Example Odour Control Report for a Sugar Refinery Facility

**Sample Sugar Refinery 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 the manufacturing processes may differ between facilities, this report should not be considered comprehensive for all facilities that require an OCR. A facility-specific OCR must be prepared to include all odorous sources at a facility and all different types of 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 Sugar Manufacturing

This Odour Control Report for the Sample Sugar Refinery Company (the ‘OCR’), a sugar manufacturing 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 sugar manufacturing with NAICS Code 311310, which is an activity set out in Table 3 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 3 (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 site-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 Sugar Manufacturing, 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 Sugar Refinery 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

The sugar industry has been a significant contributor to the Canadian economy since the early 1800s. In 2017, there were three main sugar manufacturers in Canada that operate three cane sugar refineries (in Quebec, Ontario and British Columbia) and one sugar beet processing plant (in Alberta). There are also two sugar blending facilities in Canada. The characteristic malt odour that may be associated with sugar refineries is the result of molasses that is present on the raw sugar. In addition, the storage and handling of sugars may be a potential source of fermentation odours.

A detailed process description for a typical cane sugar facility is presented in Section 3.

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).

## Odour Control Report for Sample Sugar Refinery Company

An OCR is required for the Sample Sugar Refinery Co., a large sugar manufacturer with a NAICS Code 311310, producing more than 500,000 metric tonnes of sugar annually; the NAICS code triggers the requirement for an OCR. The closest point of odour reception is less than 300 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 Sugar Manufacturing is 500 metres as listed in Table 3 of the EASR Publication.

## Odour Control Report Content

This OCR for the Sample Sugar Refinery 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, wet particulate matter control units such as scrubbers or rotoclones could serve to control odours;
* 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 Sugar Refinery 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 3 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: Ms. Kane

Contact Information: 519-123-4567; [crystal.kane@samplesugarrefineryco.com](mailto:crystal.kane@samplesugarrefineryco.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 facility produces up to 500,000 tonnes of refined sugar annually.

The operating hours are typically 24 hours per day, 7 days per week. There is one week of scheduled shutdown per year.

## 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 Sugar Refinery Co., the following processes, activities, or sources may be considered unique when compared to other similar sugar refining facilities:

* Carbonatation is used to clarify the melt liquor rather than phosphatation.
* Decolourization is carried out using ion exchange rather than using bone char.

Cane sugar refining is generally a defined process common to all facilities. However, each sugar manufacturing facility is 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 raw materials, 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

At the Sample Sugar Refinery Co., sugar manufacturing involves the following process stages:

* Raw cane sugar receiving and storage;
* Mingler;
* Affination;
* Raw sugar melter;
* Clarification using Carbonatation;
* Filter Press;
* Decolourization;
* Evaporation and Crystallization;
* Separation by Centrifugal;
* Drying;
* Storage and Packaging; and,
* Auxiliary services.

### Raw Cane Sugar Receiving and Storage

Raw cane sugar arrives by ship and is unloaded via a large scoop or self-unloading ships and transferred to storage areas and silos via conveyors.

### Mingler

The initial step in cane sugar refining is washing the sugar, called affination. Raw sugar is weighed and fed into a large mixing trough called a mingler, and blended with warm water and syrup to loosen the molasses film from the raw sugar.

### Affination

This step involves the separation of the crystals from the syrup in a centrifugal (i.e centrfuge) and washing of the separated crystals with hot water.

### Raw Sugar Melter

The washed raw sugar is sent to a premelter and then to a melter, where the washed raw sugar crystals are heated with hot water and steam until they dissolve into a thick brown syrup called raw liquor.

### Clarification using Carbonatation

Carbonatation involves adding carbon dioxide (CO2) and lime into a tank of raw liquor causing a chemical reaction that results in the precipitation of calcium carbonate in suspension. This process effectively isolates the impurities in larger particles which are easier to separate from the sugar liquor. The Sample Sugar Refinery uses compressed boiler flue gas as the CO2 supply.

### Filter Press

The calcium carbonate precipitate is removed by filtering the raw sugar liquor through a series of very fine cloth filters stacked within a tank. The result is a clear, yellowish liquid.

### Decolourization

Decolourizing the liquid sugar is achieved via an ion exchange process which removes the soluble impurities by adsorption. The sugar liquor is pumped into the ion exchange resin tanks where the liquor is allowed to percolate under pressure.

### Evaporation and Crystallization

The process of returning the sugar to a crystalline state involves removing some of the water from the clear liquor by evaporation. The clear liquor is then fed to vacuum pans where the sugar crystals are grown. Some mills will seed the vacuum pans with isopropyl alcohol and/or ground sugar. Sample Sugar Refinery uses isopropyl alcohol to initiate crystallization. When the crystals are large enough, the crystals and syrup are discharged from the pan. The mixture of sugar crystals and syrup is called “massecuite”.

### Centrifugal Separation

The massecuite are loaded into large centrifugals where the crystals are separated from the syrup. The separated syrup is collected and returned to vacuum pans for further boiling to extract the maximum amount of sugar. The separated sugar crystals (containing about 1% moisture) are transferred to the drying stage.

### Drying

Large dryers are used to dry the refined sugar to around 0.05% moisture. A granulator is commonly used, which consists of a drying drum and a cooling drum in series.

### Packaging and Shipping

The dried sugar crystals are mechanically screened by particle size and transferred to the refined sugar silos and further conveyed to storage bins prior to packaging or bulk loadout.

### Auxiliary

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

* Large combustion boilers for process heat and building heating;
* Small unit heaters, radiant heaters, make-up air units, or other HVAC;
* Quality assurance / quality control laboratory;
* Cooling systems using ammonia or other refrigerant;
* Maintenance welding and painting;
* Wastewater handling, treatment, and discharge;
* Solid waste collection and trash compaction; and,
* General (non-process) building exhausts (office space, cafeteria, and washrooms).

## Identification of Odorous Contaminants

During the refining process, the characteristic odour of malt and fermentation odours may be emitted from a number of activities and production areas at the refinery. The sweet malty odour is due to the presence of molasses. Depending on the raw sugar’s country of origin, the length of transit and conditions during transport, it is possible for the raw sugar to begin fermenting in the ship as exposure to moisture or elevated temperatures can accelerate fermentation. This can lead to an alcohol odour from the fermentation when the ships are opened and unloaded.

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 Volatile Organic Compounds (VOCs) 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 Sugar Refinery Co. facility has been classified as a primary odour source, secondary source, or a negligible odour source based upon the source’s odour emission rate and the relative contribution to potential off-site 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, factors which may affect the odour loading, and potential constraints were provided, where applicable. The key parameters are presented in tabular format.

For this sector, malt and fermentation odours are the predominant and characteristic odours, and may be released from a number of odour sources.

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.

Individual sources identified as primary or secondary sources are presented, 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.

### Primary Sources of Odour

The primary odour sources from the Sample Sugar Refinery 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.

The following are considered to be the major odour sources from cane sugar refinery operations and are the primary odour sources for the Sample Sugar Refinery Co.:

* Raw Sugar Storage – Continuous odorous emissions can be higher when unloading occurs and materials are being disturbed. Odour emissions from the raw sugar can be affected by moisture conditions and how long the sugar has been in transit and stored;
* Clarification (Carbonatation) – Continuous odorous emissions as sugar liquor is mixed with boiler flue gases and vented via dedicated exhausts;
* Process Building Ventilation – Continuous odorous emissions created from the sugar refining process that are picked up via general building ventilation that can carry moist raw sugar odours to the atmosphere. The unit processes grouped as Process Building Ventilation include Mingler, Affination, Raw Sugar Melter, Filter Press, Decolourization, Evaporation, and Centrifugal; and,
* Vacuum Pans – Sugar crystals are boiled in vacuum pans which can be a source of moist raw sugar odours via a dedicated exhaust.

These sources are described in Table 1A.

Wastewater collection, handling, treatment, and discharge, may potentially be a significant source of odour at sugar refineries. 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.

The secondary sources of odour at the Sample Sugar Refinery Co. include:

* Raw Sugar Unloading – intermittent odorous emissions may occur when there is a delivery of raw sugar. Emissions are affected by various factors including conditions of the transport vessel, length of transit, country of origin of the raw sugar, which impacts the condition of the sugar, temperature, humidity and weather conditions during transfer;
* Granulators – are used to dry the sugar crystals and particulate emissions are generally controlled via wet cyclones/rotoclones. Rotoclones are used to exhaust dehumidified heated air from the granulators and can be a sources of moist raw sugar odours; and,
* Outdoor Molasses Tanks – Intermittent odorous emissions can occur during transfer of molasses from the storage tank to trucks.

### Sources Not Considered Odorous

The following air emissions sources are not considered as significant odour sources at most sugar refinery facilities, including the Sample Sugar Refinery Co.:

* Boilers;
* Packaging;
* HVAC equipment (comfort heating and cooling);
* Chillers and refrigeration equipment;
* Parts washers;
* 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 Sugar Refining 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.

**Table 1A - Sample Odour Source Identification Table for Sample Sugar Refinery Co. (Primary Odour Sources)**

| **Source Description** | **Odorous Contaminants** | **Odour Loading** | **Exhaust**  **Characteristics** | **Flow Rate** | **Continuous or Intermittent Discharge** | **Current Odour Control Measures** |
| --- | --- | --- | --- | --- | --- | --- |
| Raw Sugar Storage | VOCs (moist raw sugar / fermented (alcohol) smell) | Moderate | General ventilation | High | Continuous | BMPP |
| Clarification (Carbonatation) | VOCs (sugar liquor with boiler flue gas) | High | Dedicated vertical stacks | High | Continuous | Stack Optimization; BMPP |
| Process building ventilation | VOCs (molasses type odour) | Moderate | Numerous roof-top exhausts | High | Continuous | BMPP |
| Vacuum Pans | VOCs (molasses type odour) | Moderate | Dedicated Stacks | High | Continuous | Stack Optimization; BMPP |

**Table 1B - Sample Odour Source Identification Table for Sample Sugar Refinery Co. (Secondary Odour Sources)**

| **Source Description** | **Odorous Contaminants** | **Odour Loading** | **Exhaust**  **Characteristics** | **Flow Rate** | **Continuous or Intermittent Discharge** | **Current Odour Control Measures** |
| --- | --- | --- | --- | --- | --- | --- |
| Raw Sugar Unloading | VOCs (moist raw sugar / fermented smell) | Low | Fugitive release | NA | Intermittent | BMPP |
| Granulators | VOCs (molasses type odour) | Low | Dedicated Stacks | High | Continuous | Rotoclone;  BMPP |
| Outdoor Molasses Truck during Transfer | VOCs (molasses) | Low | Fugitive release | Low | Intermittent | BMPP |

**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 sugar manufacturing 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 sugar refinery facilities for both beet and cane sugar raw material sources. Current practices for odour controls 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 Sugar Refineries

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 Sugar Refinery Co. and are presented in Table 3 for the primary sources and Table 4 for the secondary sources.

### Ontario

Information on one facility in Ontario with MOECC ECAs was available through the MOECC Access Environment database of historical and current approvals. The facility is located in an urban setting having a high population density and located in a port area that also has businesses, commercial properties, entertainment establishments, residential and tourist attractions surrounding its operations and all within close proximity to its property line. The publicly available data was reviewed, and the following was found in an older ECA for the only sugar refinery ECA available:

* One wet scrubber to control dust emissions from white sugar packaging;
* Four rotoclones to control dust emissions on granulators;
* One wet scrubber to control dust emission on granulator room and silo bottoms; and,
* One wet scrubber to control dust emissions from the packaging building.

There are no specific details of odour control measures implemented

This summary is not necessarily comprehensive as the information provided is based on an ECA dated 2000. A more recent ECA (2010) has been issued with Limited Operational Flexibility that does not provide details of the individual equipment or sources at the facility but does require the facility to implement and maintain an Odour Best Management Plan.

The Sample Sugar Refinery 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

There are three other sugar refineries in Canada; however, no publicly available guidance, regulatory requirements, odour emission inventories or permits for these facilities were available that provide details on emissions sources or odour control measures.

### 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.

Information on six large facilities with major sources in five US states was available from their Title V permitting posted on state environmental agency websites. The list demonstrates the range of potential control measures that have been installed to control either boiler emissions or particulate matter and are therefore not specific to odour control. It should be noted that all six have some form of pollution control equipment installed but none are identified as odour controls. It is not intended to suggest that control measures are required on any or all refinery sources identified. The list is based on available data for sugar refinery facilities. Although twenty-nine sugar beet and sugar cane refinery facilities were identified as operating in the US, not all the Title V permits and/or specific State permits were found. It is not known if all facilities have appropriate permits, meet operational criteria or if the state from which they operate provide public access to permitting documentation. The data reviewed indicated that:

* One facility has a baghouse on the Cloud Room, Packaging, and Tote Filling.
* One facility has two scrubbers for the Packaging Plant, baghouse for the hammermill for the powdered sugar processing and a BMPP for general operations.
* One facility has a wet scrubber for regeneration of carbon, multiple fabric filters for powdered sugar and starch storage and transfer systems, fabric filter for packaging of confectionary sugar, fabric filter for the tote packaging line and bulk bag supply bin, and a statement to implement RACT for boiler operations.
* One facility is required to operate a wet impingement scrubber on each fuel/gas boiler systems to control particulate matter, the biomass boiler must have two wet sand separators to remove large particles from the boiler exhaust prior to the electrostatic precipitator to remove the smaller particulate matter from the boiler exhaust, a granulated carbon regenerative furnace with a wet venture/tray scrubber system on the exhaust stream to control particulate emissions, baghouses on the sugar dryers, vacuum systems for the screening/distribution system and bagging operations as well as the sugar packaging lines and the bulk loading operations, and a cyclone collection in parallel with a wet scrubber for one of the other sugar drying systems due to the high moisture content of the product.
* One facility operates a carbon regeneration furnace with an afterburner and scrubber system; seven granular systems with rotoclone wet centrifugal collectors on the exhaust; and an independent baghouse on the dryer, lime system, powdered C/P packer, production, starch unloading/conveying and silo storage bins.
* One facility with boiler stack controls of wet scrubbers, mist eliminators, and multi-cyclones all vented to a common stack; pulp dryers with wet scrubber, mist eliminator and multi-cyclones; pellet mills/conveyor with multi-cyclones; pelletized cooler with multi-cyclones; drying and cooling sugar granulators with wet scrubbers and baghouses; lime slake vent with wet scrubber; burnt lime collection with baghouse; water spray for fugitive dust control on truck hauling, and a generic statement regarding a dust collector control device on the sugar warehouse.

A review of the US permits indicates that the targets of the control measures are particulate matter and combustion emissions. None of the systems noted in the summary above would reduce VOC related odours from the primary odour sources.

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 food, drink, and milk industries (FDM) are published in a Best Reference Document on Best Available Techniques (BREF). The BAT conclusions are presented in two tiers. The first tier lists BAT for common activities and processes in the FDM sector, and the second tier includes additional BAT for some specific activities or processes within the FDM (BREF, 2006). There three BAT that are specific to sugar refining:

* Recycle the transport water;
* Use evaporator condensate for sugar extraction from sugar beets; and,
* For beet sugar refining, avoid drying sugar beet pulp if an alternative use is available such as an ingredient for animal feed. If drying of beet pulp is necessary, it should be pressed prior to drying, dried with steam driers, dried to a maximum dry matter of 91% and dried in small batches. Whether drying beet pulp or processed cane sugar, additional control can be achieved with the use of cyclones and spray scrubbers. This is not applicable to the Sample Sugar Refinery Co. which processes cane sugar.

The first and second actions are specific to water conservation BMPs while the third action identified is specific to the control of particulate matter.

In summary, there are no specific BAT for the prevention of odour effects in the sugar refinery sector. The general FDM BAT include a number of broader environmental management techniques, not specific to sugar refining, such as the implementation of an Environmental Management System (EMS) and the prevention of accidental releases. Application of an air emissions control strategy that combines process optimization, BMPs and the use of abatement techniques is also BAT for the FDM Sector.

### Australia and New Zealand

Environment Australia publishes guidance materials for the purpose of supporting emission estimation for the federal reporting program. The document states that air emission control technologies, such as dispersion, scrubbing, incineration, adsorption on to a solid, and biofiltration are commonly considered on point sources from process industries in general. There was no specific guidance on sugar refinery operations. The common air emissions associated with sugar manufacturing processes are particulate matter, ethanol, nitrogen oxides (NOx), carbon monoxide (CO) and sulphur dioxide (SO2). Point source emission controls for these substances are dry and wet scrubber systems.

The individual Australian territories have also published technical handbooks to guide the management of odours; however, control measures or abatement techniques are not specifically identified for sugar refining. The installation of control equipment, increasing of stack heights, or other measures to reduce odour effects are determined on a case-by-case basis that depends on whether a source is new, modified, or existing, and the proximity of nearby residents (points of odour reception).

There were three Australian sugar refineries that posted their environmental records on their websites; however, these results were specific to wastewater discharge parameters. There was no facility-specific information available on emissions or odour controls for sugar refinery operations.

### Additional Control Measures Suitable for Sugar Refinery Activity

In addition to the most common approaches to controlling odours for sugar refinery 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 Sugar Refinery Co.**

| **Control Measure** | **Applicability and Limitations** |
| --- | --- |
| Thermal Treatment:  Oxidizer or Boiler Incineration | Odorous exhaust gases are directed to the site boiler combustion chamber or an oxidation unit for incineration. Supplemental fuel may be required to sustain temperature. |
| Biofilter | Process exhausts are directed to a conditioning system and biofilter where microorganisms biologically degrade the organic compounds. |
| Oxidation Scrubbers | Wet scrubbers use an oxidizing agent such as hydrogen peroxide, bleach, or others, as the scrubbing solution. |
| Ozonation | Concentrated ozone is injected into waste gas stream to oxidize VOCs. |
| Process Optimization: Decrease cooing temperature of condensers | Increase in VOC removal efficiency achieved by decreasing temperature of cooling water used in condenser, or using refrigerant. |
| Process Optimization:  Scheduling | Scheduling of process stages or activities/production runs to avoid simultaneous odour releases from multiple odorous sources. |
| Process Optimization:  Enhance Automation | Reduce leaks, spills, manual transfers and other potential sources of odour. |

## Control Measures for Primary Sources at Sample Sugar Refinery Co.

The primary sources of odour for the sugar refinery facility are the raw sugar storage and the wet process stage exhaust(s). These sources are typically controlled with specific control equipment or technologies combined with BMPs and 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 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 Sugar Refinery Co.

**Table 3 – Potential Odour Control Measures for Sample Sugar Refinery Co. Primary Sources**

| **Odour Source** | **Control Measure** | **Applicability** |
| --- | --- | --- |
| All Primary Sources | Stack Optimization | Effective stack design will improve dispersion to reduce off-site effects with vertical, unimpeded discharge at optimal stack height and velocity, as well as potentially combining individual exhausts to common tall stacks. |
| All Primary Sources | Wet Scrubber (including Rotoclones) | Effective particulate matter removal, but limited VOC removal. |
| All Primary Sources | Oxidizing 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. |
| All Primary Sources | Thermal Treatment | Thermal oxidation is highly effective at removing odorous VOCs. Odorous exhaust flow may be directed to the site boiler combustion chamber for incineration, or to a thermal oxidizer. |
| All Primary Sources | Biofilter | Process exhausts are directed to a conditioning system and biofilter where microorganisms biologically degrade the organic compounds. |
| All Primary Sources | Ozonation | Concentrated ozone injected into exhaust gases to oxidize VOCs. |
| All Primary Sources | Non-Thermal Plasma Treatment | Activated plasmas gas injected into waste gas stream to oxidize VOCs. |
| Raw Sugar Storage | Engineering Controls:  Containment and Environmental Controls | Ensure raw sugar is protected from moisture and weather exposure during transportation, receiving, and storage to prevent fermentation. |
| Clarification (Carbonatation) | Process Optimization:  Change Carbonatation Process | Use purchased pure CO2 instead of on-site boiler flue gas to eliminate the requirement of carbonatation exhausts and the associated odour emissions. |
| Clarification (Carbonatation) | Process Optimization:  Change Carbonatation Process | Change from carbonation to phosphatation to eliminate the requirement of carbonation exhaust and its associated odour source. |
| All Primary Sources | Process Optimization:  Production Scheduling | Scheduling of process stages or activities/production runs to avoid simultaneous odour releases from multiple sources. |
| All Primary Sources | Process Optimization:  Enhanced Automation | Use of tank volume monitoring, transfer flow monitoring in conjunction with automated shut-off to avoid overfills or spills. Reduced ingredient/product wastage and less potential for human error results in potential of reduced fugitive odour emission sources. |
| All Primary Sources | Best Management Practices | Develop SOPs and train employees on BMPs for process and control equipment maintenance and operation, good housekeeping, spill prevention and response, reducing chemical and cleaner usage, and managing wastes. |

## Control Measures for Secondary Sources at Sample Sugar Refinery Co.

The secondary sources identified at the Sample Sugar Refinery Co. are the raw sugar unloading, granulators and outdoor molasses receiving and handling. 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 general FDM manufacturing.

**Table 4 – Odour Control Measures for Sample Sugar Refinery Co. Secondary Sources**

| **Odour Source** | **Control Measure** | **Applicability** |
| --- | --- | --- |
| Ship Raw Sugar Unloading  Molasses Transfer | Engineering Controls:  Emission Capture | Improved emission capture to reduce the fugitive emissions and increase capture for control measures. |
| Granulator | Stack Optimization | Effective stack design will improve dispersion to reduce off-site effects. Vertical, unimpeded discharge at optimal stack height and velocity. |
| Granulator | Wet Scrubber or Rotoclone | Effective particulate matter removal, but limited VOC removal. |
| Granulator | 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. |
| Granulator | Thermal Treatment | Thermal oxidation is highly effective at removing odorous VOCs. Odorous exhaust flow may be directed to the site boiler combustion chamber for incineration, or to a thermal oxidizer. |
| Granulator | Biofilter | Process exhausts are directed to a conditioning system and biofilter where microorganisms biologically degrade the organic compounds. |
| Granulator | Ozonation | Concentrated ozone injected into exhaust gases to oxidize VOCs. |
| Granulator | Non-Thermal Plasma Treatment | Activated plasmas gas injected into waste gas stream to oxidize VOCs. |
| All Secondary Sources | Process Optimization:  Production Scheduling | 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. |
| All Secondary Sources | Process Optimization:  Enhanced Automation | Use of tank volume monitoring, transfer flow monitoring in conjunction with automated shut-off to avoid overfills or spills. Reduced ingredient/product wastage and less potential for human error results in potential of reduced fugitive odour emission sources. |
| All Secondary Sources | Best Management Practices | Develop SOPs and train employees on BMPs for process and control equipment maintenance and operation, good housekeeping, spill prevention and response, reducing chemical and cleaner usage, and managing wastes.  Of specific note, procedures are in place to ensure raw sugar and off-spec materials are segregated, handled, stored and disposed of in a manner that limits the potential for fermentation and spoilage.  Implement and enforce effective vehicle sanitation practices. |

# Feasibility Assessment

The control measures identified in Section 4 have been shown to be effective in preventing or reducing odour effects at sugar manufacturing facilities with similar sources and/or other similar operations/processes. There are, however, site-specific limitations that would affect the ability of the 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 Sample Sugar Refinery 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 Sugar Refinery Co. has previously implemented a significant number of control measures at its operations. Combinations of stack optimization, BMPPs, process optimizations and engineering controls are significantly 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 Sugar Refinery 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.

The use of caustic solutions in an oxidizing scrubber would generate a new liquid waste stream that must be treated as wastewater; however, the oxidizing agents make this wastewater incompatible with the current system. Oxidation scrubbers using caustic require the balance of oxidation chemicals and can result in the emission of odours if not maintained properly.

Non-thermal plasma and ozonation are both energy intensive, and considered to be emerging technology and there is limited documentation on demonstrated control efficiency or applicability on VOC and odour destruction for sugar refineries. There are limitations to both of these technologies as the control medium 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. The majority of sources have high moisture content so additional pre-treatment systems would be necessary.

Biofiltration units require a consistent food source, and the batch operations at the Sample Sugar Refinery Co. would result in significant fluctuations in VOC concentration. This may lead to insufficient nutrients provided to the micro-organisms needed to create a healthy biobed, or an overwhelming of degradation capacity of the filter should VOC concentrations spike or increase quickly. In the absence of sufficient nutrients, the decay of a biobed may itself become a source of odour, and there is significant effort required to re-establish a bio-bed colony and initiate the odour mitigation activity.

Process Optimization utilizing purchased CO2 instead of boiler flue gas CO2 is not technically feasible at this time as a significant amount of equipment retrofit would be required. The facility also has a limited physical space to locate new CO2 storage tanks to access the frequency of deliveries that would result in a retrofit from the boiler system.

A significant restructuring of the boiler exhaust would be required, and the boiler emissions would be discharged directly to atmosphere and not “scrubbed” through the carbonatation system. The option of changing the carbonation system to phosphatation would eliminate the carbonation exhaust. However, since the process was designed for carbonatation this option is identified as Technically Not Feasible as there is substantial uncertainty about the effect of a retrofit on product quality, process engineering, and whether odours would also be associated with this phosphatation.

**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 Sugar Refinery Co.**

| **Odour Source** | **Description of Control Measure** | **Technically Feasible?** | **Notes** |
| --- | --- | --- | --- |
| All Primary Sources | Stack Optimization | Technically Feasible –  previously implemented | If the odour loading results in off-site effects on the immediate surroundings, improved dispersion by optimizing the stack parameters can be effective. This may also include combining multiple stacks to one optimized stack. |
| All Primary Sources | Wet Scrubber (including Rotoclones) | Technically Feasible –  previously implemented on multiple sources | Although designed and installed for particulate control, some VOCs and odour control is achieved.  For process building odours, implementation would depend on collecting and ducting all process/building exhausts to a common exhaust. This may not be feasible. |
| All Primary Sources | Oxidizing Scrubber | Technically Not Feasible | The presence of oxidizing agents may affect the ability to recover dissolved and suspended sugars in the scrubber water. |
| All Primary Sources | Thermal Treatment | Technically Feasible | Thermal treatment of some process exhausts will be evaluated should additional measures be needed to control fugitive odours.  For process building odours, implementation would depend on collecting and ducting all process/building exhausts to a common exhaust. This may not be feasible. |
| All Primary Sources | Biofilter | Technically Not Feasible | The amount of free space required for a biofilter footprint large enough to achieve the appropriate residence time, as well as the humidification chamber and all the other support equipment, is not available at this facility. There may also be an issue with inconsistent feed due to the batch processes causing variability in the biofilter loading. |
| All Primary Sources | Ozonation | Technically Not Feasible | Ozonation is an emerging technology and there is limited documentation on demonstrated control efficiency or applicability. |
| All Primary Sources | 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. |
| Raw Sugar Storage | Engineering Controls:  Containment and Environmental Controls | Technically Feasible | Changes to the exhaust of raw sugar storage area will be evaluated should additional measures be needed to control fugitive odours, as well as conditions in the storage area. |
| Clarification (Carbonatation) | Process Optimization:  Use purchased CO2 rather than recovered CO2 from site boilers. | Technically Not Feasible | The replacement of the boiler flue gas with purchased CO2 would require several physical changes to the current site operations.  The facility has limited vacant space to accommodate a new CO2 storage tank with access for delivery trucks.  A significant restructuring of the boiler exhaust would be required, and the boiler emissions would be discharged directly to atmosphere and not “scrubbed” through the carbonatation system. |
| Clarification (Carbonatation) | Process Optimization:  Change to phosphatation | Technically Not Feasible | The option of changing the carbonation system to phosphatation would eliminate the carbonation exhaust.  However, since the process was designed for carbonatation this option is identified as Technically Not Feasible as there is substantial uncertainty about the effect of a retrofit on product quality, process engineering, and whether odours would also be associated with this phosphatation. |
| All Primary and Secondary Sources | Process Optimization:  Production Scheduling | Technically Feasible –  previously implemented | 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. |
| All Primary and Secondary Sources | Process Optimization:  Enhanced automation | Technically Feasible –  previously implemented | Multiple process optimizations have been implemented at the site. As different options are identified they will be evaluated for odour control opportunities and implemented accordingly. |
| Raw Sugar Unloading  Molasses Transfer | Engineering Controls:  Emission Capture | Technically Feasible | Improvements to the sugar unloading and molasses transfer activities will be evaluated should additional measures be needed to control fugitive odours if this source is identified as a major contributor to off-site odour. |
| All Primary and Secondary Sources | Best Management Practices | Technically Feasible –  previously implemented | Develop SOPs and train employees on BMPs for process and control equipment maintenance and operation, good housekeeping, spill prevention and response, reducing chemical and cleaner usage, and managing wastes.  Of specific note, procedures are in place to ensure raw sugar and off-spec materials are segregated, handled, stored and disposed such that the potential for fermentation and spoilage is limited.  Roof tops are already routinely inspected to ensure there is not accumulation of sugar leading to fermentation and decomposition leading to off-site odours. |

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 Sugar Refinery 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 Sugar Refinery 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 normal operational conditions and site parameters. Any excursions in normal operations (e.g. spills, emergency situations) or specific operational issues that were 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 primary sources identified, the Sample Sugar Refinery Co. has previously implemented at least one of the technically feasible control measures described in Section 4. There are multiple stack parameters optimized with vertical discharge orientations, high flow rates and a number of exhaust are grouped to common tall stacks to improve dispersion and reduce off-site odour impacts;
* For the secondary sources, the implementation of a BMPP and process optimization are effective in reducing off-site odour effects. The low to moderate odour concentration and, in some cases the intermittent nature of the releases, do not warrant additional control measures; and,
* Several general site BMPs, BATs, process optimizations and engineering controls have been implemented at the Sample Sugar Refinery Co. that reduce odour emissions from all process and fugitive sources.

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 emission 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 sugar refining 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 further complaints 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 control measures that will be evaluated for implementation at the Sample Sugar Refinery 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 Sugar Refinery 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** |
| --- | --- | --- |
| Primary or Secondary Sources | Thermal Treatment | Thermal treatment of some process exhausts will be evaluated should additional measures be needed to control fugitive odours.  For process building odours, implementation would depend on collecting and ducting all process/building exhausts to a common exhaust. This may not be feasible and would require an evaluation of both process emissions, open processing and full building ventilation capture. |
| Raw Sugar Storage | Engineering Controls:  Containment and Environmental Controls | Changes to the exhaust of raw sugar storage area will be evaluated should additional measures be needed to control fugitive odours, as well as conditions in the storage area. |
| Clarification (Carbonatation) | Change Carbonatation process | Use purchased pure CO2 instead of on-site boiler flue gas to eliminate the requirement of carbonatation exhausts and the associated odour emissions. |
| Primary or Secondary Sources | Process and Additional Stack Optimization | Multiple process and discharge optimizations have been implemented at the site. As different options are identified they will be evaluated for odour control opportunities and implemented accordingly. |
| Raw Sugar Unloading  Molasses Transfer | Engineering Controls:  Emission Capture | Improvements to the sugar unloading and molasses transfer activities will be evaluated should additional measures be needed to control fugitive odours. |

**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 food preparation, but may not be odorous if it is used for boiling 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 other sugar manufacturing 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.

**A.2 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 sugar milling and refining, 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.

**A.3 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.

**A.4 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.

**A.5 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.6 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.7 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 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 this sector 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 show what information 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 Rotoclones

### B2.1 Technologies

* Mechanically Aided Separator / Dynamic Separation

### B2.2 Emission Characteristics

* Primarily used to control particulate matter, may be used for oil mist droplets, grease, and sticky particulate matter.

### B2.3 Air Emission Sources

Common Applications:

* Food processing (rice, cereal, sugar)
* Vegetable oil refining
* Crushing and grinding
* Material handling and packaging
* Metal finishing

### B2.4 Description

Rotoclones are a type of mechanically aided scrubber that use a power-driven rotor to produce a spray to contact the gas. Dust and oil mist particles present in the untreated gas are brought into contact with the water droplets and become attached. The particulate is then removed from the gas stream as part of the larger droplets that are formed. A separator following the rotoclone prevents entrainment of the liquid.

### B2.5 Applicability and Performance

Particulate collection efficiency ranges from 80 to 99%. The units can handle a large range of flowrates and contaminant loadings, as well as gas streams at elevated temperatures. Water requirements may be less than for other wet scrubbers. The Rotoclone has relatively low capital and operating costs associated.

### B2.6 Limitations

A liquid or slurry waste stream is generated. VOC control is limited. Relatively high maintenance requirements due to moving parts (rotor).

### B2.7 References

American Air Filter. 2017. Type W Rotoclone.

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.

US EPA. Air Pollution Control Technology Fact Sheet: Mechanically-Aided Scrubber EPA-452/F-03-013.

## B.3 Absorption

### B3.1 Technologies

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

### B3.2 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.

### B3.3 Air Emission Sources

Common Applications:

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

### B3.4 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.

### B3.5 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.

### B3.6 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.

### B3.7 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.4 Biofiltration

### B4.1 Technologies

* Biological Treatment (beds, trickling filters, bioreactors)

### B4.2 Emission Characteristics

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

### B4.3 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

### B4.4 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.

### B4.5 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.

### B4.6 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.

### B4.7 **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.5 Carbon Adsorption

### B5.1 Technologies

* Packed beds, fluidized beds, filter cartridges

### B5.2 Emission Characteristics

* Gaseous Pollutants (Odour, VOCs, H2S)

### B5.3 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

### B5.4 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.

### B5.5 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 %.

### B5.6 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.

### B5.7 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.6 Non-Thermal Plasma (NTP)

### B6.1 Technologies

* Corona or Photocatalytic Reactors

### B6.2 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.

### B6.3 Air Emission Sources

Common Applications:

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

### B6.4 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.

### B6.5 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.

### B6.6 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.

### B6.7 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.7 Ozonation

### B7.1 Technologies

* This technology is considered an emerging technique.

### B7.2 Emission Characteristics

* Odorous exhaust gases.

### B7.3 Air Emission Sources

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

### B7.4 Description

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

### B7.5 Applicability and Performance

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

### B7.6 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.

### 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 4.4.3.8 Absorption.

# Appendix C - References

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