Example Odour Control Report for a Painting and Printing Facility

**Sample Print & Paint Company**

**Anytown, ON**

# Introduction and Scope of Odour Control Reports

## Purpose of the Example Odour Control Report

A person engaging in an activity prescribed for the purposes of the Environmental Activity and Sector Registry (EASR) by Ontario Regulation 1/17 (Air Emission EASR regulation) is required to have available at all times an Odour Control Report (OCR) if any of the circumstances set out in paragraph 5 of Section 24 of the regulation exists at the facility. If an OCR is required, the facility must prepare a facility-specific OCR that includes all the administrative and technical requirements set out in Section 27 of the Air Emissions EASR Regulation. In order to provide appropriate guidance materials and tools for facilities tasked with preparing an OCR, a total of six example OCRs have been developed by the Ministry of Environment and Climate Change (MOECC). One OCR is available for each activity with NAICS Codes listed in Table 3 – Odour – Processes and Setback Distances of the EASR publication, and for each specific process listed in Table 4 – Odour – Processes and Setback Distances, as follows:

* Dog and Cat Food Manufacturing NAICS 311111 and Cooking or Drying Animal Products
* Sugar Manufacturing NAICS 311310
* Breweries NAICS 312120
* Spraying Operation (≥ 10 L/hr) and Printing (> 400 kg/hr ink usage)
* Wastewater Treatment – Lagoons, Uncovered Clarifiers, Sludge Management
* Food Frying

The Dog and Cat Food Manufacturing and Cooking or Drying Animal Products OCR was prepared such that it is applicable to NAICS 311111 listed in Table 3 and Cooking or Drying Animal Products, a Table 4 process. One combined OCR for Spraying Operations (Painting) and Printing was prepared. Where appropriate, the wastewater treatment OCR may be combined with the other OCRs.

The purpose of the example OCRs is to simplify the level of effort required by facilities when developing an OCR. These example OCRs contain useable information and are presented in a recommended OCR format.

Some sections in the example OCRs can be used as a draft for facilities, particularly with respect to the jurisdictional review and odour control options provided in Section 4. This information can be incorporated by facilities into their site-specific OCR. It is imperative, however, that the information be reviewed and validated as it reflects information available at the time this example OCR was prepared (January 2017). There may be advancements in control technologies or other changes to the sector or process that would need to be considered. It is the responsibility of the person preparing an OCR for a facility to ensure that the information, including the jurisdictional review and odour control options is complete.

As well, a number of sections of the OCR will require site-specific inputs and considerations, in particular, Section 2 where unique attributes at a specific facility should be detailed, Section 5 which presents the assessment of control option technical feasibility, and Section 6 which summarizes the status of current odour control measures at the facility.

These example OCRs include narrative guidance text boxes throughout for instructional purposes, as well as Appendices with further guidance materials and resources.

As there are numerous facilities that have printing and painting operations as major or minor processes within their production facility, this report should not be considered comprehensive for all facilities with these activities. A facility-specific OCR must be prepared to include all odorous sources at a facility and all different types of print and painting equipment as well as the materials being used. All reasonable effort must be made to identify odour reduction measures and procedures that are available from publicly accessible resources.

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# Statements of Certification

## Licensed Engineering Practitioner

I confirm that based on the information provided to me, the information in the report is accurate as of the date it is signed and sealed.

Signature:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Name of Licensed Engineering Practitioner:

PEO License Number:

Date:

## Facility Representative

I confirm that all information provided to the Licensed Engineering Practitioner in order to prepare this report was complete and accurate, and I have the authority to bind the company.

Signature:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Name of Facility Representative:

Position in the Company:

Date:

# Introduction

## Odour Control Report for Painting and Printing Processes

This Odour Control Report for the Sample Print & Paint Company (Co.) (the ‘OCR’), a fabrication based facility that conducts both printing and painting operations at its facility, was prepared to comply with the odour requirements of Ontario Regulation 1/17- Activities Requiring Assessment of Air Emissions (the ‘Air Emissions EASR Regulation’) for facilities that meet the following criteria:

* The facility is required to register their activities in the EASR under the Air Emissions EASR Regulation;
* The facility has completed an odour screening report in accordance with Section 25 of the Air Emissions EASR Regulation;
* The facility engages in a spraying operation at which the total of the maximum hourly application rates of all coatings used in spraying operations at the facility is greater than or equal to 10 litres/hr (L/hr), which is a process set out in Table 4 of Chapter 4 of the “Environmental Activity and Sector Registry – Limits and Other Requirements” (EASR Publication) published by the Ministry of Environment and Climate Change (MOECC), and available on a government website;
* The facility engages in a printing process at which the total of the maximum hourly application rates of all printing inks used in printing processes at the facility is greater than 400 kg/hr, which is a process set out in Table 4 of Chapter 4 of the “Environmental Activity and Sector Registry – Limits and Other Requirements” (EASR Publication) published by the Ministry of Environment and Climate Change (MOECC), and available on a government website; and,
* The distance between the facility and the closest point of odour reception is less than the distance set out opposite the process in Table 4 (Chapter 4 of the EASR publication explains what a point of odour reception is and how the distance between a point of odour reception and the facility must be measured).

A facility is required to prepare an OCR if any of the circumstances set out in paragraph 5 of Section 24 of the Air Emissions EASR Regulation exist at the facility. If an OCR is required, the facility must prepare a facility-specific OCR that includes all the administrative and technical requirements set out in Section 27 of the Air Emissions EASR Regulation.

While this example OCR report pertains to industrial processes which engage in printing (>400 kg/hr of printing inks) or spraying operations (>10 L/hr of coatings), it can also be used to assist facilities outside of this sector that have similar sources and emissions of odour in preparing their OCRs.

A facility is required to prepare a Best Management Practices Plan for Odour (BMPP) if any of the circumstances set out in paragraph 3 of Section 24 of the Air Emissions EASR Regulation exist at the facility at the time the most recent odour screening report is prepared. BMPPs must be prepared on a facility-basis. In this example, the Sample Print and Paint Company must, in addition to this OCR, develop and implement a BMPP. Best Management Practices (BMPs) are practices or procedures to prevent or minimize odorous effects. These may be general in nature and applicable to a wide range of facilities, or they may be facility-specific and intended to help reduce odorous releases from process operations or activities at an individual site. These practices are most easily implemented and most effective if they are incorporated into Standard Operating Procedures (SOPs) and training programs and workers are assigned responsibility and accountability. BMPs in general would not require additional engineering or significant process modifications or the installation of pollution control equipment.

Senior management at the facility must participate in the development of the OCR, and support the Licensed Engineering Practitioner by providing comprehensive and accurate information regarding site processes, activities, and emissions. The accuracy and completeness of the information provided for the preparation of the OCR must be certified by a representative of the facility.

## Sector Description

It is not a mandatory requirement of the OCRs to include a sector description. However, it is recommended that a facility demonstrates that the activities and operations carried out at their site are consistent with other facilities in their sector (Section 1.4), and to highlight the differences or aspects of operations that are unique to their operation (Section 2.6).

### Printing

Printing means a printing process at a facility and includes lithographic printing, flexographic printing, digital printing, rotogravure printing, and screen printing. In most cases, it is the use of organic solvent and VOCs in the inks that result in odour emissions.

Lithography, or web offset lithography, uses a planographic image carrier where the image and non-image areas are on the same plane. The image area is ink wettable and water repellent, and the non-image area is chemically repellent to ink. The inks used in lithography are either heatset or non-heatset. In offset printing, the graphic image is applied from an ink-covered print plate to a rubber-covered ‘blanket’ cylinder and then transferred onto the substrate, hence the term ‘offset’ lithography. The substrate in offset lithography can be either a web or sheet. A web substrate can be used with either heatset or non-heatset inks. Isopropyl alcohol is a common ‘fountain’ or ‘dampening’ solution used to dampen the non-image area on the plate. Offset lithographers may also use solvents as cleaning solutions to clean the press and machine parts.

In flexographic printing, the image area is raised from the surface of a plate with a polymer image carrier (often rubber) and uses solvent based inks containing alcohol or acetate. The process is usually web-fed and used for medium or long multi-colour runs on varied substrates, including heavy paper, milk cartons, metal and plastic foil. The inks dry by absorption into the web or by evaporation, usually in high-velocity hot-air dryers at temperatures below 120°C.

Rotogravure is a process that uses a cylinder on which an image is etched or engraved, or intaglio relative to the image carrier. The process is used for publication and product packaging, and is suited to long run printing jobs. Inks must be very fluid, and solvents common to rotogravure and gravure inks include ethanol, ethyl acetate, methyl ethyl ketone, toluene, and acetone.

Digital printing uses a digital image and an inkjet or laser printer to deposit water-based or solvent-based inks or toner directly onto different media such as paper, photo, canvas, glass, metal and other substances. There is no need for printing plate replacement and cleaning. Digital printing is well suited to small run, on-demand printing requiring a short turnaround time, but is becoming cost-competitive with offset technologies on larger print runs.

Screen printing involves forcing ink through a stencil in which the image areas are porous. The screens are generally made of silk, nylon, or metal mesh. Screen printing is used for signs, displays, electronics, wallpaper, greeting cards, ceramics, decals, banners, and textiles. Ink systems used in screen printing include ultra-violet cure, water-borne, solvent-borne, and plastisol (polyvinyl chloride), which is mainly used in textile printing. Solvent-based ink systems may contain aliphatic, aromatic, and oxygenated organic solvents. Both sheet-fed and web presses are used in screen printing. The substrate can be dried after each printing station or, in the case of absorbent substrates, after all colours are printed. Solvent and water-borne inks are dried in hot-air or infra-red drying ovens.

Please note that if the only activities engaged in at the facility are printing activities prescribed for the purposes of the EASR by O. Reg. 349/12 (EASR Printing regulation), then O. Reg. 1/17 does not apply in respect of the activities and a BMPP and OCR would not be required. O. Reg. 349/12 would continue to apply to the printing facility.

### Spraying Operations

Spraying Operations are defined as a process in which a coating is applied to a surface by way of spraying but does not include a printing process or a process that applies a coating using a spray can, electrostatic painting or electrophoretic painting or the application of a coating as part of routine maintenance at the facility.

An example of a spraying operation is solvent based painting, which is not an industrial sector in itself. It may be the main activity at a facility or may be one stage of a manufacturing process. Conventional spray processes use atomized air to apply the coating at high pressure, and are often hand-operated. High volume low pressure (HVLP) paint guns are similar to a conventional spray guns that use a compressor to supply the air, but the spray gun itself requires lower pressure (LP) and a higher volume (HV) of air is used to propel the paint. There are also Low Volume, Low Pressure (LVLP) spray guns which achieve the benefits of HVLP with lower air requirements. Airless spray systems force paint through an atomizing nozzle at high pressures, with less volumetric flow and less overspray (i.e. wastage).

Examples of industries that may have spray painting include:

* Wood cabinetry manufacturing (NAICS 337110),
* Millwork manufacturing (NAICS 32191), etc.

Please note that if the only activities engaged in at the facility are automotive refinishing at an automotive refinishing facility prescribed for the purposes of the EASR by O. Reg. 347/12 (EASR Automotive Refinishing regulation), then O. Reg. 1/17 does not apply in respect of the activities and a BMPP and OCR would not be required. O. Reg. 347/12 would continue to apply the automotive refinishing facility.

## Odour Control Report for Sample Print & Paint Co.

An OCR is required for the Sample Print & Paint Co., a large fabrication shop that provides custom millwright services. It is a large manufacturing facility operating two paint spray booths, one touch up paint area, and one solvent-based printing press.

The total paint usage is greater than 10 litres per hour, and the printing rate is greater than 400 kg/hr; both usage rates trigger the requirement for an OCR. The closest point of odour reception is less than 500 metres from the nearest source of odour at the facility.

Chapter 4 of the EASR publication explains what a point of odour reception is and how the distance between a point of odour reception and the facility must be measured. The required setback distance for Spray Painting >10 L/hr or Printing >400 kg/hr is 500 metres as listed in Table 4 of the EASR Publication.

## Odour Control Report Content

This OCR for the Sample Print and Paint Co. has been prepared in accordance with the Air Emissions EASR Regulation, and therefore includes the following required elements:

* Legal name of each facility owner and name under which the owner carries on business, if different from the legal name;
* If the facility operator is not an owner of the facility, the legal name of each facility operator and name under which each operator carries on business, if different from the legal name;
* Facility address;
* A facility description and a detailed process description;
* Measures and procedures used by facilities in this sector, or at facilities with similar sources of odour or activities, to prevent or minimize the discharge of odour, including control equipment, engineering controls, process optimization, pollution prevention, or other associated measures. In many cases, these measures were intended to abate specific contaminants but have the net effect of reducing odour emissions. For example, particulate (overspray) control could control odours from the Sample Print and Paint Co.;
* An analysis of the technical feasibility of implementing the measures and procedures identified, or potential combinations thereof at the facility;
* For the control measures identified as technically feasible but not implemented, rationale for why the control measures are not implemented at the facility to prevent or minimize odour;
* A discussion of the adequacy of measures and procedures currently implemented and set out in the BMPP, to prevent or minimize odour effects from the facility;
* A statement by the Licensed Engineering Practitioner confirming that based on the information provided to the practitioner, the information in the report is accurate as of the date it is signed and sealed; and,
* A statement signed by the person engaging in the prescribed activity confirming that all information the person gave to the Licensed Engineering Practitioner in order to prepare the report was complete and accurate.

# Facility Description

## Site Location and Location of Points of Odour Reception

The facility is located at 100 Sample Drive, in Anytown, Ontario.

The UTM co-ordinates for the facility are:

* Zone – 17
* UTM Easting - 723000 m
* UTM Northing - 4840000 m

The Sample Print & Paint Co. is located in an industrial area that lies adjacent to a residential development. The closest point of odour reception is a residence located 200 metres from the fenceline of the facility and 300 metres from the nearest odour source at the facility, which is less than the required setback distance of 500 metres from Table 4 of the EASR Publication. There are other residences, as well as a public sports field, within 500 metres of the facility.

## Facility Owner Legal Name and Contact Information

Legal name of the owner: Mr. Roman Pressman

Contact Information: 519-123-4567; roman.pressman@sampleprintandpaintco.com

## Facility Operator Legal Name and Contact Information

The facility is operated by the owner.

The Air Emissions EASR Regulation requires that the OCR sets out the legal name of each owner of the facility, and the name under which each owner carries on business, if it is not the owner’s legal name. Further, if the person who operates the facility is not an owner, the report must set out the legal name of each person who operates the facility and the name under which each operator carries on business, if it is not the operator’s legal name.

## Production Rate and Operating Hours

The operating hours are typically 12 hours per day (7am to 7pm), 5 days per week, with occasional weekend work as required. There is one week of scheduled shutdown per year.

The facility is capable of printing rates of more than 400 kg of ink per hour and painting of up to 20 litres per hour of solvent based paints. Typical production rates are notably lower and depend upon customer requirements.

## Facility Complaint History

The facility maintains accurate records of all complaints received and the measures taken to investigate and respond to each complaint following the process outlined in the facility BMPP. This includes complaints made to the facility directly, as well as those made to the local MOECC office. There have been no complaints received over the last 5 years.

It may be beneficial for a facility to document all complaints received and their resolution in the OCR. Some complaints may have been resolved or were the result of a process upset. Resolved complaints could lead to changes or improvements in the facility’s BMPP for odour. However, documenting complaints in an OCR is not a legal requirement.

## Unique Facility or Process Attributes

At the Sample Print & Paint Co., the following processes, activities, or sources may be considered unique when compared to other facilities:

* Automated paint mixing and dispensing to paint spray guns used in the two paint booths.
* Automated paint gun cleaner and recycling system.

Each type of production facility that utilizes printing equipment, and/or paint systems are unique and source to source variations in process, source configurations or location at the facility can significantly affect emissions and off-property impacts. The emission variations result from differences in the paint formulations, printing ink formulations, the type and age of equipment used, total production, etc. All of these factors and production details need to be clearly described in a facility’s OCR.

# Process Description

## General Process Description

The main processes and activities at the Sample Print & Paint Co. include:

* Solvent-based spray painting;
* Sheet-fed off-set printing and flexography printing;
* Paint kitchen;
* Bulk receiving and storage; and,
* Auxiliary services.

### Spray Painting

The Sample Print & Paint Co. operates four downdraft paint booths. Each paint booth has a maximum spray rate of 5 litres per hour of solvent based paints and can be used simultaneously. The booths are fitted with dry type paint arrestor filters. The spray guns are of the High Volume Low Pressure (HVLP) type. Paint formulations are mixed in the paint kitchen. In addition, there is a touch-up paint area in the main building.

### Printing (Offset and Flexography)

Offset (Lithography)

The heat off-set printing line produces magazines and pamphlets. When an inked image is applied from a plate to a rubber-covered "blanket" cylinder and then transferred onto the printing surface or substrate, the process is known as "offset" lithography. A dampening solution containing isopropanol is used on the plate to distinguish between printed and non-printed areas, and the printing inks contain approximately 40% solvents including petroleum derived hydrocarbons. Most of the solvent in the ink evaporates upon application and drying; however, a significant fraction of the solvent remains on the printed page. The heat-set inks dry very quickly as they pass through a hot air dryer and then cool over chill rolls before folding and cutting.

Flexography

The flexographic printing line uses a rubber image carrier and alcohol-based inks to print on flexible and multiwall packaging, heavy paper, fiberboard, metal and plastic foil. Flexography printing uses very fluid inks of about 75 volume percent organic solvent. The solvent ink is rubber compatible, and is usually an alcohol based mixture with aliphatic hydrocarbons, esters, glycols, ketones, and ethers. The inks dry by solvent absorption into the web and by evaporation in a dryer, after which the media is cooled on chill rolls.

### Paint Kitchen

The paints and printing inks received at the Sample Print & Paint Co. are prepared in the Paint Kitchen area. Mixing bases to colours, primers, hardeners and thinners are all done to specification required by the specific application. The Paint Kitchen area also contains the spray gun cleaning systems which are closed-loop ‘green’ solvent systems. Spent solvent storage is also located along the one side of the room in a proper containment system.

### Bulk Receiving, and Storage

The Sample Print & Paint Co. receives bulk liquids in 55 gallon drums and 200 gallon totes, including:

* Solvent based paints (including primers, clearcoats, and topcoats);
* Printing inks; and,
* Solvents and cleaning solutions.

Bulk paper and cardboard products are also received by truck.

### Auxiliary

The auxiliary equipment and processes are those of any large manufacturing facility, and include:

* Combustion boilers for process heat and building heating;
* Small unit heaters, radiant heaters, make-up air units, or other HVAC;
* Maintenance welding and painting;
* Solid waste collection and trash compaction; and,
* General building (non-process) exhausts (office space, cafeteria, and washrooms).

## Identification of Odorous Contaminants

In this fabrication facility, the odours associated with painting and printing operations are the result of the volatile organic compound (VOC) content of paints, inks, and associated materials. The printing activity uses VOC-containing inks, cleaners, solvents, emulsions, thinners, retardants and de-emulsifiers. The type of VOCs used for painting depends upon the substrate and the type of coating required. It may involve the use of solvent-based paints, primers, thinners, solvents, topcoats, clearcoats, rust inhibitors, and potentially other VOC-containing products. Paint solvents may include, among others, benzene, toluene, mixed xylenes, and ethylbenzene (BTEX), white spirits (mixtures of aliphatic and alicyclic hydrocarbons), and aliphatic hydrocarbons (hexane, heptane).

The intention of the OCR is to focus efforts on odour emissions that are associated with facilities that have these activities. The speciation of odour in the exhaust gases by specific contaminant is not required.

However, a better understanding of the nature of the odour and the expected chemical composition of odorous emissions may be useful, if available, in determining which control options have been proven effective on similar processes. For example, control options for VOC odours may not be effective or technically feasible on odours from sulphur-containing emissions. This detail also allows for discussion of the offensiveness of the odour and the identification of potential contaminants with low odour detection thresholds.

## Identification of Odour Sources and Source Groupings

Each odour source at the Sample Print & Paint Co. has been classified as a primary odour source, secondary source, or a negligible odour source based upon the source’s relative contribution to potential odour effects. For each odour source, a general description of the associated process, unit operation, equipment or activity, expected contaminants in the exhaust gas, typical odour loadings, and potential constraints were provided, where applicable. The key parameters are presented in tabular format.

For the operations associated with printing and painting, VOC emissions are the predominant source of odours. The control of particulate matter emissions is not discussed in detail, as paint overspray is effectively controlled by filters and the paint solids are not the source of odour.

The odour sources at the Sample Print & Paint Co. were classified as primary and secondary based upon the odour emission rates as well as the relative contribution to modelled off-site odour effects.

Dispersion modelling is not a requirement of the OCR. If no previous odour assessment with dispersion modelling has been completed for the facility, other methods of assessing the relative significance of odour sources may be employed to identify odour sources.

If dispersion modelling for odour has previously been completed, the model output should be reviewed as it may be useful in assessing odour effects and classifying sources as primary, secondary, or negligible. Even if accurate emission data are not available, dispersion modelling for odour and the use of a dilution factor is an effective tool in ranking odour sources by considering the dispersion (i.e. dilution) characteristics of different sources such as tall stacks and wall mounted vents. A dilution or dispersion factor is the modelled odour strength or concentration at a receptor (OU/m³) divided by the source strength as an emission rate (odour units per second OU/s) that can be used for screening purposes to evaluate the effects of odour emissions from one individual odour source at an odour receptor.

**Estimating Odour Loading (Concentration OU/m³ and Emission Rates OU/s)**

Estimating the odour loading from sources may be done using emission factors, data from similar processes at other facilities, or source measurement. In many cases the only available emission factors are for VOCs as little data on odour loadings is publicly available and difficult to apply on a generalized basis. The odour and VOC emissions may not be directly proportional; however, these values will also assist in site-specific determination of the VOC concentration and emission rate for individual sources to allow for comparisons, ranking of sources, and discussion of the suitability of control measures.

Odour measurement at the source may be conducted on-site to determine the odour concentration and emission rate in OU/m³ and OU/s, respectively. Odour sampling methodology is published in the MOECC Source Testing Code, and odour concentrations are frequently measured using an olfactometer. An odour unit (OU) is a measure of the intensity or strength of an odour. One odour unit is the level at which half the population would detect or respond to an odour, and the odour concentration, in OU/m³, refers to the number of times the sample must be diluted to reach 1 OU.

### Primary Sources of Odour

The primary odour sources from the Sample Print & Paint Co. were identified based upon a previous odour survey conducted to rank the sources by potential for off-site effects. The previous odour survey is up to date and reflects current operations.

Individual sources are provided or, where possible, sources are grouped where it is reasonable to do so. Grouping is useful when sources are associated with the same process stage, same production area, or have similar odour and exhaust characteristics. These sources may be combined and directed to individual pollution control equipment or dealt with as an aggregate.

The following are considered to be the major odour sources from the print and paint operations:

#### Paint Booths;

#### Off-set Printing; and,

#### Flexography Printing.

The two printing sources are carried forward as a group as they have similar VOC emissions and exhaust gas characteristics. The Off-set Printing and Flexography Printing processes are identified as the Solvent Based Printing Group. All of the primary sources are identified in Table 1A.

Wastewater collection, handling, treatment, and discharge, may potentially be a significant source of odour. Due to the complexity of wastewater treatment and odour control measures, a separate sample Wastewater OCR has been developed to provide guidance with systems operated to achieve the requirements of municipalities for liquid discharge to the sanitary sewers or the requirements for direct discharge that would likely involve advanced treatment systems

The example OCR for industrial wastewater handling and treatment should be reviewed if applicable as it pertains to the potential to generate odours from wastewater processes. If wastewater is identified as a source of odours, the overall OCR for the facility should include both the sector specific and wastewater aspects.

### Secondary Sources of Odour

The secondary odour sources are presented in Table 1B and have the potential to contribute to odour effects, but not to the same extent as those deemed primary sources of odour.

There is one source group for the secondary odour sources that includes the Paint Kitchen and touch-up paint area and identified as the Secondary Painting Sources.

### Sources Not Considered Odorous

The following air emissions sources are not considered as significant odour sources at most painting or printing facilities, including the Sample Print & Paint Co.:

* Handling and storage of paper products and other media;
* Boilers;
* Gas-fired drying of printed materials;
* HVAC equipment (comfort heating and cooling);
* Parts washers (aqueous);
* Product label gluing;
* Laser / ink printing;
* Cafeteria exhausts and other employee comfort areas; and,
* Office Areas.

All potentially odorous sources have been included in the BMPP for the facility.

All potentially odorous sources should be included in the BMPP for the facility, if applicable. For the Sample Print & Paint Co., the product label gluing was included in their BMPP to ensure proper management of glues and glue residues. There is no odour associated with the other insignificant sources.

| **Source Description**  | **Odorous Contaminants** | **Odour Loading** | **Exhaust****Characteristics**  | **Flow Rate** | **Continuous or Intermittent Discharge** | **Current Odour Control Measures** |
| --- | --- | --- | --- | --- | --- | --- |
| Paint Booths | VOCs | High | Dedicated Vertical Stack | High | Continuous | Paint Arrestor Filter, Water Wash, Reduced Paint VOC Content, and Stack Optimization |
| Heat-set Offset Printing | VOCs | High | Dedicated Vertical Stack | Moderate | Continuous | Thermal oxidation (waste gas treatment) |
| Flexography Printing | VOCs | High | Dedicated Vertical Stack | Moderate | Continuous | Thermal oxidation (waste gas treatment) |

**Table 1A - Sample Odour Source Identification Table for Sample Painting and Printing (Primary Odour Sources)**

**Table 1B - Sample Odour Source Identification Table for Sample Painting and Printing (Secondary Odour Sources)**

| **Source Description**  | **Odorous Contaminants** | **Odour Loading** | **Exhaust****Characteristics**  | **Flow Rate** | **Continuous or Intermittent Discharge** | **Current Odour Control Measures** |
| --- | --- | --- | --- | --- | --- | --- |
| Secondary Painting Sources | VOC | Low | Room exhaust fan | Moderate | Continuous | Carbon Filter |
| Paint and Ink Storage Room | VOC | Low | Room exhaust fan | Low | Continuous | None |

**Site-specific Source Description**

General indicators of the odour loading, stack parameters, and exhaust gas flow rate are provided in Tables 1A and 1B. Facilities should ensure that all available source and stack data, available through their Emission Summary and Dispersion Modelling (ESDM) report, is used to describe the odour sources as accurately as possible.

# Sector Odour Control Measures

This section of the OCR is provided as a summary of general industry practices and BMPs for print and painting operations that are considered when dealing with uncontrolled or problematic odour sources, where appropriate.

In Ontario, the need to implement odour control measures depends upon many factors, including the presence of odour receptors, a history of odour complaints, or siting in an area with multiple industrial sources. In the absence of off-site odour impacts, there is typically no motive for additional control equipment, engineering controls, or abatement measures specific to odour.

A review of publicly available information was completed to identify what measures and procedures are in use to control air emissions. Sources included Environmental Compliance Approvals (ECAs) for Ontario facilities, European Union BAT reference documents (BREFs) and associated guidance materials, US EPA Title V Permits and Reasonably Available Control Technology (RACT) Analysis documents, among others. In many cases, the control measures were implemented to reduce total VOC discharges, which had the added benefit of reducing odour emissions. A review of measures that can be used on similar sources was also completed to identify any that are potentially transferrable.

The odour control measures identified in this section have been demonstrated to be effective at print and painting operations within potentially larger production sites. Current practices for odour control for print and painting operations range from the implementation of BMPs for smaller processes to control equipment on all odorous sources at larger operations or those that have nearby odour receptors.

A review of a number of facilities or organizations within Ontario, the US, the EU, and Australia was conducted to identify what measures, if any, have been implemented.

## Current Practices at Printing and Painting Operations

The odour control measures and procedures identified are currently in use at processes similar to each odour source or source grouping identified at the Sample Print & Paint Co. and are presented in Table 3 for the primary sources and Table 4 for the secondary sources.

### Ontario

Facilities that have printing and painting processes as part of their productions do not always have the same NAICs code. As such it was difficult to obtain a group of similar business ECAs through the MOECC Access Environment database of historical and current approvals that would present a representation of all the potential types of printing and painting operations in Ontario. A set of ECAs were obtained for general review of small, medium and large print and paint users in Ontario and where possible sole business NAICs code searches were also done. There was no data obtained on how many businesses in Ontario operate printing equipment and/or have operational spray booths that may require OCRs.

The operational data provided for the print operations presents variations in the methods of control and operational production limits:

* One facility that operates a lithographic printing system with a maximum production limit of 36 kg/hr of ink used has an ECA issued with a Limited Operational Flexibility condition. As such, there are no details provided on control technologies. The facility is located in a rural setting with agricultural activities and residential properties as adjacent neighbours.
* One facility that operates a lithographic printing and drying system has a maximum production limit of 1475 kg/hr of offset ink. The facility directs the printing emissions to a regenerative thermal oxidizer and discharges to a dedicated stack. The facility is located in a large urban centre, in a light industry area with the nearest odour receptor being a residential sub-division approximately 100m from the operations.
* One facility having two heatset web offset printing presses has a total ink consumption of 24 kg/hr. Each press is controlled by a common regenerative thermal oxidizer that discharges through a dedicated stack. It also has two UV web offset printing presses having a total ink consumption of 14.7 kg/hr that discharge to a common dedicated stack. The facility is located in an isolated rural setting having agricultural operations adjacent to the site, as well as other industrial sites. The closest odour receptor is approximately 350m from the operations.
* One facility has no control technologies on five colour printing presses, all operating at 5 kg/hr of aqueous printing solution. This facility is located on the edge of a heavy industrial area but has a residential neighbourhood approximately 100m from its operations.
* Emissions from another facility with four offset web presses and two drying ovens are controlled by one common catalytic thermal oxidizer discharging through a dedicated stack. The closest odour receptors are residential properties located approximately 325m from the operations. The facility is located in a moderately sized urban area within an industrial area.

The data presented for painting operations in Ontario identifies varying production limits and control measures; the ECAs do not specify whether solvent or aqueous based paint systems are used:

* One facility operates a paint spray booth at a maximum rate of 0.25 L/hr and is equipped with an integrated bake feature and a dry paint arrestor filter. The facility is located in an industrial urban area with the closest odour receptor approximately 600m from the operations.
* One facility that operates a paint spay booth has a production limit of 5,400 L/week. The booth has a dry type paint arrestor filter. There is no heat curing cycle. The facility is located in a light industrial area with a commercial, retail and residential properties located in the community. The closest odour receptor is approximately 250m from the property line and there is a large public recreational attraction within 300m of the site.
* One facility operates three paint spray booth systems that are connected to one air curtain exhaust system with a pre-filter dry type arrestor system and integrated bake oven discharging through a dedicated vertical stack. The facility is located in a rural / industrial area. There is a residential area approximately 100m from the property line.
* One facility operates two paint spray booths with no control equipment identified, discharging through a dedicated vertical stack. This facility is located in an industrial area with the closest odour receptor, being residential, over 1km area from the property line.
* One facility is noted as operating one paint spray booth with a maximum production limit of 9.5 L/hr equipped with a dry type paint arrestor filter and exhausting through a dedicated stack. No information was available as to distance to odour receptors.
* One facility was found to operate one paint spray booth equipped with a dry type arrestor system with a water curtain that discharges to a dedicated vertical stack. The maximum paint usage was not detailed in the ECA. The facility is located in an urban area in a mixed-use zoning. There are retails properties, light industry operations, as well as commercial and residential properties surrounding the site. There is a major highway system between the site operations and the closest odour receptor which is approximately 225m from the property.
* One facility operates four open face paint spray booths with dry type paint arrestor filters and dedicated stacks, one closed face paint spray booth with a dry type paint arrestor filter discharging to a dedicated stack and one paint storage room with dedicated ventilation discharging through a dedicated stack. This facility has its closest odour receptor approximately 450m from the site and is located in a heavy industrial area. No production data was available.

The Sample Print & Paint Co. is considered to be a moderately sized production facility. Though production data for other facilities is limited, it can be inferred that the more stringent emission controls in Ontario and other jurisdictions are a result of either significantly larger scale operations or where site-specific issues have warranted more extensive controls. However, facilities developing an OCR should consider all relevant controls for facilities of various sizes and specific locations.

### Other provinces

Due to the incorporation of printing and painting activities within other industrial processes and manufacturing, it is difficult to identify multiple facilities across Canada that would have similar permitting and approvals from the publicly available resources. There were no specific guidance, regulatory requirements, or odour emission inventories for facilities in other provinces that provide details on odour control measures utilized by facilities that operate printing or painting production operations.

### United States

It is important to note that “odour” is not a regulated emission in the US. The following discussions consider controls required for volatile organic emissions (VOCs). Some of these control systems and requirements will also reduce odour emissions.

In the US, Title V operating permits are federally mandated for major stationary sources of air pollution with actual or potential emissions at or above the major source threshold for specified air pollutants defined by regulation (the major source threshold list can be found at the [Air Toxics Web Site](https://www3.epa.gov/airtoxics/pollsour.html)). The permitting is administered by state or district agencies. A limited number of smaller sources also require Title V permitting.

In addition to the requirement for operating permits, New Source Review (NSR) is a Clean Air Act program that requires industrial facilities to install modern pollution control equipment when they are built or when making a change that increases emissions significantly. The NSR permitting varies depending upon the attainment status of the district in which the facility is located. For major sources, Best Available Control Technology (BACT) would be required in attainment areas under the Prevention of Significant Deterioration program, Lowest Achievable Emission Rate (LAER) in non-attainment areas, there are no specified controls for minor sources or minor modifications to major sources. No documentation is available for facilities that do not trigger Title V permit or NSR requirements.

Similar to Ontario operations, US companies can have printing and painting operations as a support process of a bigger production facility. To facilitate a search for US companies, well- known manufacturer brands relying on printing and painting processes were searched to determine if any odour control requirements were included in their Part V Permits. Information on Part V Permits was reviewed for two companies in two states as posted on the individual state environmental agency websites. It should be noted that all of the facilities appear to have some form of control equipment installed; however, it is not always specified as odour control equipment, and it is not intended to suggest that control measures are required on all print and paint processes. The list is based on data available for facilities which have installed control equipment. Data was not found for smaller facilities or facilities without controls, nor were the total number of facilities with printing or painting operations in the US available. The data is summarized as follows:

* One facility is permitted to operate with one paint booth at 100 – 500 gallons/day with a 75% VOC maximum content; however, no details on control equipment of technologies were provided.
* One facility is equipped with a thermal oxidizer having a pre-treatment of a dry filter particulate control system, the use of unrestricted, vertically oriented stacks for the discharge of sealer ovens, the use of a carbon concentrator in series with a regenerative thermal oxidizer for VOC control on the guidecoat and topcoat ovens, operation of a water wash particulate control system with any paint booth operation, and a detailed list of all stacks with maximized discharge areas which are vertically oriented and unobstructed for optimized emission flow rates. There are specific limits for VOC, HAP, and NOx emissions as well as natural gas volumes on an annual basis but no values provided for maximum spray rates or volumes of paint, thinner or hardener usage.

The information on control measures provided in the publicly accessible Title V permits from state or district environmental agencies are for facilities identified as major sources. Small and medium sized facilities are unlikely to reach the release-based thresholds that would trigger requirement of a Title V permit. The odour control measures required, if any, depend upon production levels at the facility. Caution should be used when comparing controls from large facilities as the control measures identified may not be appropriate for smaller facilities.

### European Union

The Best Available Techniques (BAT) for European Surface Treatment Using Organic Solvents (STS) are published in a Best Reference Document on Best Available Techniques (BREF) published by the European Commission. The BAT conclusions are presented in two tiers. The first tier lists BAT for common activities and processes in the STS sector, and the second tier includes additional BAT for some specific industries or processes within the STS sector (BREF, 2007).

#### General BAT for Odour Abatement

The following are general BATs for odour abatement from STS processes and activities (BREF Section 21.1.56):

1. Change the type of process.
2. Change the materials used.
3. Implement waste gas treatment and/or destruction.
4. Optimization of discharge by increasing stack height.

The information presented on the EU BREF is based upon the most recent version of this document available (published in 2007) at the time this example OCR was prepared. This summary of the BREF BATs is not comprehensive, and a facility may choose to review the BREF document for further details specific to the facility’s operation. It is also recommended that the information published by the European Commission be reviewed prior to completing an OCR for any updates or revisions.

#### BAT for Heatset Web Offset

The following are specific BAT for heatset web offset presses, in addition to the General BATs (BREF Section 21.2.1– BATs 60 to 66):

1. BAT 60 - Reduce the sum of fugitive emissions and VOCs remaining after waste gas treatment.
2. BAT 61 - Reduce the emission of isopropyl alcohol (IPA) by printing with a low IPA concentration dampening solution by using all or a combination of the following techniques:

| **Technique** | **Applicability** |
| --- | --- |
| Replacement of IPA in the dampening solution | Applicable to all heatset web offset printing. |
| Optimizing the concentration of IPA in the dampening solution | All heatset web offset printing applying IPA. |
| Applying a ceramic, chromium-plated or hydrophilic distributing roller in combination with hydrophilic plate rollers. | This technique is applicable to all printing plants applying IPA. However, ceramic or metal rollers are now used less since the BATs were published (2007). Hydrophilic rollers are now used, have the same effect, and are cheaper. |
| Exact adjustment of the inking rollers | New presses are now generally equipped for exact adjustment of rollers and so this technique may not be applicable. For older presses, retrofitting is not usually possible. |
| Cooling the dampening solution | Applicable to all heatset web offset printing and commonly applied. |
| Cooling the dampening rollers and plate cylinders | New presses may have this capability. Retrofitting for older models is not generally possible. |
| Removal of IPA solutions overnight from the dampening unit  | Applicable to all heatset web offset printing. |
| Filtering the dampening solution | Applicable to all heatset web offset printing running at low IPA concentrations. |
| Controlling the hardness of the water for the dampening solution | This technique is applied in large heatset web offset plants but may not be beneficial where the water is of a suitable constant composition. |

1. BAT 62 - Reduce other fugitive VOC emissions by following the following techniques:

| **Technique** | **Applicability** |
| --- | --- |
| Replacement and control of VOCs used in cleaning | All, however vegetable cleaning agents are not applicable in heatset web printing, because the rinse-water can break the paper web. |
| High pressure water cleaners for dampening rollers | Applicable in offset printing using dampening rollers with a molleton covering; however, these may be are obsolete. (They occur rarely in sheetfed offset). |
| Automatic cleaning systems for printing and blanket cylinders | Applicable in new and existing plants. Currently, automatic cleaning is standard. Retrofitting costs are high. |

1. BAT 63 - Waste gas collection and treatment by thermal, catalytic, recuperative or regenerative incineration of air from the dryers using a combination of techniques, and reducing VOC emissions by applying maintenance techniques.

#### BAT for Flexography

The following are specific BAT for flexography and packaging gravure that are applicable to odour control, in addition to the General BATs (BREF Section 21.2.2 – BAT 67 and 68):

1. BAT 67: Reduce the sum of fugitive emissions of VOC and the VOCs remaining after waste gas treatment using the General BAT (Section 4.1.4.1), and/or the following techniques:

| **Technique** | **Applicability** |
| --- | --- |
| Replacement of conventional solvent-based inks with water-based inks, UV‑curing, or electron beam-curing alternatives. | Water-based inks (not varnishes) are successfully applied in flexo packaging printing processes for printing paper sacks, plastic refuse sacks and carrier bags. Where water-based products (inks, varnishes, etc.) are applied on existing presses, the dryer systems are often found to lack capacity. This reduces the applicability on existing presses. Water-based inks are currently not applicable in packaging gravure because a comparable quality cannot be achieved.UV curing inks can be applied in flexo processes for printing paper packaging materials, labels, and carton packaging materials for dairy products. However, manufacturers of packaging materials for food are often reluctant to employ UV curing inks since the migration of minute quantities of some of the ingredients of these inks into the packed food may lead to non-compliance with food contact legislation. Electron beam curing would be applicable to new presses. |
| Substitution of conventional varnishes and adhesives by water-based, high solids, UV-curing or solvent-free adhesives and varnishes or co-extrusion | Water based varnished and adhesive are applicable in all printing and laminating processes in the manufacturing of flexible packaging, and commonly applied in flexo and packaging gravure plants. However, they cannot replace the solvent-based varnishes in all situations. Where on existing presses water-based products (inks, varnishes, etc.) are applied, the dryer systems are often found to lack capacity. This reduces the applicability on existing presses. High solid and UV curing alternatives are applicable in new and existing plants. No information was available on the applicability of solvent-free alternatives or co-extrusion.  |
| Extraction and treatment of air from dryers | Applicable where little or no ink substitution has taken place, and in flexible packaging as dryers are always enclosed. Local extraction of VOCs from solvent use not normally sent to abatement equipment due to low VOC concentration.  |
| Extraction from the presses and other production areas: Covering ink fountains or using chamber doctor blades | Not applicable on existing presses equipped with a central impression cylinder. In-built in new standalone varnishing and lamination units. The venting of automatic washing machines is commonly applied where incineration has recently been installed. Generally not applicable where solvents are recovered for re-use, since recovered solvents are used for cleaning that cannot be re-used in inks, varnishes or adhesives. |
| Concentration of solvents in waste gas flow | Applicable where waste gas is treated.  |
| Extraction and treatment of air from automatic cleaning machines | Applicable where waste gas is treated.  |
| Optimization of incineration usage | Applicable where waste gas is treated.  |
| Optimization of VOC concentration to incineration by variable speed fan | Applicable where waste gas is treated.  |
| Automatic and timely closure of bypass systems | Applicable where waste gas is treated.  |
| Substitution using low or non-VOC cleaning materials | Applicable to all facilities. |
| In-press cleaning of cylinders | Applicable only to new presses.  |
| High pressure water cleaning | This technique is used for in-depth cleaning of cylinders and anilox rollers used in flexible packaging.  |
| Other non-solvent cleaning techniques | All facilities. |

The STS BREF provides examples of how the BAT for flexography would be applied in typical facilities, and what emission reductions may be achieved by BAT implementation. Further, the STS BREF document provides significantly more detail on the BATs identified for heatset web offset and flexography printing than what is provided in this example OCR and should be reviewed if any of the identified techniques may potentially be feasible at a facility.

1. BAT 68 - The BAT for waste gases and other fugitive emissions is to:
* Reduce emissions of VOC by applying extraction and treatment of air from the dryers.
* Apply a selection of techniques to minimize energy consumption and to optimize the waste gas treatment with system selection, design and optimization.
* Reduce VOC emissions by applying preventative maintenance techniques.

#### BAT for Painting

Painting processes can involve a single brush or spray pass, or multiple passes, in a booth done manually or in a fully automated and complex integrated system. The odours associated with painting operations are generally associated with the VOC content. The first option in reducing the VOC emissions is to choose a low-VOC paint product. The choice of paint product is based on the materials being painted, the desired finished effect, and ultimate end use of the product. The paint gun use, solvents, thinners, hardeners, dryers and any waste gas treatment systems are all dependant on the paint systems utilized.

The Generic BAT for surface treatment, application, and drying/curing is to minimize VOC emissions and energy consumption, and maximize raw material efficiency (minimize waste). Further BAT are available for painting of various specific items, such as cars, buses, aircraft, metal surfaces, and wood materials as examples. These sections provide numerous BAT, with a number of common BAT including:

1. Reduce solvent (VOC) consumption and emissions in coating applications, cleaning, and degreasing.
2. Maximize efficiency of coating application.
3. Minimizes waste production.
4. Reduce particulate emissions.
5. Reduce water consumption and effluent treatment and discharges by optimizing transfer efficiency and minimizing the build-up of paint sludge.

### Australia and New Zealand

Environment Australia publishes guidance materials for the purpose of supporting emission estimation for the federal reporting program; this guidance does not provide details of air emissions control technologies commonly installed at printing or painting operations and/or unit processes.

The individual Australian territories have also published technical handbooks/guides or factsheets to guide the management of odours; however, there are no specifics on control measures or abatement techniques that are appropriate or applicable to printing. There is air quality guidance on spray painting operations that discuss equipment, emissions and control technologies for painting operations, such as a Guidance Note published by New South Wales Local Government (NSW, 2017). This guidance recommends general principles for minimizing air pollution and includes:

Reducing the use of VOC coatings, including using water-based coatings.

Adding on air pollution control devices such as thermal or catalytic incinerators, carbon adsorbers, condensers, or wet collection system (e.g. scrubber). In some cases, the recovery of solvents from solid adsorbent material regeneration is possible.

Stack modifications for better dispersion.

Regardless of the site operations, the installation of control equipment, increasing of stack heights, or other measures to reduce odour effects is determined on a case-by-case basis that depends on whether a source is new, modified, or existing, and the proximity of nearby residents (odour receptors).

There was no facility-specific information available on emission or odour controls for printing or painting.

### Additional Control Measures Suitable for Printing and Painting Activities

In addition to the most common approaches to controlling odour emissions for printing and painting operations, other alternative control measures that may be effective but are not as widely used have been identified in Table 2.

**Table 2 – Potential Alternative Odour Control Measures for Sample Print & Paint Co.**

| **Control Measure** | **Applicability and Limitations** |
| --- | --- |
| Biofilter | Process exhaust streams are directed to a conditioning process/system to optimize the transfer of substances from the exhaust stream to the biofilter substrate and ultimately removal through microbiological consumption. If a biofilter is in use for wastewater treatment, may be possible to direct additional process exhaust gases to this unit. |
| Oxidation Scrubbers | Wet scrubbers that use an oxidizing agent such as hydrogen peroxide, bleach, or others, as the scrubbing solution. Oxidizing agents may be problematic for wastewater treatment.  |
| Ozonation | Concentrated ozone injected into waste gas stream to oxidize VOCs.  |
| Non-Thermal Plasma | Non-thermal plasma is an end-of-pipe control that creates a reactive treatment zone where odorous VOCs are broken down.  |
| Scheduling of process stage or activity to avoid simultaneous releases from multiple odorous sources.  | Avoid cumulative odour effects from multiple sources.  |
| Automated release/solenoid systems. | Reduced spillage will reduce odours from paint kitchen, paint storage, and ink storage areas.  |
| Improve fume capture in paint kitchen and touch-up paint area.  | Achieves a reduction in fugitive odours. The capture of fumes will allow for effective dispersion from a well-designed stack, or fumes may be directed to odour control equipment prior to discharge. |

## Control Measures for Primary Sources at Sample Print & Paint Co.

The primary sources of odour for printing facilities are the actual printing presses. At the Sample Print & Paint Co. it is the Heatset Offset and the Flexography printing systems. The painting system has the primary sources of odour from the paint booth operations. These sources are typically controlled with specific control equipment or technologies combined with process optimization to minimize odorous emissions.

Table 3 provides the methodology, equipment and techniques implemented at other facilities to control the odours from these primary sources. The options presented in Table 3 are also considered as EU BAT for odour control measures for surface treatments using organic solvents.

The control measures considered include the following:

* Installation of control equipment;
* Process optimization;
* Stack or discharge optimization;
* Engineering controls (odour capture, combined exhausts, recirculation, as examples);
* Pollution prevention; and,
* BMPs.

Where appropriate, measures from other industrial sectors are considered if the technology or measure may be transferrable to this sector.

Even though odour control measures are designed for specific applications, not all implementations are successful.  This section of the OCR is provided as guidance on general industry practices for the sector. It is possible that some measures may not be effective at odour control due to site-specific process or exhaust conditions. The selection of odour control measures requires engineering, and possibly pilot testing, to ensure odour reduction is achieved.

The measures presented in Tables 3 and 4 are examples that reflected the information available at the time the sample OCR was prepared. It is the responsibility of the facility to ensure that the odour control measures presented in the OCR are reviewed and updated as needed to reflect current information on control measures and best practices.

Further information on the control equipment is provided as an Appendix to this example OCR.

The measures presented have been demonstrated as reasonable and effective to prevent or minimize the discharge of odour, and will be carried forward to assess technical feasibility at the Sample Print & Paint Co.

**Table 3 – Potential Odour Control Measures for Sample Print & Paint Co. Primary Sources**

| **Odour Source** | **Control Measure** | **Applicability** |
| --- | --- | --- |
| Solvent Based Printing  | Thermal Oxidizer | Thermal oxidation highly effective at removing odorous VOCs.  |
| Solvent Based Printing | Catalytic Oxidation | A catalyst is used to achieve oxidation of VOCs to destroy odorous compounds. Moisture and fouling may be problematic. Catalyst efficiency may decrease over time, and replacement may be costly. |
| Solvent Based Printing | Carbon Filter | Activated carbon is effective on low VOC concentration streams.  |
| Solvent Based Printing  | Stack Optimization | Effective stack design will improve dispersion to reduce off-site effects. Vertical, unimpeded discharge at optimal stack height and velocity. |
| Solvent Based Printing  | Oxidation Scrubber  | Wet scrubbers that use an oxidizing agent such as hydrogen peroxide, bleach, or others, as the scrubbing solution. Oxidizing agents may be problematic for wastewater treatment. |
| Solvent Based Printing  | Biofilter | Process exhaust streams are directed to a conditioning process/system to optimize the transfer of substances from the exhaust stream to the biofilter substrate and ultimately removal through microbiological consumption.  |
| Solvent Based Printing  | Ozonation | Concentrated ozone injected into waste gas stream to oxidize VOCs. |
| Solvent Based Printing  | Non-Thermal Plasma Treatment | Activated plasmas gas injected into waste gas stream to oxidize VOCs. |
| Solvent Based Printing  | Process Optimization:Material Substitution | Reducing VOC content of inks, or quantity released to atmosphere, likely to reduce off-site odour effects.Use of lower VOC inks or substitution of isopropanol with less volatile solvent. |
| Solvent Based Printing  | Process Optimization:Dryer Temperature / Recirculation | Optimize dryer temperature and recirculate air in dryer combustion chamber. Recirculation would substantially reduce the exhaust gas flow rate, and may be used as pre-treatment for thermal oxidation. |
| Solvent Based Printing | Process Optimization:Material Handling | Refrigerate fountain solution to reduce the volatilization and fugitive emissions during operations. |
| Solvent Based Printing | Process Optimization: Scheduling | Scheduling of process stages or activities/production runs to avoid simultaneous odour releases from multiple sources. |
| Solvent Based Printing | Engineering Controls: Dryer Emission | Improve press and dryer enclosures to reduce the fugitive emissions and increase capture for control measures. |
| Solvent Based Printing | Engineering Controls: Emission flow rate control | Use of variable frequency drive fans on emission source allows for fluctuations on processes to reduce or increase flow rate on control equipment to maximize efficiency. |
| Solvent Based Printing | Engineering Controls: Enhanced Automation | Use process monitoring, transfer flow monitoring in conjunction with automated shut-off to avoid overfills or spills. Reduced ingredient wastage and less potential for human error results in potential of reduced fugitive odour emission sources. |
| Solvent Based Printing | Best Management Practices | Develop SOPs and train employees on BMPs for equipment and control measures, such as good housekeeping, minimizing transfer spills, reducing paint batching by scheduling like product runs, and managing paint residues beyond what is described in the current BMPP.  |
| Solvent Based Printing | Engineering Control: Group like emission sources  | If an existing control measure is operating for a similar contaminant emission, group all sources to the common control. If similar contaminant source emissions are grouped to a common stack and optimized, odour dispersion would be improved. |
| Printing - Heatset Web Offset | BREF - BAT | Reduce fugitive emissions and VOCs after waste gas treatment by:* Replacement of IPA
* Optimizing concentration of IPA
* Ceramic, metal and hydrophilic distributing and plate rollers
* Exact adjustment of the inking rollers
* Cooling the dampening solution
* Cooling the dampening rollers and plate cylinders
* Removing IPA solutions overnight
* Filtering the dampening solutions
* Controlling the hardness of the water for the dampening solutions.

Reduce other fugitive VOC emissions by:* Replacement and control of VOCs in cleaning
* Change to high pressure water cleaning
* Automatic cleaning systems for printing and blanket cylinders
* Waste gas collection and treatment.
 |
| Printing - Flexography | BREF - BAT | Reduce fugitive VOC emissions and VOCs remaining after gas treatment by:* Substituting water-based inks, UV-curing or electron beam curing
* Extracting and treating dryer air from dryers
* Extracting from presses and other production areas
* Concentrating solvents in waste gas flow if treatment such as thermal oxidation is applied
* Extracting and treating air from automatic cleaning machines
* Optimizing incineration usage
* Optimizing VOC concentration to incineration by variable speed fan
* Automatic and timely closure of bypass systems
* Substituting using low or non-VOC cleaning materials
* In-press cleaning of cylinders, high pressure water cleaning, or other non-solvent cleaning techniques.
 |
| Paint Booth | Thermal Oxidizer | Highly effective at removing odorous VOCs.  |
| Paint Booth | Catalytic Oxidation | A catalyst is used to achieve oxidation of VOCs to destroy odorous compounds. Moisture and fouling may be problematic. Catalyst efficiency may decrease over time, and replacement may be costly. |
| Paint Booth | Water Curtain | System works as a wet filter to remove suspended paint particles. The physical removal of the paint particle removes the associated VOCs and does not allow for volatilization or release in the spray booth emissions. |
| Paint Booth | Carbon Filter | Activated carbon is effective on low VOC concentration streams.  |
| Paint Booth | Stack Optimization | Effective stack design will improve dispersion to reduce off-site effects. Vertical, unimpeded discharge at optimal stack height and velocity. |
| Paint Booth | Oxidation Scrubber  | Wet scrubbers that use an oxidizing agent such as hydrogen peroxide, bleach, or others, as the scrubbing solution. Oxidizing agents may be problematic for wastewater treatment. |
| Paint Booth | Biofilter | Process exhaust streams are directed to a conditioning process/system to optimize the transfer of substances from the exhaust stream to the biofilter substrate and ultimately removal through microbiological consumption.  |
| Paint Booth | Ozonation | Concentrated ozone injected into waste gas stream to oxidize VOCs. |
| Paint Booth | Non-Thermal Plasma Treatment | Activated plasma gas is injected into waste gas stream to oxidize VOCs. |
| Paint Booth | Material Substitution: Low VOC paint or water-based | Use of lower VOC or water-based paints and/or solvents. Reducing VOC content of paints or solvents, or quantity released to atmosphere, likely to reduce off-site odour effects. |
| Paint Booth | Process Optimization: Scheduling | Scheduling of process stages or activities/production runs to avoid simultaneous releases from multiple odorous sources. Avoid cumulative odour effects from multiple sources. |
| Paint Booth | Engineering Control: Group like emission sources  | If an existing control measure is operating for a similar contaminant emission, group all sources to the common control. If similar contaminant source emissions are grouped to a common stack and optimized, odour dispersion would be improved. |
| Paint Booth | Engineering Control: Spray gun equipment  | Use high-volume, low-pressure (HVLP) spray guns to improve material transfer and minimize overspray, resulting in lower VOC emissions. |
| Paint Booth | Engineering Control: Emission flow rate control | Use of variable frequency drive fans on emission source allows for fluctuations on processes to reduce or increase flow rate on control equipment to maximize efficiency. |
| Paint Booth | Engineering Controls: Enhanced Automation | Use of process monitoring, transfer flow monitoring in conjunction with automated shut-off to avoid overfills or spills. Reduced ingredient wastage and less potential for human error results in potential of reduced fugitive odour emission sources. |
| Paint Booth | Best Management Practices | Develop SOPs and train employees on BMPs for equipment and control measures, such as good housekeeping, minimizing transfer spills, reducing paint batching by scheduling like product runs, and managing paint residues. |
| Paint Booth | BREF - BAT | BATs may include reducing VOC concentrations in paints and inks, reducing solvent usage, modifying painting process, reducing paint solid emissions, and minimize VOC emissions from water from abatement technologies. |

## Control Measures for Secondary Sources at Sample Print & Paint Co.

The secondary sources at the Sample Print & Paint Co. include one source group (Painting Sources) and one individual source (Paint and Ink Storage Room), as defined in Section 3.3.2. The odour source, or grouped odour sources, and the associated control measures, as well as potential alternative control measures, are provided in Table 4. It should be noted that the options presented in Table 4 are also considered as EU BAT for odour control measures for surface treatments using organic solvents.

**Table 4 – Potential Odour Control Measures for Sample Print & Paint Co. Secondary Sources**

| **Odour Source** | **Control Measure** | **Applicability and Limitations** |
| --- | --- | --- |
| Secondary Painting Sources | Carbon Filter  | Activated carbon is effective on low VOC concentration streams.  |
| Secondary Painting Sources | Stack Optimization | Effective stack design will improve dispersion to reduce off-site effects. Vertical, unimpeded discharge at optimal stack height and velocity. |
| Secondary Painting Sources | Oxidation Scrubber  | Wet scrubbers that use an oxidizing agent such as hydrogen peroxide, bleach, or others, as the scrubbing solution. Oxidizing agents may be problematic for wastewater treatment. |
| Secondary Painting Sources | Engineering Control:Material Handling | Implement an automated spray-gun cleaner and closed-loop solvent recycling/recovery system to reduce the amount of solvent used as well as optimize the cleaning process. |
| Secondary Painting Sources | Engineering Controls:Emissions Capture  | Enclosure in touch-up paint area to capture paint VOCs for optimized discharge or to direct to on-site waste gas treatment. High volume gas streams with low VOC content.  |
| Secondary Painting Sources | Best Management Practices | Develop SOPs and train employees on BMPs for equipment and control measures. Good housekeeping, minimizing transfer spills, reduce paint batching by scheduling like product runs, etc. |
| Paint and Ink Storage Room | Engineering Controls:Emission Capture | Improved emission capture from specific process units and operations to reduce the fugitive emissions and increase emission capture for directing to appropriate odour control measures. |
| Paint and Ink Storage Room | Engineering Controls:Material Handling | Maintain cooler temperatures in the storage area to reduce the potential of volatilization of VOCs. |
| Paint and Ink Storage Room | Enhanced Automation:Material Handling | Implement an automated dispensing system to prevent VOC losses during material transfer. |
| Paint and Ink Storage Room | Best Management Practices | Develop SOPs and train employees on BMPs for equipment and control measures, such as good housekeeping, minimizing transfer spills, reducing paint batching by scheduling like product runs, and others. |

# Feasibility Assessment

The control measures identified in Section 4 have been shown to be effective in preventing or reducing odour effects at printing and painting facilities with similar sources and/or other similar operations/processes. There are, however, site-specific limitations that would affect the ability of a facility to implement particular measures or procedures.

The results of the facility technical evaluation for the feasibility of implementation of the potential measures and procedures are summarized below in the form of a table (Table 5). Those justified as not technically feasible are not considered further in the OCR. Those measures deemed technically feasible are discussed in Section 6 (Discussion of Feasible Measures and Procedures). It should be noted that most of the technically feasible control measures described in Table 5 may be used in combination to achieve greater odour reduction. An example of this is the use of both control equipment and stack optimization. In general, any BMPP, process optimization, engineering control or stack optimization can be used in combination. In some cases, combinations of control equipment may also be feasible (e.g. using a carbon filter as a polishing step in combination with another type of control equipment). However, multiple end-of-pipe control equipment is uncommon for these types of sources.

It is a requirement of the Air Emissions EASR Regulation to provide an analysis of the odour control measures and procedures, and potential combinations of them, to determine which would be technically feasible to implement at the facility in order to prevent or minimize the discharge of odour. Table 5 summarizes the individual control measures and the findings of the feasibility assessment for the Sample Print & Paint Co. The feasibility assessment must consider potential combinations of the control measures identified.

The technical feasibility of a control measure is a factor of the effectiveness of the mitigation, safety considerations, physical implementation as well as consideration of the impact of the other processes at the facility that could be detrimentally impacted. Although a control measure could be implemented on one specific odour source, the treatment could generate a new waste stream that contains a difficult substance to handle or cause a synergistic effect that results in a new odour source associated with a solid or liquid carrier.

The Sample Print & Paint Co. has previously implemented a significant number of control measures at its operations. Combinations of stack optimization, BMPPs, process optimizations and engineering controls are utilized throughout the operations.

The ability to isolate an odour source and direct the exhaust gases to an optimized stack, process optimization, and/or the implementation of BMPs for odour are the preferred approaches for odour control for the Sample Print & Paint Co. Where possible, maintaining a negative pressure in a specific process area will allow for isolation of an odour source that can be discharged from an optimized stack or, if need be, controlled; this will help to prevent or minimize poorly dispersing fugitive odour releases.

It may be possible and beneficial to combine exhaust streams to one common exhaust; however, this must be evaluated as there are potential synergistic effects (e.g. back pressure on some ventilation areas, increased flows causing increased pressure drop through the system that cannot be handled by the fan and stack design). If there is no net negative impact to the operations resulting from the combining of individual sources to one common stack, this may allow for the design of one unimpeded vertical discharge at an optimized height and exhaust velocity to enhance odour dispersion, or the future installation of odour control equipment on one combined exhaust stream.

Carbon filter use on the high VOC concentration emission flows is not feasible as these filter systems have a finite adsorption capacity. Once the capacity is consumed, breakthrough occurs and the VOCs are no longer captured and can actually result in stripping away those compounds previously captured. It is not feasible for a carbon filter to treat the highly concentrated emission flows due to the frequency of breakthrough, but the lower concentrated emission flows such as the Paint Kitchen are technically feasible and the site has this system in place.

Non-thermal plasma is considered to be emerging technology and there is limited documentation on demonstrated control efficiency or applicability on VOC and odour destruction for paint and printing operations.

Ozonation is an energy intensive process where ambient air is electrically induced to create ozone which is then reacted with the odorous air flow. There are limitations to this technology as the ozone must come into direct contact with the odorous substance or contaminant to complete the reaction. If there is moisture or particulate matter in the air flow to be treated, the odorous compounds may not have the contact residence time or sufficient exposure to the ozone to completely react. There is a significant potential that the exhaust gases at the Sample Print & Paint Co. will contain high concentrations of particulate matter, and that the paint spray booth will have high moisture content from the water curtain.

Having an oxidation scrubber system in the production area would not be technically feasible as it has too great of a potential impact on the quality of the product quality. The facility is operated as clean and dry as possible due to the raw material utilized and the expected product quality. The printing is done on fine quality and specialty materials and having exposure to oxidizing solutions and increased moisture may cause product quality issues. Additionally the physical space required for a packed column scrubber, pumping system, chemical make-up system and piping is not available in the production area of the current site configuration. The use of water or caustic solutions also generates a new liquid waste stream that must be treated as a wastewater.

Biofiltration is not feasible for the Sample Print & Paint Co. due to variability in the contaminant concentration and the facility’s operational hours. To ensure a properly functioning biological system, there needs to be a consistent supply of compatible food for the micro-organisms. The operations at the Sample Print & Paint Co. have the potential to significantly change from day to day, contain high levels of substances that are detrimental to micro-organisms and may not provide a steady feed source as the production schedule is dependent on customer demand. The type of raw materials used, the concentrations and quantities are all a function of the specifications of the finished product. The site operations are also not currently 24 hours per day 7 days per week so there would be significant periods of time with no food source and/or an improper food source and therefore major periods of biological inactivity. If occurring on a regular basis, this would lead to loss of biomass and micro-organism death and could result in worse odour issues. There is also additional concern with the physical size constraints of the biofilter in addition to the support systems and equipment that is required.

**Technical Feasibility Assessment**

The feasibility assessment requires an analysis of the measures and procedures identified, as well as potential combinations thereof. This assessment should be undertaken in conjunction with facility management to determine which would be technically feasible to implement. This discussion would take process or site-specific constraints into account. Technical feasibility can consider commercial viability of the control for the specific source, experience and use in the industry or for similar sources, other environmental considerations (wastewater impacts), availability of materials (e.g. if natural gas is not available, RTOs are not technically feasible), and site-specific considerations (e.g. space).

**Economic Feasibility**

The intention of the OCR is to establish technical feasibility of odour control measures and procedures. The discussion of economic feasibility is important; however, a complete economic assessment is not required as part of the OCR.

The MOECC provides guidance on undertaking an economic feasibility study in the “Guide to Requesting a Site-Specific Standard, Version 2.0”. The US EPA also provides site-specific guidance for consideration of economic hardship and cost-effectiveness of pollution abatement in the Economic Impact Analysis and Industry Profiles by Sector Resource Documents published by the US EPA Office of Air Quality Planning and Standards (2016). These references can be used as a basis for developing an economic feasibility assessment, if needed.

**Table 5 – Summary of Feasibility Assessment for Sample Print & Paint Co.**

| **Odour Source** | **Description of Control Measure** | **Technically Feasible?** | **Notes** |
| --- | --- | --- | --- |
| Printing Operations | Thermal Oxidation | Technically Feasible – previously installed | Installed – System is operational on both printing process emissions.  |
| Paint Spray Booth | Thermal Oxidation | Technically Feasible  | Current operations utilize a dry arrestor filter, water curtain and stack optimization. |
| Printing OperationsPaint Spray Booth | Catalytic Oxidation | Technically Feasible  | Current operations utilize alternative control measures. |
| Paint Spray Booth | Water Curtain | Technically Feasible – previously installed | Installed at the facility as a particulate control system; however, removal of paint particles also removes the associated VOCs and reduces the overall emissions. |
| Printing OperationsPaint Spray Booth | Carbon Filter | Technically Not Feasible | Activated carbon filter systems are effective on low VOC concentration streams and the anticipated loadings from the production source would create a significant potential for breakthrough and result in uncontrolled odour releases. |
| Secondary Painting Sources  | Carbon Filter | Technically Feasible – previously installed on Paint Kitchen exhaust  | Effective for control of source with moderate flow rate and low odour loading.  |
| All Primary and Secondary Sources | Stack Optimization | Technically Feasible – previously implemented | Completed on the majority of the stack system at the facility. |
| Printing OperationsPaint Spray BoothSecondary Paint Sources | Oxidation Scrubber | Technically Not Feasible | The facility is operated as clean and dry as possible due to the raw material utilized and the expected product quality. The printing is done on fine quality and specialty materials and having exposure to oxidizing solutions and increased moisture may cause product quality issues. |
| Printing OperationsPaint Spray Booth | Biofilter | Technically Not Feasible  | There are significant variations in VOC concentrations which would result in an inconsistent feed source, especially when operational hours are considered.  |
| Printing OperationsPaint Spray Booth | Ozonation | Technically Not Feasible  | Ozonation is an emerging technology and there is limited documentation on demonstrated control efficiency or applicability on VOC and odour destruction. |
| Printing OperationsPaint Spray Booth | Non-Thermal Plasma Treatment  | Not Technically Feasible | Non-thermal plasma is an emerging technology and there is limited documentation on demonstrated control efficiency or applicability on fryer exhaust VOCs and odour destruction.  |
| Printing OperationsPaint Spray Booth | Material Substitution: Low VOC or water-based paints, inks, and solvents | Technically Feasible | Implemented at the facility where quality and client requirements are compatible.  |
| Printing OperationsSecondary Painting Sources | Process OptimizationMaterial Handling | Technically Feasible  | Maintain cooler temperatures to reduce paint, ink, solvent, and other VOC volatilization.  |
| Printing OperationsPaint Spray Booth | Process Optimization:Scheduling | Technically Feasible – previously implemented | Implemented on site. The BMPP for odour and the site operations plan detail the strategic scheduling of activities to avoid simultaneous releases from multiple odorous sources, where possible. |
| Printing OperationsPaint Spray Booth | Engineering Controls:Emission flow rate control | Technically Feasible – previously implemented | Where applicable, this action has been implemented with the installation of variable frequency drive fans on emission sources to allow for process fluctuations while controlling the flow rate to control equipment in order to maximize efficiency. |
| Printing OperationsPaint Spray BoothPaint and Ink Storage Room | Engineering Controls:Enhanced Automation | Technically Feasible  | The use of automation for process monitoring, dispensing, and transfer flow monitoring with automated shut-off to prevent spills is detailed in the BMPP for Odour.  |
| Secondary Painting SourcesPaint and Ink Storage Room | Engineering Controls:Emission Capture | Technically Feasible | Enclose touch-up paint area and other VOC handling activities, and/or improve capture efficiency to prevent fugitive emissions.  |
| Printing Operations and Paint Spray Booth | Engineering Controls:Group like emission sources | Technically Feasible  | Where appropriate, an existing control measure operating for a contaminant emission will be evaluated for the potential to treat multiple sources of the common contaminant. If similar contaminant source emissions are grouped to a common stack and optimized, dispersion would be improved. |
| All Primary and Secondary Sources | Best Management Practices | Technically Feasible - previously implemented | SOPs, training, EMS and BMPP have been developed and employee training completed. |
| Printing Operations | Process Optimization:Dryer Temperature / Air Recirculation | Technically Feasible  | Optimizing the dryer temperature and recirculating air in the dryer combustion chamber has substantially reduced the exhaust gas flow rate and has been used as pre-treatment for thermal oxidation |
| Printing Operations | Engineering Control:Dryer Emission | Technically Feasible – previously implemented | The press and dryer enclosures were improved to reduce the fugitive emissions and increase capture with the optimization project.  |
| Painting Spray Booth  | Engineering Control:Spray gun equipment  | Technically Feasible – previously implemented | The facility uses high-volume, low-pressure (HVLP) spray guns to improve material transfer and minimize overspray, resulting in lower VOC emissions. |
| Printing – Heatset Web Offset | BREF - BAT | Technically Feasible – previously implemented | Thermal oxidation, a BAT, is used to reduce VOC emissions.  |
| Printing - Flexography | BREF - BAT | Technically Feasible – previously implemented | Thermal oxidation, a BAT, is used to reduce VOC emissions.  |
| All Printing and Painting Sources | BREF – BATGeneral Considerations1. Change the type of process.
2. Change the materials used.
3. Implement waste gas treatment and/or destruction.
4. Optimization of discharge by increasing stack height.
 | 1. Technically Not Feasible
2. Technically Feasible
3. Technically Feasible, implemented
4. Technically Feasible, implemented
 | Some BAT have already been implemented at the facility. 1. Product specifications and equipment do not allow for changes to the type of processes used.
2. Material substitution is technically feasible, and the facility will work with suppliers to follow industry developments in low solvent inks, paints, and solvents that may reduce VOCs.
 |

Many of the technically feasible control measures described in Table 5 may be used in combination to achieve greater odour reduction. An example of this is the use of both control equipment and stack optimization. In some cases, combinations of control equipment may also be feasible.

# Adequacy of Current Odour Control Measures and BMPP

This section of the OCR provides the rationale for why the technically feasible measures identified are required or not necessary at this time, to adequately prevent or minimize the discharge of odour from the facility.

The Sample Print & Paint Co. Best Management Practices Plan (BMPP) for Odours was prepared in 2010, and most recently updated in 2017 to be compliant with the Air Emissions EASR. The odour BMPP was signed, dated and sealed by Ms. J. Engineer on Feb 2, 2017 (PEO License 1234-9999). The BMPP documents all feasible measures that have been implemented to prevent or minimize odours from process stages, activities, or material storage. In addition to BMPs, control measures that are in place to mitigate odours are detailed in the BMPP.

In 2010, a site-wide odour assessment was prepared as part of an ECA application process. This assessment identified, quantified, and ranked all odorous sources for the potential to cause an off-site odour effect. It was determined that with the control measures and BMPs there were no appreciable odour effects off-site based upon the existing operations, control measures, and the effective implementation of the BMPP.

The Sample Print & Paint Co. implemented a Good Neighbour Policy in 2005, which includes measures to prevent off-site odour effects. There have been no odour complaints in the past 5 years that were directly related to the operation of the facility under general operational conditions and site parameters. Any excursions in normal operations (e.g. spills, emergency situations) or specific operational issues that have been successfully addressed with an odour strategy (i.e. BMPP updates) and/or control technology within the last 5 years were not considered.

In the absence of odour complaints, and based upon quarterly odour surveys conducted in the residential areas and at other odour receptors (adjacent sports fields), additional measures to control odours are not warranted at this time since the following key measures are already in place and are considered to be effective:

* For the printing primary sources identified (Heatset Web Offset and Flexography Printing), the Sample Print & Paint Co. has previously implemented one of the technically feasible control measures described in Section 4. The emissions from both of the printing systems are captured and directed to the Thermal Oxidizer system. The VOCs of the printer discharges are oxidized and the final emissions discharged directly through an optimized stack which significantly reduces the overall site odour emissions;
* The Sample Print & Paint Co. previously implemented reduced VOC and water-based paints and printing inks (however VOC concentration is still greater than 50 g/L) for the production runs that allowed quality and product finishes to meet client specifications.
* This Process Optimization reduced both the source emissions from the stacks as well as the fugitive emissions associated with the handling, mixing, and cleaning;
* Several BMPs, BATs, Process Optimizations and Engineering Controls have been previously implemented for both the printing and the painting activities within the primary odour sources as well as the secondary odour sources. Incremental changes throughout the facility can impact the overall site emissions and having a flexible operational schedule and variability in the use of raw materials only assists in minimizing VOC emissions and the associated odours; and,
* For the secondary sources, a carbon filter has been previously installed on the Paint Kitchen emissions to reduce the discharge associated with the fugitive emissions from dispensing, mixing, spray gun cleaning and other associated activities with paint and ink preparation and clean-up which is an effective method for reducing overall site VOC and therefore odour emissions.

The intention of odour management and control is to prevent or minimize odour effects at odour receptors off-site. The absence of off-site odour effects, supported by five years without an odour complaint, demonstrates that the current odour control measures and BMPs are effective.

**Historical Odour Management**

A facility’s success with BMPP, good community relations, and no complaint history, or a history where the facility responds quickly and mitigates the situation with respect to odours, can be considered a reasonable rationale for not implementing additional odour control measures.

It is recommended that the facility contact the MOECC District Office to confirm that no odour complaints have been registered, and incorporate any feedback provided into this section of the OCR.

However when a facility is facing on-going challenges with its surrounding community, there are upset conditions that result in complaints and the BMPP is not meeting expectations, the facility needs to consider implementing other options. An initial review should be done of the site operations to identify the major odour source(s) and evaluate the current BMPs and/or control actions being taken. Consideration of alternative BMP-BAT-BREF actions as well as re-evaluating current activities can assist in identifying the root cause of the odour issue. If the revised BMP does not mitigate the odour situation, further consideration of control optimization, technologies and equipment should be completed.

## Control Measures or Procedures to be Evaluated for Implementation

At this time, there are no additional controls or procedures that are scheduled to be implemented. However, the facility has committed to assessing the feasibility of the technically feasible control measures should odour complaints be received in the future that are the result of the printing and painting activities.

Should the facility determine that an odour source is developing into a potential off-site issue, the BREF-BAT (BMPs) would be reviewed to determine whether additional BMPs may be incorporated into the facility’s SOP policy with appropriate employee training, monitoring, maintenance and reporting. Control technologies to manage the odour source issues would also be evaluated should compliance issues be encountered and BATs, BMPs, optimization, controls and SOP are not successful.

This site also has several control technologies in operation for specific production equipment and/or emission streams. It would be beneficial to utilize the existing control technology by connecting more of the uncontrolled odour sources.

The next phase of evaluations would include the BMPs, Process Optimization, Engineering Controls, and then control technologies to manage the odour source issues.

Table 6 provides examples of the control measures that will be evaluated for implementation at the Sample Print & Paint Co. should odour emissions become an issue for the operations and facility.

This section presents the control measures that were found to be technically feasible and could be further considered by the Sample Print & Paint Co. should additional odour control measures be needed in the future. Table 6 also presents those measures that are under consideration to be implemented, even though there have been no odour complaints.

**Table 6 - Control Measures or Procedures to be Evaluated for Implementation**

| **Odour Source** | **Control Measure** | **Applicability** |
| --- | --- | --- |
| PrintingPaint Spray Booth | BREF – BATGeneral Considerations | 1. Change the type of process.
2. Change the materials used.
3. Implement waste gas treatment and/or destruction.
4. Optimization of discharge by increasing stack height.
 |
| Printing Heatset Web Offset | BREF - BAT | Reduce the sum of fugitive emissions and VOCs after waste gas treatment by:* Replacement of IPA
* Optimizing concentration of IPA
* Installing ceramic, metal and hydrophilic distributing and plate rollers
* Exact adjustment of the inking rollers
* Cooling the dampening solution
* Cooling the dampening rollers and plate cylinders
* Removing IPA solutions overnight
* Filtering the dampening solutions
* Controlling the hardness of the water for the dampening solutions.

Reduce other fugitive VOC by:* Replacement and control of VOCs in cleaning
* Change to high pressure water cleaning
* Installing automatic cleaning systems for printing and blanket cylinders
* Waste gas collection and treatment.
 |
| PrintingFlexography | BREF - BAT | Reduction of solvent emissions as the sum of fugitive emissions of the VOC and the VOCs remaining after gas treatment by:* Substitution of water-based inks, UV-curing or electron beam curing
* Extraction and treatment of air from dryers
* Extraction from presses and other production areas
* Concentration of solvents in waste gas flow if treatment such as thermal oxidation is applied
* Extraction and treatment of air from automatic cleaning machines
* Optimization of incineration usage
* Optimization of VOC concentration to incineration by variable speed fan
* Automatic and timely closure of bypass systems
* Substitution using low or non-VOC cleaning materials
* In-press cleaning of cylinders, high pressure water cleaning, or other non-solvent cleaning techniques.
 |
| Paint Spray Booth | BREF - BAT | Reduce VOC concentrations.Reduce particulate concentrations.Reduce solvent consumptions.Minimize water pollution from abatement technologies. |
| Existing Control Technology | Thermal Oxidation | Thermal oxidation highly effective at removing odorous VOCs. The Paint Spray Booth, Paint Kitchen, Touch-Up area and Storage Areas could have the emissions directed to the existing thermal oxidizing process if there is sufficient capacity. |

# Appendix A – Supplemental Guidance for Developing a Facility‑Specific OCR

## A.1 Identification of Odour Sources and Source Groupings

Once a complete inventory of air emissions sources has been prepared, it is necessary to identify which of these sources should be classified as primary odour sources, secondary or minor sources, and negligible odour sources based upon their relative contribution to potential odour effects. This can be done in a number of ways, and often involves some level of judgment based upon process knowledge and experience.

It must be emphasized that the identification of odorous air emissions sources is very specific to each facility. What may be a potentially odorous source at one facility may not have any potential for odour at another. As an example within the brewing and pet food industries, the operation of a jacketed kettle with pressure relief valve is an odour source if it is used for wort boiling or meat cooking, but may not be odorous if it is used for boiling other liquids in other industries.

For each odour source, a general description of the associated process, unit operation, equipment or activity, expected contaminants in the exhaust gas, typical odour loadings, factors which may affect the odour loading, and potential constraints should be identified, where available. These details are necessary in order to properly assess any potential control or BMP for its technical feasibility. An odour source summary table is an effective way to summarize the odorous emission sources for further assessment, and will be useful should odour dispersion modelling be required.

Published emission factors are useful in quantifying odour loadings from common sources; however, when evaluating site potential emissions or impacts, these factors should be used by someone with technical experience. In many cases the only available emission factors are for VOCs as little data on odour loadings is publicly available. The odour and VOC emissions may not be directly proportional; however, these values will also assist in site-specific determination of the VOC concentration and emission rate for individual sources to allow for comparisons, ranking of sources, and discussion of the suitability of control measures.

Site-specific details of why the facility is unique or different from conventional printing or painting facilities should be provided in order to help in identifying sources and determining their relative contribution to facility odour classifying sources.

The location and characteristics of the discharge point must also be considered when determining which sources are major sources of odour at the facility, which are minor, and which are negligible.

The odour source inventory is another tool to consider sources that may become odorous under upset or unexpected conditions; however, these situations are more commonly addressed by BMPs. For example, the discharge from a scrubber may not be odorous when the scrubber is operating effectively; however, scrubber malfunction, insufficient liquid flow rate or insufficient makeup rate may result in odorous discharges.

It may be effective to group sources for the purposes of the OCR if they are associated with the same process stage, same production area, and have similar odour and exhaust characteristics. These sources may be combined and directed to individual control equipment or dealt with as an aggregate.

Wastewater collection, handling, treatment, and discharge, may potentially be a significant source of odour. An example OCR has been prepared that is specific to industrial wastewater, and if applicable, this OCR should be reviewed.

## Quantifying Odour Loadings and Odour Source Ranking

There are a number of reference documents that may provide expected odour emissions, emission factors for odour or VOCs, or other data that may reasonably be used to describe sources at the facility. The US EPA AP-42 Emission Factor Compendium, the Australian National Pollutant Inventory Emission Estimation Technique (EET) Manuals for Printing, publishing, and packaging, the EET for Surface Coating, and the Canadian National Pollutant Release Inventory Toolbox, are examples of sources of VOC emission factors. In addition, source testing for odours may be considered in the absence of high quality emission data. Appendix C provides links to these resources.

## Identifying Primary or Secondary Odour Sources

In order to classify the sources as primary or secondary, it would be helpful to rank the sources in terms of their potential to cause off-site odour impacts and prioritize accordingly. The ranking could be done on the basis of potential odour emissions (strength of odour), offensiveness of odour, frequency of occurrence and source configuration. The source ranking may be supported by screening level dispersion modelling for each significant source to determine the amount of dilution (i.e. dispersion) for each source. For example a tall stack source would provide much greater odour dilution at off-site locations than a horizontal exhaust at the property boundary.

## Sources Not Considered Odorous

There are a number of sources at facilities that are not identified as odour sources for the purposes of the OCR. These sources either:

* Do not emit odorous contaminants, such as heating and cooling equipment and process boilers; or,
* Discharge of odours that are not of the same characteristic that is generally attributed to the sector and have no appreciable off-site impacts.

Examples of such sources may include trash compaction, cafeteria exhausts, parts washers, product label gluing, laser / ink printing, or ammonia leaks from refrigeration equipment.

## Indoor Fugitive Emissions

BMPs are generally more appropriate for the prevention or mitigation of odours from general building exhausts and indoor fugitive sources. At specific facilities, BMPs may prove inadequate for some sources, and the installation of capture hoods or fume collection may be necessary. Once the odours are captured, they may then be directed to control equipment, or other measures may be implemented to reduce the potential off-site odour effects.

## A.2 Excess Emissions Due to an Upset or Abnormal Condition

An upset or abnormal condition may arise due to sudden and reasonably unforeseeable events beyond the control of the facility. These situations require immediate corrective action to restore normal operation. The identification of all possible odour sources during upset or emergency conditions is beyond the scope of the OCR. It is expected that the facility will include the preventive maintenance, accident prevention, spill containment, and effective response to upset conditions in the BMPP.

## A.3 Control Measures and Procedures

### Pollution Control Equipment

Often referred to as end-of-pipe or add-on controls, exhaust gases are directed to pollution control equipment to capture or destroy the odorous contaminants. Equipment that captures the contaminants often results in the generation of a new waste stream that could be either solid, liquid, or gas that may still be odorous. An example of a gaseous waste stream is air discharged during the regeneration cycle of an activated carbon bed or tower. These activities may also reduce odours or change the character of the odours making them less intense or offensive.

Destruction of VOCs in the waste stream may be achieved by thermal oxidation, catalytic oxidation, chemical oxidation, or other chemical reaction. This type of pollution control unit may result in the permanent removal of airborne contaminants that are odorous.

### Engineering Controls or Process Changes for Pollution Prevention

Although there may be some redundancy between these measures and those outlined as BMPs in the facility BMPP, the measures detailed here are differentiated from BMPs as they require actual modifications or engineering changes. In contrast, BMPs are by definition, practices or procedures that would not require additional engineering or significant process modifications, or the installation of additional control equipment.

The following are examples of measures that have been shown effective in odour mitigation:

* Optimized stack design to improve dispersion;
* Process or building fugitive odour capture to prevent fugitive odours from roof exhausts or building doors, windows, louvers, or vents;
* Process optimization and control, including adjustments to pressure and temperature on pressure vessels, monitoring aeration of waste stream or improving aeration/agitation, or others; and,
* Reducing cooling water temperature of condensers to improve odour control efficiency.

### Masking Agents or Odour Modification

Although the applicability to the painting or printing sectors may be limited, there are chemical additives, masking agents, deodorants, and odour neutralizers that may be employed to either theoretically reduce the odour loading or alter the nature of the odour to change its character or hedonic tone.

Masking agents, also called deodorizers, contain perfumes to superimpose a pleasant odour upon an unpleasant one. Although this approach can be considered an alternative for managing odour complaints, it should be considered on a site-specific case and potentially bench tested as it has been found in some cases that the deodorant or making agent may itself become an odour nuisance or the impact on odour receptors has not changed.

Neutralizers differ from masking agents as they are able to react with the odour molecules and are generally dispersed as a fine aerosol into the odorous gas.

### Best Management Practices

BMPs are practices or procedures that in this context are intended to prevent or minimize odorous effects. These may be general in nature and applicable to a wide range of facilities, or they may be facility-specific and intended to help reduce odorous releases from process operations or activities at an individual site.

The facility is required to prepare a BMPP which will outline operational practices and other measures that will be carried out in order to reduce odour emissions or odour effects.

The intention of the OCR is to identify process controls, engineering controls, or add-on control measures. Specific BMPs for the odorous sources identified should be presented if they are currently implemented at similar facilities or recommended in applicable Codes of Practice.

# Appendix B – Control Equipment Factsheets

Appendix B provides general information on the control measures identified in this example OCR. Details such as whether the control measure is considered to be in the developmental stage, where it may be applicable, and what limitations may exist, are given. Facilities may also consider contacting equipment suppliers for further information to determine whether a particular control measure may be technically feasible at their site.

This information is provided in order to illustrate what may be considered when assessing the feasibility of a control measure.

Including this level of detail on potentially feasible control measures is not a requirement of the OCR and is provided as reference material only.

## B.1 Thermal Treatment

### B1.1 Technologies

* Flaring
* Thermal Incineration in Boiler or other combustion unit
* Regenerative Thermal Oxidizer (RTO)
* Recuperative Thermal Oxidizer
* Catalytic Oxidation

### B1.2 Emission Characteristics

* Gaseous Pollutants (Odour, VOCs)

### B1.3 Air Emission Sources

Common Applications:

* Petroleum and Coal Products
* Lumber
* Printing
* Food Processing
* Surface Coating
* Paint Manufacturing

### B1.4 Description

Thermal treatment uses high temperatures to oxidize VOCs, as well as some particulate matter. The conventional type of thermal oxidizers have a direct flame in contact with the airflow. RTOs use ceramic packed beds to preheat and partially oxidize VOCs prior to incineration to increase efficiency, and catalytic oxidizers use a catalyst material rather than ceramic in the packed beds. Recuperative units incorporate a heat exchanger to recover heat for the purpose of preheating the incoming air.

### B1.5 Applicability and Performance

A properly designed and operated thermal oxidizer or flare can achieve a destruction efficiency of 95-100%, with most achieving more than 99% VOC control. Thermal oxidation is generally used for the treatment of low gas flowrates, with notable cost increases associated with heating greater volumetric flowrates. It may be suitable for malodorous streams with variable contaminant concentrations and some variability in flowrate. Some form of heat recovery is nearly always warranted to reduce operating costs and fuel consumption. Flaring may be appropriate if gas flowrate fluctuates significantly. A concentrator may be used prior to an RTO or other oxidizer for large air flows of low VOC concentration to minimize supplemental fuel requirements.

It may be possible to direct malodorous gases to an existing on-site boiler for thermal treatment, particularly if the volume of waste gas is notably less than the combustion air requirements.

### B1.6 Limitations

Supplemental fuel may be needed if the heating value of the gas is insufficient to sustain the incinerator temperature, and may be significant if the exhaust gas stream is variable or VOC concentrations are low. Water vapour present in the airstream may quench the flame, resulting in poor combustion. For safety reasons, organics present in the waste gas must be well below the respective lower explosive limit (LEL); if the organic concentration is above the relevant explosive limits, a flameless type of system may be appropriate. Pre‑treatment for particulate material removal may be required. By-products, including NOx, SO2, GHGs, acid gases and other pollutants may be generated depending upon the composition of the waste gas to be treated. When halogenated VOCs are present, the potential for dioxins formation exists.

### B1.7 References

European Commission. 2006. Integrated Pollution Prevention and Control Reference Document on Best Available Techniques in the Food, Drink and Milk Industries (EU BREF) Section 4.4.3.11 Thermal Treatment of Waste Gases

US EPA. Air Pollution Control Technology Fact Sheets: Flares EPA-452/F-03-019, Thermal Incinerators EPA-452/F-03-022, and Catalytic Incinerators EPA-452/F-03-018.

## B.2 Absorption

### B2.1 Technologies

* Wet Scrubbers (packed bed absorber, plate absorber, and spray scrubber)

### B2.2 Emission Characteristics

* Wet scrubbers are most effective on exhaust gases with high concentrations of VOCs or water soluble compounds, and to a lesser degree particulate matter.

### B2.3 Air Emission Sources

Common Applications:

* Food manufacturing and cooking
* Mineral processing
* Fertilizer plants
* Asphalt plants

### B2.4 Description

The process involves a mass transfer between a soluble gas and a liquid solvent such as water. The addition of an oxidizing agent to the scrubbing solution may increase odour removal efficiency by reacting with the odorous compounds. Sodium hypochlorite, hydrogen peroxide, ozone, potassium permanganate, acids, and caustics are frequently used as the scrubbing medium.

### B2.5 Applicability and Performance

Primarily used for inorganic fumes and gases, VOCs, and particulate matter. The control efficiency for VOCs varies depending upon the type of scrubber, and a range of 70 to 90% control is expected. Wet scrubbers have relatively low capital and operating costs compared with other treatment technologies, as well as relatively small space requirements. Absorption units can handle gases with high temperature and high moisture contents.

### B2.6 Limitations

The requirements for the scrubber outlet concentrations affect the scrubber design (liquid flowrate, scrubber dimensions), and may result in unreasonably tall towers or long liquid-gas contact times and excessive liquid volumes. A liquid waste stream is generated. Spray chambers are not generally suitable for odour or VOC control.

### B2.7 References

Air & Waste Management Association. 1992. Air Pollution Engineering Manual.

European Commission. 2006. Integrated Pollution Prevention and Control Reference

Document on Best Available Techniques in the Food, Drink and Milk Industries (EU BREF) Section 4.4.3.8 Absorption.

US EPA. Air Pollution Control Technology Fact Sheets: Packed Bed / Packed Tower Wet Scrubber EPA-452/F-03-015, Spray Tower Wet Scrubber EPA-452/F-03-016.

## B.3 Filtration

### B3.1 Technologies

* Baghouse Dust Collector, Cartridge Type Dust Collector

### B3.2 Emission Characteristics

* Exhaust gas streams with dry particulate matter.

### B3.3 Air Emission Sources

Common Applications:

* Food manufacturing
* Metals processing
* Grain milling
* Mineral processing (coal, cement)

### B3.4 Description

The gas stream passes through a porous fabric or material that removes the particulate matter. Dust cake forms on the filters, which increases collection efficiency. The filters are routinely cleaned of built-up particulate matter to prevent excessive pressure drop.

### B3.5 Applicability and Performance

Particulate removal of 99 and 99.9% is expected with new dust collectors; older units may achieve more than 95% control.

### B3.6 Limitations

A solid waste stream is generated. Oils, greases, adhesive materials, or excessive moisture may result in filter plugging and affect performance.

### B3.7 References

European Commission. 2006. Integrated Pollution Prevention and Control Reference Document on Best Available Techniques in the Food, Drink and Milk Industries (EU BREF) Section 4.4.3.8 Absorption.

US EPA. Air Pollution Control Technology Fact Sheets: Fabric Filter Pulse-Jet Cleaned Type EPA-452/F-03-025, Fabric Filter Mechanical Shaker Cleaned Type EPA-452/F-03-024, and Cartridge Collector Type with Pulse-Jet Cleaning Type EPA-452/F-03-004.

## B.4 Condensation

### B4.1 Technologies

* Heat recovery unit, refrigerated condenser, water-cooled condenser

### B4.2 Emission Characteristics

* Condensers are most effective on hot exhaust gases with high VOCs concentrations, or water soluble compounds.

### B4.3 Air Emission Sources

Common Applications:

* Petroleum refining and petrochemical manufacturing
* Food manufacturing and cooking
* Breweries
* Pharmaceutical manufacturing
* Fish processing
* Chemical / Solvent manufacturing and use.

### B4.4 Description

Condensation is the process of converting a gas or vapour to a liquid and is achieved by heat transfer. This technology is frequently utilized for heat recovery from very hot processes.

### B4.5 Applicability and Performance

Condensers are simple and relatively inexpensive and typically uses water or air as the heat transfer fluid, although refrigerants may be used to achieve lower temperatures to improve removal efficiency or target VOCs with lower vapour pressures.

Condensers are frequently used as a pre-treatment upstream of adsorbers, absorbers, or incinerators to reduce the loading to the control equipment and often to recover solvents or organics that may be reused.

### B4.6 Limitations

A liquid waste stream is generated. Control is limited for VOCs with high vapour pressures. Condensers may be prone to fouling if there is particulate matter in the exhaust gas stream.

### B4.7 References

Air & Waste Management Association. 1992. Air Pollution Engineering Manual.

European Commission. 2006. Integrated Pollution Prevention and Control Reference Document on Best Available Techniques in the Food, Drink and Milk Industries (EU BREF) Section 4.4.3.5 Dynamic Separation Techniques.

## B.5 Biofiltration

### B5.1 Technologies

* Biological Treatment (beds, filters, bioreactors)

### B5.2 Emission Characteristics

* Gaseous air pollutants (odour, VOCs, H2S) of consistent air flow rate and limited fluctuation in loading.

### B5.3 Air Emission Sources

Common Applications:

* Meat and Fish
* Coffee processing
* WWTP
* Beer yeast drying
* Oil mills
* Cocoa production
* Pump stations
* Animal feed production
* Organic processing.

### B5.4 Description

The most common type of biological treatment is the biofilter where pollutants are absorbed onto a filter and degraded by microorganisms living on the filter media.

There are a variety of biofilter styles: in-ground, in-vessel, open-bed, or up-flow systems.

The filter medium may be a blend of wood chips, compost, bark nuggets or inert materials designed to maintain porosity with high surface area to provide good contact between the contaminants and the biologically active micro-organisms.

### B5.5 Applicability and Performance

Properly designed and maintained biofilters can remove most organic contaminants, H2S and reduced sulfur compounds but can produce a slight residual “earthy” odour. An operational and balanced biofilter can achieve relatively high odour removal efficiency at relatively low operating cost compared with other treatment techniques, with odour removal efficiencies greater than 90% reported. The operation and efficiency of a bioreactor is affected by temperature, pH, moisture, gas composition and pollutant concentration, macronutrient feeding, residence time, compacted bed media, and gas channeling. A biofilter may be designed to treat a wide range of air flowrates that ensure appropriate residence time, typically 20 to 40 seconds. Moisture may be added to the gas by pre-humidification.

### B5.6 Limitations

* Particulate matter and oils may need to be removed upstream of the filter to avoid clogging that may result in a large pressure drop and reduction in operational efficiency.
* Significant fluctuations in contaminant concentrations may be problematic.
* Biofilters generally have large space requirements compared to other control technologies.
* There may be a significant energy demand, particularly if preheating or humidification is required.
* Channeling through the biofilter may result in reduced control efficiency.
* Biofilters require temperature regulation, as temperatures over 40 °C may be problematic as the micro-organisms may become sterilised and the filter bed would require re-seeding, and biological degradation decreases notably below 10 °C.
* The pH of the filter material must be maintained, typically between 6.5 and 7.5, which may require alkali addition.
* A typical lifetime of an organic based filter bed is 3 to 5 years for most filter materials.

### B5.7 References

European Commission. 2006. Integrated Pollution Prevention and Control Reference Document on Best Available Techniques in the Food, Drink and Milk Industries (EU BREF) Section 4.4.3.10.1 Biofilter.

Water Environment Research Foundation WERF. 2007. Minimization of Odours and Corrosion in Collection Systems, Section 8.5 Biofilters.

US EPA. 2003. Using Bioreactors to Control Air Pollution EPA-456/R-03-003.

## B.6 Carbon Adsorption

### B6.1 Technologies

* Packed beds, fluidized beds, filter cartridges

### B6.2 Emission Characteristics

* Gaseous Pollutants (Odour, VOCs, H2S)

### B6.3 Air Emission Sources

Common Applications:

* Paint Spraying
* Printing
* Plastic film coating
* Dry cleaning
* Degreasing
* Pharmaceuticals
* Wastewater treatment
* Food manufacturing
* Asphalt processing
* Chemical manufacturing
* Transfer systems.

### B6.4 Description

Adsorption is a unit process involving the capture of substances (primarily VOCs), from relatively low concentrations in air/water streams, onto a fine particulate active surface, with resins and activated carbon being the most common materials used. The adsorbed material is physically contained within the filter. Once saturated, the physical content of the filter will require regeneration. Reactivating the carbon requires the substances to be desorbed and this can be done by heat or vacuum. Generally, the maintenance of most carbon adsorption systems are done by a third-party or would require an additional control system to capture, contain and dispose of the absorbed substances. Carbon adsorbers are used for the cleaning of ventilated air and the treatment of malodourous process emissions.

### B6.5 Applicability and Performance

Carbon adsorption is suitable for a range of air flow rates and temperatures; however, high moisture content will significantly impact the maintenance requirements of the carbon. The control of VOC emissions and typically associated odours by carbon adsorption can achieve removal efficiencies of 80 – 99 %.

### B6.6 Limitations

Carbon adsorption is not considered applicable where dust or condensable material is present as it can seriously interfere with the efficiency of a carbon bed and will increase the operating pressure drop. It is also not applicable at a temperature above 40 °C due to the risk of fire. The efficiency of activated carbon is reduced at a relative humidity above 75 % as the moisture will be adsorbed as well as the contaminants, except for water soluble compounds such as the lower amines and hydrogen sulphide. This preferential absorbance of water can lead to condensation within the bed, thus making the carbon inactive.

The components for a carbon adsorption system consists of the filter or filter column and the fan or blower system. On-site regeneration is not normally economical, so the carbon is typically replaced when its adsorption efficiency begins to decrease, but prior to breakthrough. In addition to capital costs, operating and maintenance costs are notable due to requirement to recharge carbon and the energy requirements.

### B6.7 References

European Commission. 2007. Integrated Pollution Prevention and Control Reference Document on Best Available Techniques on Surface Treatment using Organic Solvents (EU STS BREF) Section 20.11.6.1 Adsorption Using Activated Carbon or Zeolites.

US EPA. 1999. CATC Technical Bulletin: Choosing an Adsorption System, EPA-456/F-99-004.

## B.7 Non-Thermal Plasma (NTP)

### B7.1 Technologies

* Corona or Photocatalytic Reactors

### B7.2 Emission Characteristics

* Cold plasma reactors and photocatalytic reactors are considered an emerging technology. There is limited performance data available, and the economics of the processes are unknown at this time.

### B7.3 Air Emission Sources

Common Applications:

* Food and Drink Manufacturing
* Extruders
* Dryers
* Coolers
* Hammer mills

### B7.4 Description

Non-thermal plasma treatment is an odour abatement technique that plasma to create a highly reactive treatment zone that the waste gas passes through. The plasma contains a collection of ions, electrons, charge-neutral gas molecules and other species in varying degrees of excitation. These radicals in the NTP react with the pollutants in the malodorous air stream, producing less malodorous compounds. The most active radicals in this process are nitrogen, oxygen, and hydroxyl based compounds which originate from nitrogen, oxygen and water in the waste gas. Industrial treatment systems are based on electrical discharge, where high voltages (up to 40 kV) are used to create NTP.

### B7.5 Applicability and Performance

The technique has been proven to reduce the odour emissions by 75 – 96%, with higher control efficiencies for VOCs. This technique performs better when treating high VOC. The NTP equipment requires little space when compared to other control measures. Multiple NTP modules can be installed in parallel for higher gas volumes. There is a low pressure drop associated with the NTP, and it can be installed either on either the side of the air extraction fan.

### B7.6 Limitations

Temperature affects the performance of the plasma, with an operating range up to 70°C reported as optimal. Above 80 °C, the performance of the technique may drop significantly. Significant amounts of water condensing on the equipment may be problematic, as well as high particulate matter concentrations. Since high voltages are required to sustain the plasma, there are high operating costs from the power requirements.

### B7.7 References

European Commission. 2006. Integrated Pollution Prevention and Control Reference Document on Best Available Techniques in the Food, Drink and Milk Industries (EU BREF) Section 4.4.3.12 Non-thermal Plasma Treatment.

Water Environment Research Foundation WERF. 2007. Minimization of Odours and Corrosion in Collection Systems, Section 8.10 - Cold Plasma & Photocatalytic Reactors.

## B.8 Ozonation

### B8.1 Technologies

* This technology is considered an emerging technique.

### B8.2 Emission Characteristics

* Odorous exhaust gases.

### B8.3 Air Emission Sources

* Reported installations to treat HVAC return air in smoking rooms.

### B8.4 Description

Ozone is injected to exhaust gas dust or stack in order to react with, and break down, odorous compounds.

### B8.5 Applicability and Performance

There is limited performance data available, and the economics of the processes are unknown at this time.

### B8.6 Limitations

Ozone is less reactive in the gas phase than in liquid phase. Applications of ozone use for water treatment are more common. Hot, humid airflows may not be suitable for ozone treatment systems. Insufficient VOC-ozone contact time may result in incomplete VOC reactions and emissions may still be odorous. Excess ozone may be harmful.

### B8.7 References

European Commission. 2006. Integrated Pollution Prevention and Control Reference Document on Best Available Techniques in the Food, Drink and Milk Industries (EU BREF) Section 4.4.3.8 Absorption.

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Environmental Protection Agency (Ireland). 2008. BAT Guidance Note on Best Available Techniques for Solvent Use in Coating, Cleaning and Degreasing (1st Edition).

European Commission. 2007. Reference Document on Best Available Techniques on Surface Treatment using Organic Solvents (STS BREF).

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