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Air Pollution Control +

# REPORT









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**Client:** **Iceland Manufacturing Ltd**
**Project:** **Manchester Site**
**Title:** **Vacuum Chamber emissions sampling & analysis**
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# ICELAND MANUFACTURING LTD

# GORTON SITE

# VACUUM COOLING TREATMENT PROPOSAL

MARCH 2021

**Report for:**

**Iceland Manufacturing Ltd.**
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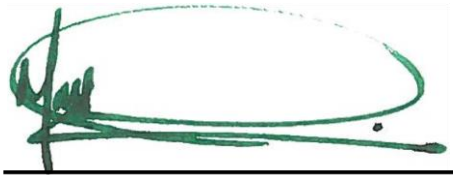

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# CONTENTS

**EXECUTIVE SUMMARY**
Purpose of the Report

**1.0 INTRODUCTION**
1.1 Scope of Study
1.2 Survey Objectives

**2.0 PLANT**
2.1 Plant Description

**3.0 METHODOLOGY**
3.1 Method of Survey

**4.0 FINDINGS/RECOMENDATIONS**
4.1 Findings from Survey

**5.0 CONCLUSION**
5.1 Conclusions

**6.0 VOC ANALYSIS SUMMARY**

**7.0 REFERENCE DOCUMENTS**

# EXECUTIVE SUMMARY

Iceland Manufacturing Ltd manufacture a range of sauces, soups and meals at their facility in Gorton, Manchester.

Plans exist to install new vacuum cooling equipment at IML to cool products from the onsite cooking vessels prior to packaging and dispatch.

The purpose of the vacuum cooling system is to cool food products cooked at the site in preparation for packaging.

Purpose of this report

This report relies upon detailed information from previous sampling and analysis of vacuum cooling and discharge ranging from December 2019 to December 2020. The odour generated in both systems emanates from a common cooking function.

The purpose of the sampling and analysis is to establish the odour value of the emissions, using dynamic olfactometry, that are currently being exhausted to the discharge drain and steam pressure release vents. The sampling and analysis also covered GCMS analysis to determine the make-up of the odour stream.

# 1.0 INTRODUCTION

## 1.1 Scope of Study

To attend site and assess if the proposed installation is a replica of the existing system commissioned at Iceland Manufacturing Ltd Gorton site and complete a feasibility study on the application of an active carbon treatment plant.

## 1.2 Survey Objectives

The purpose of the sampling and analysis is to establish the odour value of the emissions, using dynamic olfactometry, that are currently being exhausted to the discharge drain and steam pressure release vents. The sampling and analysis also covered GCMS analysis to determine the make-up of the odour stream.

To combat the odour that this process produces, Iceland Manufacturing want to implement an end-of-pipe solution but don't know what technology will offer the best solution as they do not know the properties of the odours/VOC's being released.

This report aims to provide the required information to allow a decision to be made on the best technology to employ.

**Quality Control and Assurance**

OSIL's odour measurement, assessment and consultancy services are conducted to the highest possible quality criteria by highly trained and experienced specialist staff. All activities are conducted in accordance with quality management procedures that are certified to ISO9001:2015 (Certificate No. 10010311).

All sensory odour analysis and odour sampling services are undertaken using UKAS accredited procedures (UKAS Testing Laboratory No. 8283) which comply fully with the requirements of the international quality standard ISO 17025: 2005 and the European standard for olfactometry EN13725: 2003.

The OSIL/Air Spectrum laboratory is recognised as one of the foremost laboratories in Europe, consistently outperforming the requirements of the British Standard for Olfactometry in terms of accuracy and repeatability of analysis results.

# 2.0 PLANT

## 2.1 Plant Description

The vacuum cooling system at Iceland Manufacturing Ltd is to be used to cool the product from the onsite cookers after the cooking cycle has completed.

The cooling is achieved by generating a vacuum within the cooking vessel using a vacuum pump.

As the pressure within the vessel reduces, the boiling point of water within the product also reduces which promotes evaporation of water into the air, leading to a cooling of the product. In order to continue the cooling effect until the target temperature of the food product is reached, it is necessary to continuously evacuate the vessel. The duration that the vacuum is applied will also vary depending upon the type of product being cooled.

The cooling system at Iceland Manufacturing Ltd comprises 3 no. chilling vessels, 3 no. condensers, 3 no. 'Belly tanks' and 3 no. vacuum pumps which can operate independently and are served by an indirect water-cooling system which is gravity fed from an overhead air-cooled water tank.

On completion of a cooking cycle, the vacuum pumps are turned on to draw the cooked product from the kitchen cooking vessel to the chilling vessel. The vessel is then sealed, and a vacuum created which draws the vapours from the cooked material through the condenser.

In order to aid the maintenance of a vacuum, steam is also injected into the vapour flow from the chilling vessel upstream of the condenser. The resulting condensate from the condensers (which comprises around 48% condensed steam and 52% evaporate from the product) is collected into a belly tank whilst the remaining non-condensable air is discharged through the vacuum pump into the discharge drain via a stainless-steel pipe.

# 3.0 METHODOLOGY

Vacuum Discharge Drain

Odour sampling was conducted from the discharge chamber to identify the primary contributors of odour into the drain and assess the odour concentration and formulation make up (GC-MS). The samples were taken in a single day.

The samples were collected using OSIL's UKAS accredited odour collection techniques (Testing Laboratory No. 8283) which comply with the British standard for olfactometry BS EN 13725:2003.

2 sets of Triplicate odour samples were collected from the discharge chamber across the discharge cycle and single replicate sample for GC-MS analysis.

# 4.0 FINDINGS AND RECOMMENDATIONS

## 4.1 Findings

**Odour Sampling**

The collection of samples from the vacuum discharge drain was conducted using the 'lung' principle sampling technique. 3 No. 25l Nalophane sample bags were connected to the OSIL vacuum chamber (OVSC-001 and OVSC-002) and connected directly to the discharge drain using PTFE sample lines. Air was withdrawn from this container using a vacuum pump which caused a sample of the odorous air to be drawn through the line into the bags.

Odour samples were collected as described above, with the system operational, over a period of approximately 20 minutes. This was repeated on two separate occasions over a duration of 2 hours.

The odour samples were transported to OSIL UKAS accredited laboratory at Air Spectrum in Worcester (Testing laboratory No. 8283) and analysed using olfactometry analysis to BS EN 13725: 2003 using Air Spectrum's UKAS accredited odour analysis techniques (Testing Laboratory No. 8283). This analysis determines the odour concentration of the air in human perception terms. Samples were also subjected to GC-MS analysis.

**MEASURED FINDINGS**

| Sample Location | Marker Compounds (ppm) | | |
|---|---|---|---|
| | $H_2S$ | R-SH | $NH_3$ |
| Discharge Drain | Non detected | 0.1 | Non detected |
| Discharge Drain | | | |
| Discharge Drain | | | |
| Discharge Drain | Non detected | 0.1 | Non detected |
| Discharge Drain | | | |
| Discharge Drain | | | |

**Olfactometry sampling and analysis**

Samples of air were taken using OSIL olfactometry Sampling Vacuum Chambers between 07:18hrs and 07:45hrs on Monday 16th December 2019. The odour samples were delivered direct to the laboratory within the prescribed time (30 hours are allowed) with the analysis taking place on 16th December 2019 between 14:42hrs and 15:46hrs and the results published on 20th December 2019 at 08:29hrs. The GC-MS analysis was issued on 15th January 2020 at 11:03hrs.

The samples were subjected to dynamic olfactometry by a panel of accredited olfactors in a UKAS accredited laboratory.

The results of the olfactometry analysis conducted on the samples collected from the exhaust stack are presented in the table below.

Table 1: Results of odour sampling

| Sample Location | Odour Concentration ($ou_E/m^3$) | | | Geomean |
|---|---|---|---|---|
| | Sample 1 | Sample 2 | Sample 3 | |
| Discharge Drain 1 | 12,274 | 11,585 | 13,777 | 12,545 |
| | | | | |
| Discharge Drain 3 | 13,777 | 12,274 | 10,321 | 12,124 |

The confirmed results were:
Vacuum Discharge Drain: 12,334.5 $ou_E/m^3$

**Further testing**

Samples of air were taken using OSIL olfactometry Sampling Vacuum Chambers between 12:53hrs and 13:10hrs on Thursday 10th December 2020. The odour samples were delivered direct to the laboratory within the prescribed time (30 hours are allowed) with the analysis taking place on 11th December 2020 between 13:27hrs and 13:50hrs and the results published on 17th December 2020 at 19:41hrs. Due to issues at the laboratory, the first set of samples for GCMS analysis were destroyed and a second set of samples were taken on 13th January 2021 @ 09:38hrs with the results published 27th January 2021 @ 15:30hrs.

The samples were subjected to dynamic olfactometry by a panel of accredited olfactors in a UKAS accredited laboratory.

The results of the olfactometry analysis conducted on the samples collected from the exhaust stack are presented in the table below.

Table 1: Results of odour sampling

| Sample Location | Odour Concentration ($ou_E/m^3$) | | | Geomean |
|---|---|---|---|---|
| | Sample 1 | Sample 2 | Sample 3 | |
| Discharge Drain | 813 | 912 | 912 | 879 |
| | | | | |
| Exhaust Stack | 215 | | | 215 |

The confirmed results were:
Vacuum Discharge Drain: 879 $ou_E/m^3$

Exhaust Stack 215 $ou_E/m^3$

**Collection of odour samples from the Vacuum Discharge Drain**

The collection of samples from the vacuum discharge drain was conducted using the 'lung' principle sampling technique. 3 No. 25l Nalophane sample bags were connected to the OSIL vacuum chamber (OVSC-001 and OVSC-002) and connected directly to the discharge drain using PTFE sample lines. Air was withdrawn from this container using a vacuum pump which caused a sample of the odorous air to be drawn through the line into the bags.

Odour samples were collected as described above, with the system operational, over a period of approximately 20 minutes. This was repeated on two separate occasions over a duration of 2 hours.

The odour samples were transported to OSIL UKAS accredited laboratory at Air Spectrum in Worcester (Testing laboratory No. 8283) and analysed using olfactometry analysis to BS EN 13725: 2003 using Air Spectrum's UKAS accredited odour analysis techniques (Testing Laboratory No. 8283). This analysis determines the odour concentration of the air in human perception terms. Samples were also subjected to GC-MS analysis.

**VOC sampling and analysis**

The samples collected for olfactometry analysis were also subjected to Gas chromatography–mass spectrometry (GC-MS) to determine the component parts of the odour samples.

The results (shown on page 12 in section 6 of this report), show very low concentrations of specific VOC except for Chloroform which was the predominant VOC sampled.

Given that the odour threshold for Chloroform is 192ppm. The levels detected would not give rise to an odour issue. The $mg/m^3$ level analysed equates to 0.671ppm.

If you take the total VOC's of 4.505 at an average molecular weight of 120g/mol then this will only provide for 0.918ppm of VOC.

**Measurement of odour concentration using olfactometry**

Odour measurement is aimed at characterising environmental odours, relevant to human beings. As no methods exist at present that simulates and predicts the responses of the human sense of smell satisfactorily, the human nose is the most suitable 'sensor'. Objective methods have been developed to establish odour concentration, using human assessors. A British standard applies to odour concentration measurement: ▪ BS EN13725:2003, *Air quality - Determination of odour concentration by dynamic olfactometry.*

The odour concentration of a gaseous sample of odorants is determined by presenting a panel of selected and screened human subjects with that sample, in varying dilutions with neutral gas, to determine the dilution factor at the 50% detection threshold (D50). The odour concentration of the examined sample is then expressed as multiples of one European Odour Unit per cubic meter [ouE/$m^3$] at standard conditions.

**Details of Sample Collection**

| Sample Location | Date of Sampling | Time of Collection | | |
|---|---|---|---|---|
| | | Sample 1 | Sample 2 | Sample 3 |
| Vacuum Discharge Drain (1) | 16th December 2019 | 07:18hrs | 07:18hrs | 07:18hrs |
| Vacuum Discharge Drain (2) | 16th December 2019 | 07:44hrs | 07:44hrs | 07:44hrs |

# 5.0 CONCLUSIONS

## 5.1 Conclusions

From the sampling analysis results I am confident in concluding that a simple virgin media (base activated carbon) and CuCarb mixed media will provide a robust treatment solution for your emissions. The VOC's detected were low odour threshold but the cumulative effect produces the odours reported. The average molecular weight for the detected VOC's is 116. For the purposes of an odour abatement technology, we recommend using 120 gmol as the average molecular weight to determine media life.

**Performance of Recommended solution**
An activated carbon unit will provide 99.9% removal. So, if we use 428,000ou/$m^3$ (the higher value from a previous odournet report) then we will see 428 ou/$m^3$ at the exhaust stack.

Based on an operating regime of 24/5 for 50 weeks of the year (i.e.6000 hours per year), then we would anticipate a media life of around 17 months.

The OCU proposed works passively in that odorous air is displaced form the process discharge and treated through the OCU without the need for forced extraction. This way there is no additional noise pollution from the system.



We recommend a minimum empty bed retention time of 4 seconds and would even go as high as 6 seconds. If an airflow can be established, then we can easily design a suitable unit to fit in the available space.

You must ensure that odour is controlled so as not to materially affect your neighbours' enjoyment of their property, cause them harm or offence or reduce their legitimate use of the environment, and if problems do occur, or are likely to occur, you must take the appropriate actions to prevent or minimise them (UK Legislation).

While for some activities it may not be practicable to avoid all odour, your neighbours have a right to expect that your activities will not detract from their quality of life. It is unlikely; however, that action will be taken over occasional, slight odours.

By "neighbour" we mean anyone living, working, visiting or making use of public space outside your site. It means any sensitive receptor.

## SUMMARY OF VOC MONITORING RESULTS

The tables below presents the individual VOC compounds that were detected on the Tenax sorbet tube. Each individual compound detected was then quantified with the GC-MS instrument operating in the scanning mode against an internal Toluene calibration standard.

**VOC Results: Sample ID: 01651 -004**

| Sample reference | VOC Detected in sample air | Mass of VOC compound detected on sorbent tube (nanograms) | VOC Concentration in ug/m$^3$ |
|---|---|---|---|
| **Inlet – 01651 -004** | Sabiene | 200 | 40 |
| | beta-myrcene | 680 | 140 |
| | beta- pinene | 2900 | 580 |
| | alpha - phellandrene | 300 | 60 |
| | Alpha - terpinene | 200 | 40 |
| | tetramethylbenzene | 7900 | 1600 |
| | limonene | 960 | 190 |
| | beta-Phellandrene | 460 | 91 |
| | gamma- terpinene | 14000 | 2800 |
| | diallyl disulphide | 3400 | 680 |
| | Terpinolene | 720 | 140 |
| | 1- Allyl - 2 - isopropyldisulphane | 300 | 61 |
| | 1- Allyl - 2 - (prop-1-en-1- yl) disulphane | 1400 | 290 |
| | Disulphide , dipropyl | 600 | 120 |
| | 1- (prop-1-en-1-yl) - 2 - propyldisulphane | 390 | 78 |
| | Anethole | 2400 | 480 |
| | Propanal , 2- methyl - 3- phenyl | 3600 | 720 |
| | 1,4-p.Menthadien - 7 - al | 430 | 85 |
| | Daucene | 810 | 160 |
| | Caryophyllene | 610 | 120 |

No other VOC's were detected above the analytical limit of detection which is 20 nanograms.



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**VOC Results: Sample ID: 01651 -008**

| Sample reference | VOC Detected in sample air | Mass of VOC compound detected on sorbent tube (nanograms) | VOC Concentration in ug/m³ |
|---|---|---|---|
| Inlet – 01651 -008 | Sabiene | 50 | 8 |
| | Beta myrcene | 90 | 20 |
| | Beta pinene | 790 | 140 |
| | limonene | 200 | 30 |
| | Gamma terpinene | 3200 | 580 |
| | Diallyl dislphide | 2700 | 500 |
| | terpinolene | 200 | 30 |
| | 1- Allyl -2 isopropyldisulphane | 100 | 30 |
| | 1- Allyl-2 (prop-1-en-1-yl) disulphane | 380 | 69 |
| | Disulphide, dipropyl | 370 | 66 |
| | 1-(prop-1-en-1-yl)-2-propyldisulphane | 100 | 20 |
| | Anethole | 200 | 30 |
| | Ethyl acetate | 80 | 10 |
| | Butanal, 3- methyl | 50 | 9 |
| | Hexanal | 50 | 9 |
| | Diallyl sulphide | 200 | 30 |
| | Disulphide, methyl 2-propenyl | 100 | 20 |
| | p- cymene | 200 | 30 |
| | Benaldehyde, 4-(1-methylethyl)- | 250 | 45 |
| | Copane | 80 | 10 |

No other VOC's were detected above the analytical limit of detection which is 20 nanograms.



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## 7.0 REFERENCE DOCUMENTS


- ENVIRONMENT AGENCY TECHNICAL GUIDANCE NOTE H4 – *ODOUR MANAGEMENT (APRIL 2011)*

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