (e.g. esters).	

1.1.4. *Storage and handling of raw materials*

BAT 5. In order to prevent or reduce fugitive VOC emissions during storage and handling of solvent-containing materials and/or hazardous materials, BAT is to apply the principles of good housekeeping by using all of the techniques given below.

BAT IN HEATSET

- BAT 5.b, c, d, e & g are covered by Heatset Technique S: 'Storage of solvent containing raw materials'.
- BAT 5.a is part of Heatset Techniques S: 'Storage of solvent containing raw materials' and W: 'General: Management system'.

Heatset inks are not fluid and do not contain any VOC at room temperature. Since only cleaning agents and additives for the dampening solution may give rise to emissions during storage and handling, the 'nature, scale and complexity of the installation and the qantity of the materials used' is such that an eleborate or formalised plan for storage is not necessary. BAT 5.a is however recommended as a checklist.

- BAT 5.f: The only volatile bulk chemical used in Heatset is Isopropanol, as used in a part of the plants. The amount of IPA that could be captured during delivery is minute, where the bulk (up to 90%) of the IPA will emitted fugitively. Reduction of these fugitive emissions through the capture of the vapours during delivery is not efficient or cost effective.

	Technique	Description	Applicability
Management techniques			
(a)	Preparation and implementation of a plan for the prevention and	A plan for the prevention and control of leaks and spillages is part of the EMS (see BAT 1) and includes, but is not limited to:	Generally applicable. The scope (e.g. level of detail) of the plan will generally be related to the nature, scale and

	control of leaks and spillages	—site incident plans for small and large spillages; —identification of the roles and responsibilities of persons involved; —ensuring staff are environmentally aware and trained to prevent/deal with spillage incidents; —identification of areas at risk of spillage and/or leaks of hazardous materials and ranking them according to the risk; —in identified areas, ensuring suitable containment systems are in place, e.g. impervious floors; —identification of suitable spillage containment and clean-up equipment and regularly ensuring it is available, in good working order and close to points where these incidents may occur; —waste management guidelines for dealing with waste arising from spillage control; —regular (at least once every year) inspections of storage and operational areas, testing and calibration of leak detection equipment and prompt repair of leaks from valves, glands, flanges, etc. (see BAT 13).	complexity of the installation, as well as to the type and quantity of materials used.
Storage techniques			
(b)	Sealing or covering of containers and bunded storage area	Storage of solvents, hazardous materials, waste solvents and waste cleaning materials in sealed or covered containers, suitable for the associated risk and designed to minimise emissions. The containers' storage area is bunded and of adequate capacity.	Generally applicable.
(c)	Minimisation of storage of hazardous materials in production areas	Hazardous materials are present in production areas only in amounts that are necessary for production; larger quantities are stored separately.	
Techniques for pumping and handling liquids			
(d)	Techniques to prevent leaks and spillages during pumping	Leaks and spillages are prevented by using pumps and seals suitable for the material handled and which ensure proper tightness. This includes equipment such as canned motor pumps, magnetically coupled pumps, pumps with multiple mechanical seals and a	Generally applicable.

		quench or buffer system, pumps with multiple mechanical seals and seals dry to atmosphere, diaphragm pumps or bellow pumps.	
(e)	Techniques to prevent overflows during pumping	This includes ensuring for example that: — the pumping operation is supervised; — for larger quantities, bulk storage tanks are fitted with acoustic and/or optical high-level alarms, with shut-off systems if necessary.	
(f)	Capture of VOC vapour during solvent-containing material delivery	When delivering solvent-containing materials in bulk (e.g. loading or unloading of tanks), the vapour displaced from receiving tanks is captured, usually by back-venting.	May not be applicable for solvents with low vapour pressure or due to cost considerations.
(g)	Containment for spills and/or rapid take-up when handling solvent-containing materials	When handling solvent-containing materials in containers, possible spills are avoided by providing containment, e.g. by using trolleys, pallets and/or stillages with built-in containment (e.g. 'catch pans') and/or rapid take-up by using absorbent materials.	Generally applicable.

1.1.5. *Distribution of raw materials*

BAT 6. In order to reduce raw material consumption and VOC emissions, BAT is to use one or a combination of the techniques given below.

BAT IN HEATSET

- BAT 6.a is covered by Heatset Technique T: 'Pumping & handling of solvent containing raw materials'.
- BAT 6.b – f are not applicable in Heatset. They are all aimed at emissions associated with colour changes. In Heatset however changes in colour rarely occur since always the same four olours are used.

Technique		Description	Applicability
(a)	Centralised supply of VOC-containing materials (e.g.	Supply of VOC-containing materials (e.g. inks, coatings, adhesives, cleaning agents) to the application area by direct piping with	May not be applicable in the case of frequent changes of

	inks, coatings, adhesives, cleaning agents)	ring lines, including system cleaning such as pig cleaning or air flushing.	inks/paints/coatings/adhesives or solvents.
(b)	Advanced mixing systems	Computer-controlled mixing equipment to achieve the desired paint/coating/ink/adhesive.	Generally applicable.
(c)	Supply of VOC-containing materials (e.g. inks, coatings, adhesives, cleaning agents) at the point of application using a closed system	In the case of frequent changes of inks/paints/coatings/adhesives and solvents or for small-scale usage, supply of inks/paints/coatings/adhesives and solvents from small transport containers placed near the application area using a closed system.	
(d)	Automation of colour change	Automated colour changing and ink/paint/coating line purging with solvent capture.	
(e)	Colour grouping	Modification of the sequence of products to achieve large sequences with the same colour.	
(f)	Soft purge in spraying	Refilling the spray gun with new paint without intermediate rinsing.	

1.1.6. *Coating application*

BAT 7. In order to reduce raw material consumption and the overall environmental impact of the coating application processes, BAT is to use one or a combination of the techniques given below.

BAT IN HEATSET

- BAT 7 is not applicable to Heatset. Printing is not a coating process.

Technique		Description	Applicability
Techniques for non-spraying application			
(a)	Roller coating	Application where rollers are used to transfer or meter the liquid coating onto a moving strip.	Only applicable to flat substrates [4].

(b)	Doctor blade over roller	The coating is applied to the substrate through a gap between a blade and a roller. As the coating and substrate pass, the excess is scraped off.	Generally applicable (4).
(c)	No-rinse (dry-in-place) application in the coating of coil	Application of conversion coatings which do not require a further water rinse using a roller coater (chemcoater) or squeegee rollers.	Generally applicable (4).
(d)	Curtain coating (casting)	Work-pieces are passed through a laminar film of coating discharged from a header tank.	Only applicable to flat substrates (4).
(e)	Electrocoating (e-coat)	Paint particles dispersed in a water-based solution are deposited on immersed substrates under the influence of an electric field (electrophoretic deposition).	Only applicable to metal substrates (4).
(f)	Flooding	The work-pieces are transported via conveyor systems into a closed channel, which is then flooded with the coating material via injection tubes. The excess material is collected and reused.	Generally applicable (4).
(g)	Co-extrusion	The printed substrate is coupled with a warm, liquefied plastic film and subsequently cooled down. This film replaces the necessary additional coating layer. It may be used between two different layers of different carriers acting as an adhesive.	Not applicable where high bond strength or resistance to sterilisation temperature is needed (4) .
Spraying atomisation techniques			
(h)	Air-assisted airless spraying	An airflow (shaping air) is used to modify the spray cone of an airless spray gun.	Generally applicable (4).
(i)	Pneumatic atomisation with inert gases	Pneumatic paint application with pressurised inert gases (e.g. nitrogen, carbon dioxide).	May not be applicable to coating of wooden surfaces (4).
(j)	High-volume low-pressure (HVLP) atomisation	Atomisation of paint in a spray nozzle by mixing paint with high volumes of air with a low pressure (max. 1,7 bar). HVLP guns have a paint transfer efficiency of > 50 %.	Generally applicable (4).
(k)	Electrostatic atomisation (fully automated)	Atomisation by high-speed rotational discs and bells and shaping the spray jet with electrostatic fields and shaping air.	
(l)	Electrostatically assisted air or airless spraying	Shaping the spray jet of pneumatic or airless atomisation with an electrostatic field. Electrostatic paint guns have a transfer efficiency of > 60 %. Fixed electrostatic methods have a transfer efficiency of up to 75 %.	

(m)	Hot spraying	Pneumatic atomisation with hot air or heated paint.	May not be applicable for frequent colour changes (4).
(n)	'Spray, squeegee and rinse' application in the coating of coil	Sprays are used for application of cleaners, pretreatments and for rinsing. After spraying, squeegees are used to minimise solution dragout, which is followed by rinsing.	Generally applicable (4).
Automation of spray application			
(o)	Robot application	Robot application of coatings and sealants to internal and external surfaces.	Generally applicable (4).
(p)	Machine application	Use of paint machines for the handling of the sprayhead/spray gun/nozzle.	

1.1.7. *Drying/curing*

BAT 8. In order to reduce energy consumption and the overall environmental impact from drying/curing processes, BAT is to use one or a combination of the techniques given below.

BAT IN HEATSET

- BAT 8.f resembles to some extent the Integrated Dryer Oxidiser as recommended in BAT 28.d and is fully covered by Heatset Technique A: 'VOC: Waste Gas emissions'.
- Where in Heatset the oxidiser is separate from the dryers, none of the techniques in BAT 8 are applicable.

The typical characteristics of the Heatset waste gasses, such as their smell and high condensation temperature, very much limit the technical possibilities for the application of anyrhing other then the drying techniques that are usual in the industry. The odour of Heatset waste gasses may make the printed product unsaleable where dryer air is recirculated too often and Heatset waste gasses will condense as soon as their temperature decreases even slightly, producing a messy mixture of mineral oils and reaction products from the heat in the dryer.

Technique		Description	Applicability
(a)	Inert gas convection drying/curing	The inert gas (nitrogen) is heated in the oven, enabling solvent loading above the LEL.	Not applicable where dryers need to be opened regularly (5).

		Solvent loads of > 1 200 g/m^3 nitrogen are possible.	
(b)	Induction drying/curing	Online thermal curing or drying by electromagnetic inductors that generate heat inside the metallic work-piece by an oscillating magnetic field.	Only applicable to metal substrates (5).
(c)	Microwave and high-frequency drying	Drying using microwave or high-frequency radiation.	Only applicable to water-based coatings and inks and non-metallic substrates (5).
(d)	Radiation curing	Radiation curing is applied based on resins and reactive diluents (monomers) which react on exposure to radiation (infrared (IR), ultraviolet (UV)), or high-energy electron beams (EB).	Only applicable to specific coatings and inks (5).
(e)	Combined convection/IR radiation drying	Drying of a wet surface with a combination of circulating hot air (convection) and an infrared radiator.	Generally applicable (5).
(f)	Convection drying/curing combined with heat recovery	Heat from off-gases is recovered (see BAT 19 (e)) and used to preheat the input air of the convection dryer/curing oven.	Generally applicable (5).

1.1.8. *Cleaning*

BAT 9. In order to reduce VOC emissions from cleaning processes, BAT is to minimise the use of solvent-based cleaning agents and to use a combination of the techniques given below.

BAT IN HEATSET

A distinction must be made between the frequent automatic cleaning of rubber blankets and the occasional manual cleaning of other parts of the press.

- With regard to automatic cleaning of rubber blankets, BAT 9 is covered by BAT 28.c and Heatset Technique B: ‘VOC: Cleaning rubber blankets’.
- When addressing manual cleaning, BAT 9 c & d may be useful as covered in Heatset Technique C: ‘VOC: Manual cleaning’.
- The other techniques in BAT 9 are not applicable in Heatset.

Sparse use of volatile solvents in manual cleaning in Heatset is necessary to attain the BATAEL for fugitive emissions, but the working methods in the industry are too different for a more specific BAT for the sector.

	Technique	Description	Applicability
(a)	Protection of spraying areas and equipment	Application areas and equipment (e.g. spray booth walls and robots) susceptible to overspray and drips, etc. are covered with fabric covers or disposable foils where foils are not subject to tearing or wear.	The selection of cleaning techniques may be restricted by the type of process, the substrate or equipment to be cleaned and the type of contamination.
(b)	Solids removal prior to complete cleaning	Solids are removed in a (dry) concentrated form, usually by hand, with or without the aid of small amounts of cleaning solvent. This reduces the amount of material to be removed by solvent and/or water in subsequent cleaning stages, and therefore the amount of solvent and/or water used.	
(c)	Manual cleaning with pre-impregnated wipes	Wipes pre-impregnated with cleaning agents are used for manual cleaning. Cleaning agents may be solvent-based, low-volatility solvents or solvent-free.	
(d)	Use of low-volatility cleaning agents	Application of low-volatility solvents as cleaning agents, for manual or automated cleaning, with high cleaning power.	
(e)	Water-based cleaning	Water-based detergents or water-miscible solvents such as alcohols or glycols are used for cleaning.	
(f)	Enclosed washing machines	Automatic batch cleaning/degreasing of press/machine parts in enclosed washing machines. This can be done using either: (a) organic solvents (with air extraction followed by VOC abatement and/or recovery of the used solvents) (see BAT 15); or (b) VOC-free solvents; or (c) alkaline cleaners (with external or internal waste water treatment).	
(g)	Purging with solvent recovery	Collection, storage and, if possible, reuse of the solvents used to purge the guns/applicators and lines between colour changes.	
(h)	Cleaning with high-pressure water spray	High-pressure water spray and sodium bicarbonate systems or similar are used for automatic batch cleaning of press/machine parts.	
(i)	Ultrasonic cleaning	Cleaning in a liquid using high-frequency vibrations to loosen the adhered contamination.	
(j)	Dry ice (CO_2) cleaning	Cleaning of machinery parts and metallic or plastic substrates by blasting with CO_2 chips or snow.	
(k)	Plastic shot-blast cleaning	Excess paint build-up is removed from panel jigs and body carriers by shot-blasting with plastic particles.	

1.1.9. *Monitoring*

1.1.9.1. Solvent mass balance

BAT IN HEATSET

- BAT 10 is fully covered by Heatset Technique K: 'VOC: Solvent Mass Balance'.

A sector specific SMB for the fugitive emissions is available in the BREF and has been reproduced as Annex 6 of Part 1. This SMB has been extended with a method to determine the VOC emissions in waste gasses and the calculation of the total emissions. An Excel template for the SMB is available here https://www.intergraf.eu/images/documents/IntergrafGuidanceBATHeatset_SMP.xlsx

BAT 10. BAT is to monitor total and fugitive VOC emissions by compiling, at least once every year, a solvent mass balance of the solvent inputs and outputs of the plant, as defined in Part 7(2) of Annex VII to Directive 2010/75/EU and to minimise the uncertainty of the solvent mass balance data by using all of the techniques given below.

	Technique	Description
(a)	Full identification and quantification of the relevant solvent inputs and outputs, including the associated uncertainty	This includes: — identification and documentation of solvent inputs and outputs (e.g. emissions in waste gases, emissions from each fugitive emission source, solvent output in waste); — substantiated quantification of each relevant solvent input and output and recording of the methodology used (e.g. measurement, calculation using emission factors, estimation based on operational parameters); — identification of the main sources of uncertainty of the aforementioned quantification, and implementation of corrective actions to reduce the uncertainty; — regular update of solvent input and output data.
(b)	Implementation of a solvent tracking system	A solvent tracking system aims to keep control of both the used and unused quantities of solvents (e.g. by weighing unused quantities returned to storage from the application area).
(c)	Monitoring of changes that may influence the uncertainty of the solvent mass balance data	Any change that could influence the uncertainty of the solvent mass balance data is recorded, such as: — malfunctions of the off-gas treatment system: the date and duration are recorded;

		— changes that may influence air/gas flow rates, e.g. replacement of fans, drive pulleys, motors; the date and type of change are recorded.

Applicability
The level of detail of the solvent mass balance will be proportionate to the nature, scale and complexity of the installation, and the range of environmental impacts it may have, as well as to the type and quantity of materials used.

1.1.9.2. Emissions in waste gases

BAT 11. BAT is to monitor emissions in waste gases with at least the frequency given below and in accordance with EN standards. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.

BAT IN HEATSET

- BAT 11 is the main part of Heatset Technique L: 'VOC: Oxidiser Monitoring'.

See below the table for detailed annotations.

Substance/Parameter	Sectors/Sources	Standard(s)	Minimum monitoring frequency	Monitoring associated with
Dust	Coating of vehicles – Spray coating	EN 13284-1	Once every year [6]	BAT 18
	Coating of other metal and plastic surfaces – Spray coating			
	Coating of aircraft – Preparation (e.g. sanding, blasting) and coating			
	Coating and printing of metal packaging – Spray application			
	Coating of wooden surfaces – Preparation and coating			

TVOC	All sectors	Any stack with a TVOC load < 10 kg C/h	EN 12619	Once every year (6) (7) (8)	BAT 14, BAT 15
		Any stack with a TVOC load ≥ 10 kg C/h	Generic EN standards (9)	Continuous	
DMF	Coating of textiles, foils and paper (10)		No EN standard available (11)	Once every three months (6)	BAT 15
NOx	Thermal treatment of off-gases		EN 14792	Once every year (12)	BAT 17
CO	Thermal treatment of off-gases		EN 15058	Once every year (12)	BAT 17

BAT IN HEATSET

Notes 7 & 12: Frequency

The measurement frequency applicable in Heatset is determined by notes 7 (VOC) & 12 (NOx & CO). The frequency for all measurements depends on the TVOC load. The frequency of the measurement for NOx and CO is always equal to that of the VOC measurements. (Please note: The numbering of the notes refers to the HTML version of the Commission Decision. In the PDF version these are notes 2 & 7 of BAT 11.)

BAT IN HEATSET

TVOC: Monitoring of 'Any stack'

Linguistic differences

Occasionally small linguistic differences occur between the different language versions of EU legislation. Where this is the case, the version that applies in a Member State is the version in the language of that Member State. In EU legislation there is no hierarchy between different language versions. It is for example not relevant in what language the legislation was drafted originally.

For practical reasons the Intergraf Guidance is written in English and for that same reason this Part 2 of the Intergraf Guidance refers to the English version of the Commission Decision.

On an important point there is a significant difference between the English version of the Commission Decision and at least three other language versions (French, German and Dutch). According to the English version of the Commission Decision, the TVOC concentration should be monitored at 'any stack'. The use of the word 'stack' is confusing and might be understood as an obligation to monitor many different and irrelevant in- and outlets of air.

In the three other languages this confusion does not occur. In these languages the word used not only indicates 'a pipe on the roof of the building', but also the function of the pipe. It thus prevents irrelevant and nonsensical measurements.

Below, the two different language situations are described and discussed. It is suspected that other language versions may also differ from the English version. The reader should check the Commission Decision version in his/her own language to determine which of the two situations applies.

'Any stack' in French, German and Dutch

In French, German and Dutch a word is used that not only refers to the object (i.e. the pipe on the roof) but also indicates the function of the pipe. In French the word 'cheminee' is used which is an exhaust for smoke, steam or combustion gasses. In German and Dutch the words 'Schornstein' and 'schoorsteen' are used respectively, which in both describe an exhaust for 'Rauchgas' or 'rookgas', which are defined as gases that result from burning a fuel. In Heatset, where all the dryers are attached to an oxidiser, the only exhaust covered by any of these terms ('cheminee, 'Schornstein' or 'schoorsteen') are the exhausts of the oxidisers. In these languages, the monitoring obligation is therefore clearly limited to these oxidiser exhausts.

Please note that the monitoring obligation only refers to Heatset and its directly associated processes. This means that it does not refer to, for example, a steam generator used for general heating purposes.

'Any stack' in English

The word 'stack' is not defined in the English language version of the Commission Implementing Decision nor in the IED. It can be understood to comprise every single exhaust and air-inlet of the Heatset plant; not only the exhausts from the oxidisers but also from the pressroom ventilation or even from the ventilation of the staffs offices and the toilets. The phrase 'any stack' can even include inlets for fresh air. And where a ventilator exhausts horizontally, through a wall for example, it would not need to be monitored, since such an exhaust cannot be called a ‘stack’. ‘Any stack’ could even mean that it is not at all important which of the stacks is monitored; ‘any’ stack will do!

Where monitoring air-inlets and toilet ventilation for VOC is obviously nonsense, the pressroom ventilation may indeed contain VOC and its exhausts may indeed look like a chimney or a ‘stack’. This does however not mean that these exhaust need to be monitored for TVOC in accordance with BAT 11.

Ventilation of the pressroom and the press encapsulation is necessary for reasons of Health and Safety since it is there that the bulk of the fugitive emissions in Heatset takes place. The quantity of fugitive emissions is seriously limited through BAT 28 (BATAEL: either 10% of solvent input or, as a part of the total emissions, 4% of ink weight). In both cases the fugitive emissions are to be monitored through the Solvent Mass Balance in accordance with BAT 10 as described in Annex 6 of Part 1 of this Guidance.

It is certainly not BAT to monitor the same emission twice. This is the more the case because the result of the monitoring in accordance with BAT 11 is expressed in mgC/Nm^3 and is thus completely useless for making the Solvent Mass Balance, for which the values need to be expressed in tons of solvent per year.

Perhaps it is hoped to find large hidden VOC emissions that should be abated. But in Heatset there are no substantial sources of evaporation other than the dryers that might fruitfully be sent to the oxidiser.

As a result: monitoring VOC concentration anywhere else than at the oxidiser exhaust does nothing ‘to increase the level of environmental protection’. This implies that, in accordance with the opening sentence under ‘General Considerations’ in the Commission Implementing Decisions, ‘another technique’ can be used. For Heatset the periodic TVOC measurements are therefore, like the measurements of NOx and CO, limited to ‘Thermal treatment of off-gases’, i.e. the oxidiser exhaust. The quantity of the otherwise emitted VOC is determined through the Solvent Mass Balance and checked for compliance against a Fugitive or Total Emission Limit Value based on the corresponding BATAEL.

1.1.9.3. Emissions to water

BAT IN HEATSET

- BAT 12 does not apply to Heatset.

BAT 12. BAT is to monitor emissions to water with at least the frequency given below and in accordance with EN standards. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.

Substance/Parameter	Sector	Standard(s)	Minimum monitoring frequency	Monitoring associated with
TSS ([13])	Coating of vehicles	EN 872	Once every month ([14]) ([15])	BAT 21
	Coil coating			
	Coating and printing of metal packaging (only for DWI cans)			
COD ([13]) ([16])	Coating of vehicles	No EN standard available		
	Coil coating			
	Coating and printing of metal packaging (only for DWI cans)			
TOC ([13]) ([16])	Coating of vehicles	EN 1484		
	Coil coating			
	Coating and printing of metal packaging (only for DWI cans)			
Cr(VI) ([17]) ([18])	Coating of aircraft	EN ISO 10304-3 or EN ISO 23913		
	Coil coating			
Cr ([18]) ([19])	Coating of aircraft	Various EN standards available (e.g. EN ISO 11885, EN ISO 17294-2, EN ISO 15586)		
	Coil coating			
Ni ([18])	Coating of vehicles			
	Coil coating			

Zn [18]	Coating of vehicles			
	Coil coating			
AOX [18]	Coating of vehicles	EN ISO 9562		
	Coil coating			
	Coating and printing of metal packaging (only for DWI cans)			
F^- [18] [20]	Coating of vehicles	EN ISO 10304-1		
	Coil coating			
	Coating and printing of metal packaging (only for DWI cans)			

1.1.10. *Emissions during OTNOC*

BAT IN HEATSET

The equipment in Heatset that leads to excessive VOC emissions in case of failure are integrated dryer oxidisers and conventional oxidisers.

- BAT 13 a & b are part of Heatset Technique F: 'VOC: OTNOC (Other than normal operating conditions)'.

BAT 13. In order to reduce the frequency of the occurrence of OTNOC and to reduce emissions during OTNOC, BAT is to use both of the techniques given below.

	Technique	Description
(a)	Identification of critical equipment	Equipment critical to the protection of the environment ('critical equipment') is identified on the basis of a risk assessment. In principle, this concerns all equipment and systems handling VOCs (e.g. off-gas treatment system, leak detection system).
(b)	Inspection, maintenance and monitoring	A structured programme to maximise critical equipment availability and performance which includes standard operating procedures, preventive maintenance, regular and unplanned maintenance. OTNOC periods, duration, causes and, if possible, emissions during their occurrence are monitored.

1.1.11. *Emissions in waste gases*

1.1.11.1. VOC emissions

BAT IN HEATSET

Oxidisers

BAT 14, 15 and 16 describe how a waste gas treatment system should be selected and designed.

Where in Heatset integrated dryer-oxidisers, as described and recommended in Heatset Technique A and M and BAT 28.d, are used, the design and selection have already taken place. Several of the techniques in BAT 14 and 15 are incorporated in this design. Others techniques, amongst which in BAT 16, are incompatible or not applicable.

The following BATs are part of Heatset Technique A: 'VOC: Waste Gas Emissions' (BAT 28 d)

- BAT 14 a, b, d,e and f.
- BAT 15 e

The following BATs are not part of Heatset Technique A: 'Waste Gas Emissions' (BAT 28 d)

- BAT 14 c, g and h (Inks are non-volatile at room temperature. No mixing takes place. No VOC emissions in storage room, no separate cleaning areas)
- BAT 15 a, b, c, d, f, g, h and i. (Not compatible with integrated dryer-oxidiser)
- BAT 16 (Not compatible with integrated dryer oxidiser)

Where conventional oxidisers, treating the dryer air from multiple presses are to be installed, BAT 15 f & g may also apply .

Other abatement systems

Where for Heatset another abatement system than integrated dryer-oxidisers is designed, the same techniques as incorporated in the design of integrated dryer-oxidiser should be considered.

In such a case the typical characteristics of the Heatset waste gasses, such as their smell and high condensation temperature, will very much limit the technical possibilities. The odour of Heatset waste gasses will for example make the printed product unsaleable and Heatset waste gasses will condense as soon as their temperature decreases even slightly, producing a messy mixture of mineral oils and reaction products from the heat in the dryer.

BAT 14. In order to reduce VOC emissions from the production and storage areas, BAT is to use technique (a) and an appropriate combination of the other techniques given below.

	Technique	Description	Applicability
(a)	System selection, design and optimisation	An off-gas system is selected, designed and optimised taking into account parameters such as: — amount of extracted air; — type and concentration of solvents in extracted air; — type of treatment system (dedicated/centralised); — health and safety; — energy efficiency. The following order of priority for the system selection may be considered: — segregation of off-gases with high and low VOC concentrations; — techniques to homogenise and increase the VOC concentration (see BAT 16 (b) and (c)); — techniques for the recovery of solvents in off-gases (see BAT 15); — VOC abatement techniques with heat recovery (see BAT 15); — VOC abatement techniques without heat recovery (see BAT 15).	Generally applicable.
(b)	Air extraction as close as possible to the point of application of VOC-containing materials	Air extraction as close as possible to the point of application with full or partial enclosure of solvent application	May not be applicable where enclosure leads to difficult machinery access during operation.

		areas (e.g. coaters, application machines, spray booths). Extracted air may be treated by an off-gas treatment system.	Applicability may be restricted by the shape and size of the area to be enclosed.
(c)	Air extraction as close as possible to the point of preparing paints/coatings/adhesives/inks	Air extraction as close as possible to the point of preparing paints/coatings/adhesives/inks (e.g. mixing area). Extracted air may be treated by an off-gas treatment system.	Only applicable where paints/coatings/adhesives/inks are prepared.
(d)	Extraction of air from the drying/curing processes	The curing ovens/dryers are equipped with an air extraction system. Extracted air may be treated by an off-gas treatment system.	Only applicable to drying/curing processes.
(e)	Minimisation of fugitive emissions and heat losses from the ovens/dryers either by sealing the entrance and the exit of the curing ovens/dryers or by applying sub-atmospheric pressure in drying	The entrance to and the exit from curing ovens/dryers are sealed to minimise fugitive VOC emissions and heat losses. The sealing may be ensured by air jets or air knives, doors, plastic or metallic curtains, doctor blades, etc. Alternatively, ovens/dryers are kept under sub-atmospheric pressure.	Only applicable when curing ovens/dryers are used.
(f)	Extraction of air from the cooling zone	When substrate cooling takes place after drying/curing, the air from the cooling zone is extracted and may be treated by an off-gas treatment system.	Only applicable when substrate cooling takes place after drying/curing.
(g)	Extraction of air from storage of raw materials, solvents and solvent-containing wastes	Air from raw material stores and/or individual containers for raw materials, solvents and solvent-containing wastes is extracted and may be treated by an off-gas treatment system.	May not be applicable for closed containers or for storage of raw materials, solvents and solvent-containing wastes with a low vapour pressure and low toxicity.
(h)	Extraction of air from cleaning areas	Air from the areas where machine parts and equipment are cleaned with organic solvents, either by hand or automatically, is extracted and may be treated by an off-gas treatment system.	Only applicable to areas where machine parts and equipment are cleaned with organic solvents.

BAT 15. In order to reduce VOC emissions in waste gases and increase resource efficiency, BAT is to use one or a combination of the techniques given below.

	Technique	Description	Applicability
I. **Capture and recovery of solvents in off-gases**			
(a)	Condensation	A technique for removing organic compounds by reducing the temperature below their dew points so that the vapours liquefy. Depending on the operating temperature range required, different refrigerants are used, e.g. cooling water, chilled water (temperature typically around 5 °C), ammonia or propane.	Applicability may be restricted where the energy demand for recovery is excessive due to the low VOC content.
(b)	Adsorption using activated carbon or zeolites	VOCs are adsorbed on the surface of activated carbon, zeolites or carbon fibre paper. Adsorbate is subsequently desorbed, e.g. with steam (often on site), for reuse or disposal and the adsorbent is reused. For continuous operation, typically more than two adsorbers are operated in parallel, one of them in desorption mode. Adsorption is also commonly applied as a concentration step to increase the subsequent oxidation efficiency.	Applicability may be restricted where the energy demand for recovery is excessive due to the low VOC content.
(c)	Absorption using a suitable liquid	Use of a suitable liquid to remove pollutants from the off-gas by absorption, in particular soluble compounds and solids (dust). Solvent recovery is possible, for example, using distillation or thermal desorption. (For dust removal, see BAT 18.)	Generally applicable.
II. **Thermal treatment of solvents in off-gases with energy recovery**			
(d)	Sending off-gases to a combustion plant	Part or all of the off-gases are sent as combustion air and supplementary fuel to a combustion plant (including CHP (combined heat and power) plants) used for steam and/or electricity production.	Not applicable for off-gases containing substances referred to in IED Article 59(5). Applicability may be restricted due to safety considerations.
(e)	Recuperative thermal oxidation	Thermal oxidation using the heat of the waste gases, e.g. to preheat the incoming off-gases.	Generally applicable.
(f)	Regenerative thermal oxidation with multiple beds or with a valveless rotating air distributor	An oxidiser with multiple beds (three or five) filled with ceramic packing. The beds are heat exchangers, alternately heated by flue-waste gases from oxidation, then the flow is reversed to heat the inlet air to the oxidiser. The flow is reversed on a regular basis. In the valveless rotating air distributor, the ceramic medium is held in a single rotating vessel divided into multiple wedges.	Generally applicable.

(g)	Catalytic oxidation	Oxidation of VOCs assisted by a catalyst to reduce the oxidation temperature and reduce the fuel consumption. Exhaust heat can be recovered with recuperative or regenerative types of heat exchangers. Higher oxidation temperatures (500–750 °C) are used for the treatment of off-gas from the manufacturing of winding wire.	Applicability may be restricted by the presence of catalyst poisons.
III. **Treatment of solvents in off-gases without solvent or energy recovery**			
(h)	Biological off-gas treatment	Off-gas is dedusted and sent to a reactor with biofilter substrate. The biofilter consists of a bed of organic material (such as peat, heather, compost, root, tree bark, softwood and different combinations) or some inert material (such as clay, activated carbon, and polyurethane), where the off-gas stream is biologically oxidised by naturally occurring microorganisms into carbon dioxide, water, inorganic salts and biomass. The biofilter is sensitive to dust, high temperatures or high variations in the off-gas, e.g. of the inlet temperature or the VOC concentration. Supplementary nutrient feeding may be needed.	Only applicable to the treatment of biodegradable solvents.
(i)	Thermal oxidation	Oxidation of VOCs by heating off-gases with air or oxygen to above their auto-ignition point in a combustion chamber and maintaining a high temperature long enough to complete the combustion of VOCs to carbon dioxide and water.	Generally applicable.

BAT-associated emission levels (BAT-AELs) are given in Tables 11, 15, 17, 19, 21, 24, 27, 30, 32 and 35 of these BAT conclusions.

BAT IN HEATSET

- The BATAEL for Heatset can be found in Table 27 and in Heatset Technique H: ‘VOC: Oxidiser Limits’

BAT 16. In order to reduce the energy consumption of the VOC abatement system, BAT is to use one or a combination of the techniques given below.

	Technique	Description	Applicability
(a)	Maintaining the VOC concentration sent to the off-gas treatment system by using variable-frequency drive fans	Use of a variable-frequency drive fan with centralised off-gas treatment systems to modulate the airflow to match the exhaust from the equipment that may be in operation.	Only applicable to central thermal off-gas treatment systems in batch processes such as printing.
(b)	Internal concentration of solvents in the off-gases	Off-gases are recirculated within the process (internally) in the curing ovens/dryers and/or in spray booths, so the VOC concentration in the off-gases increases and the abatement efficiency of the off-gas treatment system increases.	Applicability may be limited by health and safety factors such as the LEL, and product quality requirements or specifications.
(c)	External concentration of solvents in the off-gases through adsorption	The concentration of solvent in off-gases is increased by a continuous circular flow of the spray booth process air, possibly combined with curing oven/dryer off-gases, through adsorption equipment. This equipment can include: —fixed bed adsorber with activated carbon or zeolite; —fluidised bed adsorber with activated carbon; —rotor adsorber with activated carbon or zeolite; — molecular sieve.	Applicability may be restricted where the energy demand is excessive due to the low VOC content.
(d)	Plenum technique to reduce waste gas volume	Off-gases from curing ovens/dryers are sent to a large chamber (plenum), and partly recirculated as inlet air in the curing ovens/dryers. The surplus air from the plenum is sent to the off-gas treatment system. This cycle increases the VOC content of the curing ovens/dryers' air and decreases the waste gas volume.	Generally applicable.

1.1.11.2. NO_X and CO emissions

BAT 17. In order to reduce NO_X emissions in waste gases while limiting CO emissions from the thermal treatment of solvents in off-gases, BAT is to use technique (a) or both of the techniques given below.

BAT IN HEATSET

- BAT 17 a & b are adressed in Heatset Techniques H: 'VOC Oxidiser limits' and A: 'VOC: Waste gas emissions'.

	Technique	Description	Applicability
(a)	Optimisation of thermal treatment conditions (design and operation)	Good design of the combustion chambers, burners and associated equipment/devices is combined with optimisation of combustion conditions (e.g. by controlling combustion parameters such as temperature and residence time) with or without the use of automatic systems and the regular planned maintenance of the combustion system according to suppliers' recommendations.	Design applicability may be restricted for existing plants.
(b)	Use of low-NO_X burners	The peak flame temperature in the combustion chamber is reduced, delaying but completing the combustion and increasing the heat transfer (increased emissivity of the flame). It is combined with increased residence time in order to achieve the desired VOC destruction.	Applicability may be restricted at existing plants by design and/or operational constraints.

Table 1

BAT-associated emission level (BAT-AEL) for NO_X emissions in waste gases and indicative emission level for CO emissions in waste gases from the thermal treatment of off-gases

BAT IN HEATSET

BAT 17.a & b specify that their applicability may be 'restricted at existing plants by design or operational constraints'. This implies that where existing oxidisers or integrated dryer-oxidisers cannot meet the BATAEL or BATAEPL and their design does not allow technical changes that would reduce the NOx or CO emissions sufficiently, compliance with Table 1 below cannot be expected before their replacment at the end of their technical or economic lifetime.

For this reason Heatset Technique H: 'Oxidiser limits' is claused such that compliance with the BATAEL for NOx should be waved where existing waste gas treatement can not be modified to ensure compliance. The same is the case for the BATAEPL for CO.

The number of non-complying Heatset plants is not large. Out of 27 dryer-oxidisers for which data were collected for the STS BREF, only one did not comply with the BATAEL for NOx and five did not comply with the BATAEPL for CO. In each of these cases the non-compliance was relatively small.

It must be noted that integrated dryer-oxidisers cf BAT 28.a must answer to many more design restrictions than separate dryers and oxidisers as generally used in other industries. (Space limitations, built in safety, automatic operation, to name but a few).

Parameter	Unit	BAT-AEL (21) (Daily average or average over the sampling period)	Indicative emission level (21) (Daily average or average over the sampling period)
NOx	mg/Nm³	20–130 (22)	No indicative level
CO		No BAT-AEL	20–150

The associated monitoring is given in BAT 11.

BAT IN HEATSET

Please note that in accordance with BAT 11 and notes 7 & 12 the monitoring frequency is equal to the applicable monitoring frequency of the VOC emissions from the waste gas treatment; i.e. once every three year.

1.1.11.3. Dust emissions

BAT 18. In order to reduce dust emissions in waste gases from substrate surface preparation, cutting, coating application and finishing processes for the sectors and processes listed in Table

BAT IN HEATSET

- Although BAT 18 does not address Heatset (Heatset is not listed in Table 2) 'Heatset Technique U: 'Dust: Emissions' adresses the paper dust that may be produced by in-line cutting and folding on Heatset presses.

2, BAT is to use one or a combination of the techniques given below.

	Technique	Description
(a)	Wet separation spray booth	A water curtain cascading vertically down the spray cabin rear panel captures paint particles from overspray. The water-paint mixture is captured in a reservoir and the water is recirculated.

	(flushed impact panel)	
(b)	Wet scrubbing	Paint particles and other dust in the off-gas are separated in scrubber systems by intensive mixing of the off-gas with water. (For VOC removal, see BAT 15 (c).)
(c)	Dry overspray separation with pre-coated material	A dry paint overspray separation process using membrane filters combined with limestone as pre-coating material to prevent fouling of the membranes.
(d)	Dry overspray separation using filters	Mechanical separation system, e.g. using cardboard, fabric or sinter.
(e)	Electrostatic precipitator	In electrostatic precipitators, particles are charged and separated under the influence of an electrical field. In a dry electrostatic precipitator (ESP), the collected material is mechanically removed (e.g. by shaking, vibration, compressed air). In a wet ESP, it is flushed with a suitable liquid, usually a water-based separation agent.

Table 2

BAT-associated emission levels (BAT-AELs) for dust emissions in waste gases

Parameter	**Sector**	**Process**	**Unit**	**BAT-AEL (Daily average or average over the sampling period)**
Dust	Coating of vehicles	Spray coating	mg/Nm^3	< 1–3
	Coating of other metal and plastic surfaces	Spray coating		
	Coating of aircraft	Preparation (e.g. sanding, blasting), coating		
	Coating and printing of metal packaging	Spray application		
	Coating of wooden surfaces	Preparation, coating		

The associated monitoring is given in BAT 11.

1.1.12. *Energy efficiency*

BAT 19. In order to use energy efficiently, BAT is to use techniques (a) and (b) and an appropriate combination of the techniques (c) to (h) given below.

BAT IN HEATSET

- BAT 19.a & b are addressed in Heatset Techniques N: ‘Energy: Other reduction measures’ and W: General: Management’.
- BAT 19.b is addressed in Heatset Technique O: ‘Energy: record keeping’.
- BAT 19.e is addressed in Heatset Technique M: ‘Energy: Integrated Dryer Oxidiser’.
- The other techniques in BAT 19 are not applicable in Heatset.

	Technique	Description	Applicability
Management techniques			
(a)	Energy efficiency plan	An energy efficiency plan is part of the EMS (see BAT 1) and entails defining and calculating the specific energy consumption of the activity, setting key performance indicators on an annual basis (e.g. MWh/tonne of product) and planning the periodic improvement targets and related actions. The plan is adapted to the specificities of the plant in terms of process(es) carried out, materials, products, etc.	The level of detail and nature of the energy efficiency plan and of the energy balance record will generally be related to the nature, scale and complexity of the installation and the types of energy sources used. It may not be applicable if the STS activity is carried out within a larger installation, provided that the energy efficiency plan and the energy balance record of the larger installation sufficiently cover the STS activity.
(b)	Energy balance record	The drawing up once every year of an energy balance record which provides a breakdown of the energy consumption and generation (including energy export) by the type of source (e.g. electricity, fossil fuels, renewable energy, imported heat and/or cooling). This includes: (i)defining the energy boundary of the STS activity; (ii)information on energy consumption in terms of delivered energy; (iii)information on energy exported from the plant; (iv)energy flow information (e.g. Sankey diagrams or energy balances)	

		showing how the energy is used throughout the process. The energy balance record is adapted to the specificities of the plant in terms of process(es) carried out, materials, etc.	
Process-related techniques			
(c)	Thermal insulation of tanks and vats containing cooled or heated liquids, and of combustion and steam systems	This may be achieved for example by: — using double-skinned tanks; — using pre-insulated tanks; — applying insulation to combustion equipment, steam pipes and pipes containing cooled or heated liquids.	Generally applicable.
(d)	Heat recovery by cogeneration – CHP (combined heat and power) or CCHP (combined cooling, heat and power)	Recovery of heat (mainly from the steam system) for producing hot water/steam to be used in industrial processes/activities. CCHP (also called tri-generation) is a cogeneration system with an absorption chiller that uses low-grade heat to produce chilled water.	Applicability may be restricted by the plant layout, the characteristics of the hot gas streams (e.g. flow rate, temperature) or the lack of a suitable heat demand.
(e)	Heat recovery from hot gas streams	Energy recovery from hot gas streams (e.g. from dryers or cooling zones), e.g. by their recirculation as process air, through the use of heat exchangers, in processes, or externally.	
(f)	Flow adjustment of process air and off-gases	Adjustment of the flow of process air and off-gases according to the need. This includes reduction of air ventilation during idle operation or maintenance.	Generally applicable.
(g)	Spray booth off-gas recirculation	Capture and recirculation of the off-gas from the spray booth in combination with efficient paint overspray separation. Energy consumption is less than in the case of fresh air use.	Applicability may be restricted by health and safety considerations.
(h)	Optimised circulation of warm air in a large-volume curing booth using an air turbulator	Air is blown into a single part of the curing booth and distributed using an air turbulator which turns the laminar airflow into the desired turbulent flow.	Only applicable to spray coating sectors.

Table 3

BAT-associated environmental performance levels (BAT-AEPLs) for specific energy consumption

BAT IN HEATSET

In this Heatset BAT Guidance note menergy consumption is addressed in Techniques M, N & O. These imply the application of integrated dryer-oxidisers, implementation of an energy reduction program and measuring and monitoring the energy consumption with clear and well defined boundaries.

However: the BAT-AEPL (yearly average) for specific energy consumption for Heatset of 4-14 Wh/m^2 of printed area is not part of the Intergraf Heatset Guidance. The value is confusing and not relevant where integrated dryer-oxidisers are used cf BAT 28d and Heatset Technique A. To a slightly lesser extent the same is the case where conventional oxidisers are used.

The value does not distinguish between the consumption of electricity and the consumption of gas. This distinction should however be made because, the gas consumption of oxidisers in Heatset (between 30 and 70% of the total energy consumption) only depends on the ink coverage of the printed products. The ink coverage depends on the graphic design of the printed product and is therefore outside the operators control. The ink coverage may vary from less than 50% for magazines with a lot of text and few photographs, to well over 200% for colourful brochures.

In the case of mishaps during the printing process the ink coverage may suddenly increase to a value of 400% on both sides of the paper web. The resulting sudden increase of the VOC-load in the hot dryer could easily lead to an explosion. The intergrated dryer-oxidiser is designed to be able to cope safely with such printing mishaps at all times, and may therefore not be tuned to a low average ink coverage.

In the case of a low ink coverage, a considerable amount of gas must to be added to maintain the temperature required for the drying and the oxidation processes. In the case of a high ink coverage, the integrated dryer oxidisers will be close to autothermic, using very little gas. As a result, the specific gas consumption and therefor the specific total energy consumption does not give any indication about the energy efficiency in the plant. Indeed, a high ink coverage and its consequently low gas consumption may lead to a low specific total energy consumption and give the impression of good energy efficiency for electricity, even though this would be unwarranted. Vice versa a low electricity consumption may be hidden by a high gas consumption where average ink coverage is low.

In addition to the above, the value itself is based on inadequate data regarding the electricity consumption. For the BREF data collection, boundaries were not defined and in several cases the electricity consumption of sheetfed offset and finishing were included in the reported figures.

Sector	**Product type**	**Unit**	**BAT-AEPL (Yearly average)**
Coating of vehicles	Passenger cars	MWh/vehicle coated	0,5–1,3
	Vans		0,8–2
	Truck cabins		1–2
	Trucks		0,3–0,5
Coil coating	Steel and/or aluminium coil	kWh/m^2 of coated coil	0,2–2,5 ([23])
Coating of textiles, foils and paper	Coating of textiles with polyurethane and/or polyvinyl chloride	kWh/m^2 of coated surface	1–5
Manufacturing of winding wires	Wires with an average diameter > 0,1 mm	kWh/kg of coated wire	< 5
Coating and printing of metal packaging	All product types	kWh/m^2 of coated surface	0,3–1,5
Heatset web offset printing	All product types	Wh/m^2 of printed area	4–14
Flexography and non-publication rotogravure printing	All product types	Wh/m^2 of printed area	50–350
Publication rotogravure printing	All product types	Wh/m^2 of printed area	10–30

The associated monitoring is given in BAT 19 (b).

1.1.13. *Water use and waste water generation*

BAT 20. In order to reduce water consumption and waste water generation from aqueous processes (e.g. degreasing, cleaning, surface treatment, wet scrubbing), BAT is to use technique (a) and an appropriate combination of the other techniques given below.

BAT IN HEATSET

- BAT 20 is not relevant in Heatset since there are no aqueous processes such as degreasing etc.

Heatset may however give rise to a small amount of aqueous waste from cleaning rubber blankets and dirty dampening solutions. These wastes are addressed in Heatset Techniques P 'Water: Emissions', Q 'Water: Dampening solution,' and R 'Water: 'Cleaning agents', where industry best practice is described.

Technique		Description	Applicability
(a)	Water management plan and water audits	A water management plan and water audits are part of the EMS (see BAT 1) and include: — flow diagrams and a water mass balance of the plant; — establishment of water efficiency objectives; — implementation of water optimisation techniques (e.g. control of water usage, water recycling, detection and repair of leaks). Water audits are carried out at least once every year.	The level of detail and nature of the water management plan and water audits will generally be related to the nature, scale and complexity of the plant. It may not be applicable if the STS activity is carried out within a larger installation, provided that the water management plan and the water audits of the larger installation sufficiently cover the STS activity.
(b)	Reverse cascade rinsing	Multiple stage rinsing in which the water flows in the opposite direction to the work-pieces/substrate. It allows a high degree of rinsing with a low water consumption.	Applicable where rinsing processes are used.
(c)	Reuse and/or recycling of water	Water streams (e.g. spent rinse water, wet scrubber effluent) are reused and/or recycled, if necessary after treatment, using techniques such as ion exchange or filtration (see BAT 21). The degree of water reuse and/or recycling is limited by the water balance of the plant, the content of impurities and/or the characteristics of the water streams.	Generally applicable.

Table 4

BAT-associated environmental performance levels (BAT-AEPLs) for specific water consumption

Sector	Product type	Unit	BAT-AEPL

			(Yearly average)
Coating of vehicles	Passenger cars	m^3/vehicle coated	0,5–1,3
	Vans		1–2,5
	Truck cabins		0,7–3
	Trucks		1–5
Coil coating	Steel and/or aluminium coils	l/m^2 of coated coil	0,2–1,3 ([24])
Coating and printing of metal packaging	Two-piece DWI beverage cans	l/1 000 cans	90–110

The associated monitoring is given in BAT 20 (a).

1.1.14. *Emissions to water*

BAT 21. In order to reduce emissions to water and/or to facilitate water reuse and recycling from aqueous processes (e.g. degreasing, cleaning, surface treatment, wet scrubbing), BAT is to use a combination of the techniques given below.

BAT IN HEATSET

- BAT 21 is not relevant in Heatset since there are no aqueous processes such as degreasing etc.

Techniques		Description	Typical pollutants targeted
Preliminary, primary and general treatment			
(a)	Equalisation	Balancing of flows and pollutant loads by using tanks or other management techniques.	All pollutants.
(b)	Neutralisation	The adjustment of the pH of waste water to a neutral value (approximately 7).	Acids, alkalis.
(c)	Physical separation, for example, by using screens, sieves, grit separators, primary settlement tanks and magnetic separation		Gross solids, suspended solids, metal particles.
Physico-chemical treatment			
(d)	Adsorption	The removal of soluble substances (solutes) from the waste water by transferring them to the surface of solid, highly porous particles (typically activated carbon).	Adsorbable dissolved non-biodegradable or inhibitory pollutants, e.g. AOX.
(e)	Vacuum distillation	The removal of pollutants by thermal waste water treatment under reduced pressure.	Dissolved non-biodegradable or inhibitory pollutants that

			can be distilled, e.g. some solvents.
(f)	Precipitation	The conversion of dissolved pollutants into insoluble compounds by adding precipitants. The solid precipitates formed are subsequently separated by sedimentation, flotation or filtration.	Precipitable dissolved non-biodegradable or inhibitory pollutants, e.g. metals.
(g)	Chemical reduction	Chemical reduction is the conversion of pollutants by chemical reducing agents into similar but less harmful or hazardous compounds.	Reducible dissolved non-biodegradable or inhibitory pollutants, e.g. hexavalent chromium (Cr(VI)).
(h)	Ion exchange	The retention of ionic pollutants from waste water and their replacement by more acceptable ions using an ion exchange resin. The pollutants are temporarily retained and afterwards released into a regeneration or backwashing liquid.	Ionic dissolved non-biodegradable or inhibitory pollutants, e.g. metals.
(i)	Stripping	The removal of purgeable pollutants from the aqueous phase by a gaseous phase (e.g. steam, nitrogen or air) that is passed through the liquid. The removal efficiency may be enhanced by increasing the temperature or reducing the pressure.	Purgeable pollutants, e.g. some adsorbable organically bound halogens (AOX).
Biological treatment			
(j)	Biological treatment	Use of microorganisms for waste water treatment (e.g. anaerobic treatment, aerobic treatment).	Biodegradable organic compounds.
Final solids removal			
(k)	Coagulation and flocculation	Coagulation and flocculation are used to separate suspended solids from waste water and are often carried out in successive steps. Coagulation is carried out by adding coagulants with charges opposite to those of the suspended solids. Flocculation is a gentle mixing stage so that collisions of microfloc particles cause them to bond to produce larger flocs. It may be assisted by adding polymers.	Suspended solids and particulate-bound metals.
(l)	Sedimentation	The separation of suspended particles by gravitational settling.	
(m)	Filtration	The separation of solids from waste water by passing them through a porous medium, e.g. sand filtration, nano-, micro- and ultrafiltration	
(n)	Flotation	The separation of solid or liquid particles from waste water by attaching them to fine gas bubbles, usually air. The buoyant particles accumulate at the water surface and are collected with skimmers.	

Table 5

BAT-associated emission levels (BAT-AELs) for direct discharges to a receiving water body

Substance/Parameter	Sector	BAT-AEL (25)
Total suspended solids (TSS)	Coating of vehicles	5–30 mg/l
Chemical oxygen demand (COD) (26)	Coil coating	30–150 mg/l

Adsorbable organically bound halogens (AOX)	Coating and printing of metal packaging (only for DWI cans)	0,1–0,4 mg/l
Fluoride (F^-) [27]		2–25 mg/l
Nickel (expressed as Ni)	Coating of vehicles Coil coating	0,05–0,4 mg/l
Zinc (expressed as Zn)		0,05–0,6 mg/l [28]
Total chromium (expressed as Cr) [29]	Coating of aircraft Coil coating	0,01–0,15 mg/l
Hexavalent chromium (expressed as Cr(VI)) [30]		0,01–0,05 mg/l

The associated monitoring is given in BAT 12.

Table 6

BAT-associated emission levels (BAT-AELs) for indirect discharges to a receiving water body

Substance/Parameter	**Sector**	**BAT-AEL [31] [32]**
Adsorbable organically bound halogens (AOX)	Coating of vehicles Coil coating Coating and printing of metal packaging (only for DWI cans)	0,1–0,4 mg/l
Fluoride (F^-) [33]		2–25 mg/l
Nickel (expressed as Ni)	Coating of vehicles Coil coating	0,05–0,4 mg/l
Zinc (expressed as Zn)		0,05–0,6 mg/l [34]
Total chromium (expressed as Cr) [35]	Coating of aircraft Coil coating	0,01–0,15 mg/l
Hexavalent chromium (expressed as Cr(VI)) [36]		0,01–0,05 mg/l

The associated monitoring is given in BAT 12.

1.1.15. *Waste management*

BAT 22. In order to reduce the quantity of waste sent for disposal, BAT is to use the techniques (a) and (b) and one or both of the techniques (c) and (d) given below.

BAT IN HEATSET

The Intergraf Guidance note is limited to solvent containing waste resulting from cleaning activities and waste dampening solutions.

- BAT 22.a is part of Heatset Technique W: 'General: Management System'.
- BAT 22.b is the main BAT in Heatset Technique V: 'Monitoring solvent containing waste'

BAT 22.c and d are not applicable in Heatset. The quantities of solvent containing waste are too small. Also most of the waste cleaning agent is either mixed with water or trapped in tissue from rubber blanket cleaning. Waste cleaning agents and waste dampening solutions are disposed of as hazardous waste. The treatment of the waste is left to waste collecting company.

Other waste streams

The two most important waste streams in Heatset are waste paper and used aluminium offset plates. These two waste streams are however not included in the Intergraf Guidance Note, for the following reasons:

- Paper waste: All the paper waste generated in a Heatset plant is collected, kept separate by quality, and sold for recycling. It is a much appreciated raw material for the manufacture of high quality graphic paper. The amount can be considerable but largely depends on the characteristics of the product printed. These characteristics are outside the printers' control. Paper is costly and the avoidance of waste paper is an integral part of the operation in a heatset plant. How to avoid unnecessary paper losses is a vast and complicated issue. This Commission Implementing Decision does not contain any practical advice on the topic.

- Used offset plates: For every print job new image carriers are necessary. These 'offset plates' are made of aluminium with a very thin polymer layer that does not hamper their recycling. Used plates are collected and sold as scrap.

	Technique	Description
(a)	Waste management plan	A waste management plan is part of the EMS (see BAT 1) and is a set of measures aiming to: 1) minimise the generation of waste, 2) optimise the reuse, regeneration and/or recycling of waste and/or the recovery of energy from waste, and 3) ensure the proper disposal of waste.
(b)	Monitoring of waste quantities	Annual recording of waste quantities generated for each type of waste. The solvent content in the waste is determined periodically (at least once every year) by analysis or calculation.
(c)	Recovery/recycling of solvents	Techniques may include: — recovering/recycling solvents from liquid waste by filtration or distillation on site or off site; — recovering/recycling the solvent content of wipes by gravitational draining, wringing or centrifugation.

(d)	Waste-stream-specific techniques	Techniques may include: —reducing the water content of the waste, e.g. by using a filter press for the sludge treatment; —reducing the sludge and waste solvent generated, e.g. by reducing the number of cleaning cycles (see BAT 9); —using reusable containers, reusing the containers for other purposes, or recycling the container material; —sending the spent limestone generated from dry scrubbing to a lime or cement kiln.

1.1.16. *Odour emissions*

BAT IN HEATSET

- BAT 23 is the main BAT in Heatset Technique G: 'VOC: Odour'.

The applicability of BAT 23 is restricted to cases where odour nuisance is expected or substantiated.

Where in Heatset oxidisers are employed answering to the IED emission limit value (20 mgC/Nm^3) or the BAT-AEL (15 mgC/Nm^3), there is no odour issue.

BAT 23. In order to prevent or, where that is not practicable, to reduce odour emissions, BAT is to set up, implement and regularly review an odour management plan, as part of the environmental management system (see BAT 1), that includes all of the following elements:

— a protocol containing actions and timelines;
— a protocol for response to identified odour incidents, e.g. complaints;
— an odour prevention and reduction programme designed to identify the source(s), to characterise the contributions of the source(s), and to implement prevention and/or reduction measures.

Applicability
The applicability is restricted to cases where an odour nuisance at sensitive receptors is expected and/or has been substantiated.

1.2. BAT conclusions for the coating of vehicles
1.3. BAT conclusions for the coating of other metal and plastic surfaces
1.4. BAT conclusions for the coating of ships and yachts
1.5. BAT conclusions for the coating of aircraft
1.6. BAT conclusions for coil coating
1.7. BAT conclusions for the manufacturing of adhesive tapes
1.8. BAT conclusions for the coating of textiles, foils and paper
1.9. BAT conclusions for the manufacturing of winding wire

1.10. BAT conclusions for the coating and printing of metal packaging

1.11. BAT conclusions for heatset web offset printing

The BAT conclusion in this section applies to heatset web offset printing, and applies in addition to the general BAT conclusions given in Section 1.1.

BAT 28. In order to reduce total VOC emissions, BAT is to use a combination of the techniques given below.

BAT IN HEATSET

BAT 28 is at the core of the Intergraf BAT Guidance for heatset. The techniques are specific to the heatset process. There is a considerable overlap between BAT 28 and several of the General BAT's. Where this is the case preference is given to BAT 28. The full text of each of the techniques in BAT 28 (except 28.b Waterless Offset) is annexed to part 1 of the Guidance note.

- BAT 28.a is the main BAT in Heatset Technique D: 'VOC: Dampening solution'
- BAT 28.c is the main BAT in Heatset Technique B: 'VOC: Cleaning rubber blankets.'
- BAT 28.d is the main BAT in Heatset Technique A: 'VOC: Waste gas emissions'.
- BAT 28.e is the main BAT in Heatset Technique E: 'VOC: Treatment of air from press room or press encapsulation'.

BAT 28.b 'Waterless offset' is not addressed in any Heatset Technique since the Guidance is aimed at the vast majority of heatset web offset plants that have technically a lot in common. All these plants employ the traditional offset technique using a dampening solution (i.e 'water'). It is actually unknown whether in the EU any IED-size Heatset plants employing waterless offset exist.

From an emission point of view, waterless offset is indeed an alternative to the application of BAT 28a (low IPA or IPA free additives in dampening solutions). Technically and ecconomically waterless offset is however generally not an acceptable alternative to traditional offset. (For details see the STS BREF for a further description of this technique).

	Technique	Description	Applicability
Material-based and printing techniques			
(a)	Use of low-IPA or IPA-free additives in dampening solutions	Reduction or avoidance of isopropanol (IPA) as a wetting agent in dampening solutions, through substitution by mixtures of other organic compounds which are not volatile or have a low volatility.	Applicability may be limited by technical and product quality requirements or specifications.
(b)	Waterless offset	Modification of the press and the pre-press processes to enable the use of specially coated offset plates, eliminating the need for dampening.	May not be applicable for long print runs due to the need for more frequent changes of plates.
Cleaning techniques			
(c)	Use of VOC-free solvents or solvents with low volatility for automatic blanket cleaning	Use of organic compounds which are not volatile or have a low volatility as cleaning agents for automatic blanket cleaning.	Generally applicable.
Off-gas treatment techniques			
(d)	Web offset dryer integrated with off-gas treatment	A web offset dryer with an integrated off-gas treatment unit, enabling incoming dryer air to be mixed with a part of the waste gases returned from the off-gas thermal treatment system.	Applicable to new plants or major plant upgrades.
(e)	Extraction and treatment of air from the press room or the press encapsulation	Routing of extracted air from the press room or the press encapsulation to the dryer. As a result, a part of the solvents evaporated in the press room or press encapsulation is abated by the thermal treatment (see BAT 15) downstream of the dryer.	Generally applicable.

Table 25

BAT-associated emission level (BAT-AEL) for total emissions of VOCs from heatset web offset printing

BAT IN HEATSET

- Table 25 is the main part of Heatset Technique J (VOC: Total emission Limit).
- The ‘associated monitoring’ given in BAT 10 concerns an annual Solvent Mass Balance. BAT 10 is the main BAT in Heatset Technique K: ‘VOC: Solvent Mass Balance’.

Parameter	Unit	BAT-AEL (Yearly average)
Total VOC emissions as calculated by the solvent mass balance	kg VOCs per kg of ink input	< 0,01–0,04 ([50])

The associated monitoring is given in BAT 10.

As an alternative to the BAT-AELs in Table 25, the BAT-AELs in both Table 26 and Table 27 may be used.

BAT IN HEATSET

For an explanation of the alternative BATAELs and their applicability see BAT Guidance Part 1 section 3.4 'VOC: Two alternative limit values'...

Table 26

BAT-associated emission level (BAT-AEL) for fugitive emissions of VOCs from heatset web offset printing

BAT IN HEATSET

- Table 26 is the main part of Heatset Technique I (VOC: Fugitive emission Limit)
- The 'associated monitoring' given in BAT 10 concerns an annual Solvent Mass Balance. BAT 10 is the main BAT in Heatset Technique K (VOC: Solvent Mass Balance).

Parameter	Unit	BAT-AEL (Yearly average)
Fugitive VOC emissions as calculated by the solvent mass balance	Percentage (%) of the solvent input	< 1–10 ([51])

The associated monitoring is given in BAT 10.

Table 27

BAT-associated emission level (BAT-AEL) for VOC emissions in waste gases from heatset web offset printing

BAT IN HEATSET

- Table 27 is the main part of Heatset Technique L: 'VOC: Oxidiser monitoring'.
- The 'associated monitoring' given in BAT 11 concerning method and frequency for waste gas measurements of VOC concentrations expressed in mgC/Nm^3 is also part of Heatset Technique L.

Parameter	Unit	BAT-AEL (Daily average or average over the sampling period)
TVOC	mg C/Nm^3	1–15

The associated monitoring is given in BAT 11.

1.12. BAT conclusions for flexography and non-publication rotogravure printing

The emission levels for flexography and non-publication rotogravure printing given below are associated with the general BAT conclusions given in Section 1.1.

Table 28

BAT-associated emission level (BAT-AEL) for total emissions of VOCs from flexography and non-publication rotogravure printing

Parameter	Unit	BAT-AEL (Yearly average)
Total VOC emissions as calculated by the solvent mass balance	kg VOCs per kg of solid mass input	< 0,1–0,3

The associated monitoring is given in BAT 10.

As an alternative to the BAT-AEL in Table 28, the BAT-AELs in both Table 29 and Table 30 may be used.

Table 29

BAT-associated emission level (BAT-AEL) for fugitive emissions of VOCs from flexography and non-publication rotogravure printing

Parameter	Unit	BAT-AEL (Yearly average)

Fugitive VOC emissions as calculated by the solvent mass balance	Percentage (%) of the solvent input	< 1–12

The associated monitoring is given in BAT 10.

Table 30

BAT-associated emission level (BAT-AEL) for VOC emissions in waste gases from flexography and non-publication rotogravure printing

Parameter	Unit	BAT-AEL (Daily average or average over the sampling period)
TVOC	mg C/Nm^3	1–20 (52) (53)

The associated monitoring is given in BAT 11.

1.13. BAT conclusions for publication rotogravure printing

The BAT conclusion in this section applies to publication rotogravure printing, and applies in addition to the general BAT conclusions given in Section 1.1.

BAT 29. In order to reduce VOC emissions from publication rotogravure printing, BAT is to use a toluene recovery system based on adsorption and one or both of the techniques given below.

	Technique	Description
(a)	Use of retention inks	Retention inks slow the formation of the dried film surface, which allows toluene to evaporate over a longer time and therefore more toluene to be released in the dryer and recovered by the toluene recovery system.
(b)	Automatic cleaning systems connected to the toluene recovery system	Automated cylinder cleaning with air extraction to the toluene recovery system.

Table 31

BAT-associated emission level (BAT-AEL) for fugitive emissions of VOCs from publication rotogravure printing

Parameter	Unit	BAT-AEL (Yearly average)
Fugitive VOC emissions as calculated by the solvent mass balance	Percentage (%) of the solvent input	< 2,5

The associated monitoring is given in BAT 10.

Table 32

BAT-associated emission level (BAT-AEL) for VOC emissions in waste gases from publication rotogravure printing

Parameter	Unit	BAT-AEL (Daily average or average over the sampling period)
TVOC	mg C/Nm^3	10–20

The associated monitoring is given in BAT 11.

[…]

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(1) Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment (OJ L 135, 30.5.1991, p. 40).

(2) Directive (EU) 2015/2193 of the European Parliament and of the Council of 25 November 2015 on the limitation of emissions of certain pollutants into the air from medium combustion plants (OJ L 313, 28.11.2015, p. 1).

(3) For any parameter where, due to sampling or analytical limitations and/or due to operational conditions, a 30-minute sampling/measurement and/or an average of three consecutive measurements is inappropriate, a more representative sampling/measurement procedure may be employed.

(4) The selection of the application techniques may be restricted at plants with low throughput and/or high product variety as well as by the substrate type and shape, product quality requirements and the need to ensure that the materials used, coating application techniques, drying/curing techniques and off-gas treatment systems are mutually compatible.

(5) The selection of the drying/curing techniques may be restricted by the substrate type and shape, product quality requirements and the need to ensure that the materials used, coating application techniques, drying/curing techniques and off-gas treatment systems are mutually compatible.

(6) To the extent possible, the measurements are carried out at the highest expected emission state under normal operating conditions.

(7) In the case of a TVOC load of less than 0,1 kg C/h, or in the case of an unabated and stable TVOC load of less than 0,3 kg C/h, the monitoring frequency may be reduced to once every 3 years or the measurement may be replaced by calculation provided that it ensures the provision of data of an equivalent scientific quality.

(8) For the thermal treatment of off-gases, the temperature in the combustion chamber is continuously measured. This is combined with an alarm system for temperatures falling outside the optimised temperature window.

(9) Generic EN standards for continuous measurements are EN15267-1, EN15267-2, EN15267-3 and EN 14181.

(10) The monitoring only applies if DMF is used in the processes.

(11) In the absence of an EN standard, the measurement includes the DMF contained in the condensed phase.

(12) In the case of a stack with a TVOC load of less than 0,1 kg C/h, the monitoring frequency may be reduced to once every 3 years.

(13) The monitoring only applies in the case of direct discharge to a receiving water body.

(14) The monitoring frequency may be reduced to once every 3 months if the emission levels are proven to be sufficiently stable.

(15) In the case of batch discharge that is less frequent than the minimum monitoring frequency, monitoring is carried out once per batch.

(16) TOC monitoring and COD monitoring are alternatives. TOC monitoring is the preferred option because it does not rely on the use of very toxic compounds.

(17) Monitoring of Cr(VI) only applies if chromium(VI) compounds are used in the processes.

(18) In the case of indirect discharge to a receiving water body, the monitoring frequency may be reduced if the downstream waste water treatment plant is designed and equipped appropriately to abate the pollutants concerned.

(19) Monitoring of Cr only applies if chromium compounds are used in the processes.

(20) Monitoring of F- only applies if fluorine compounds are used in the processes.

(21) The BAT-AEL and indicative level do not apply where off-gases are sent to a combustion plant.

(22) The BAT-AEL may not apply if nitrogen-containing compounds (e.g. DMF or NMP (*N*-methylpyrrolidone)) are present in the off-gas.

(23) The BAT-AEPL may not apply where the coil coating line is part of a larger manufacturing installation (e.g. steelworks) or for combilines.

(24) The BAT-AEPL may not apply where the coil coating line is part of a larger manufacturing installation (e.g. steelworks) or for combilines.

(25) The averaging period is given in the general considerations.

(26) The BAT-AEL for COD may be replaced by a BAT-AEL for TOC. The correlation between COD and TOC is determined on a case-by-case basis. The BAT-AEL for TOC is the preferred option because TOC monitoring does not rely on the use of very toxic compounds.

(27) The BAT-AEL only applies if fluorine compounds are used in the processes.

(28) The upper end of the BAT-AEL range may be 1 mg/l in the case of zinc-containing substrates or of substrates pretreated using zinc.

(29) The BAT-AEL only applies if chromium compounds are used in the processes.

(30) The BAT-AEL only applies if chromium(VI) compounds are used in the processes.

(31) The BAT-AELs may not apply if the downstream waste water treatment plant is designed and equipped appropriately to abate the pollutants concerned, provided this does not lead to a higher level of pollution in the environment.

(32) The averaging period is given in the general considerations.

(33) The BAT-AEL only applies if fluorine compounds are used in the processes.

(34) The upper end of the BAT-AEL range may be 1 mg/l in the case of zinc-containing substrates or of substrates pretreated using zinc.

(35) The BAT-AEL only applies if chromium compounds are used in the processes.

(36) The BAT-AEL only applies if chromium(VI) compounds are used in the processes.

[…]

(50) The upper end of the BAT-AEL range is related to the production of high-quality products.

(51) The upper end of the BAT-AEL range is related to the production of high-quality products.

(52) The upper end of the BAT-AEL range is 50 mg C/Nm3 if techniques are used which allow the reuse/recycling of the recovered solvent.

(53) For plants using BAT 16 (c) in combination with an off-gas treatment technique, an additional BAT-AEL of less than 50 mg C/Nm3 applies to the waste gas of the concentrator.

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