Environmental Permit Application – Supporting Documentation

Sawston Pilot Plant

Immaterial Limited

Unit 3, Cambridge South Business Park, Sawston, Cambridge, CB22 3FG.

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Making Sustainability Happen

Revision Record

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Basis of Report

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1.0 Non-technical Summary

This application is for a new bespoke Environmental Permit for an Installation to operate a Schedule 1 Part 2 Section 4.1 Part A(1) (a) activity ‘Producing organic chemicals such as – (vii) organometallic compounds’.

The Operator will be Immaterial Limited, and the site is located at Unit 3, South Cambridge Business Park, Sawston, Cambridge, CB22 3FG.

The Installation name shall be the ‘Sawston Pilot Plant’.

The processes to be undertaken at site all involve the reaction of metal salts with organic materials and in some cases metal hydroxides in the presence of a solvent (either an organic solvent or water depending on the process), and additives to generate densified metal-organic framework (MOF) product materials with subsequent recovery and purification processes. All processing will be on a batch basis with each stage of the process being able to operate independently.

A set of technical supporting documentation has been prepared which presents details of the site and the proposed site activities and operations supported by appropriate definition of potential emissions to the environment, emission control measures and environmental risk and impact assessments. The documentation also presents details of the management controls that will be developed and utilised to operate and control the Installation activities.

The application demonstrates that the operation of the new Installation will not lead to any significant environmental impacts.

The Installation is still going through the design process and hence there are certain specific details of the site activities that are yet to be finalised. However, the design approach is intended to ensure that the final plant design and associated operational controls (e.g. the Environmental Management System) will be fully compliant with the requirements of Best Available Techniques (BAT) and appropriate Environment Agency guidance in advance of commencement of commissioning and operation of the processes.

Immaterial has committed to providing additional data required on the plant design and operating controls to the Environment Agency prior to commencement of commissioning and operation.

2.0 Applicant Details

Table 1: Applicant Company Details

Aspect	Applicant Details
Company Name	Immaterial Limited
Company Number	09829727
Registered Office Address	25 Cambridge Science Park, Milton Road, Cambridge, England, CB4 0FW
Date Of Incorporation	19 October 2015
Nature of Business (SIC)	72190 - Other research and experimental development on natural sciences and engineering

Table 2: List of Company Directors (as recorded at Companies House)

Director Name (Last Name , First Name)	Role	Date of Birth	Appointed On
BRINKSMA, Jogchum	Director	[redacted]	18 December 2018
CORELL, Belen Linares	Director	[redacted]	24 April 2024
EGGERS, Kevin Arthur	Director	[redacted]	23 September 2024
FAIREN JIMENEZ, David, Dr	Director	[redacted]	19 October 2015
KHAN, Mohammed Hussain	Director	[redacted]	1 April 2022
NELSON, Alan	Director	[redacted]	24 August 2023
VISSER, Ate Sjoerd	Director	[redacted]	18 December 2020

Table 3: Applicant Site Contact Details

Aspect	Applicant Details
Site Name	Sawston Pilot Plant
Site Address	Unit 3, South Cambridge Business Park, Sawston, Cambridge, CB22 3FG.
Approximate Grid Reference	TL 49004 50410
Site Contact	Giorgos Karaglanis
Role	Site Operations Manager
Email	g.karaglanis@immaterial.com
Telephone Number	+44 (0)7450491676

3.0 Requirement For the Environmental Permit

3.1 Overview of Proposed Site Activities

Immaterial is proposing to develop a pilot scale testing and production facility which is currently expected to be located at South Cambridgeshire Business Park in Sawston.

The activities proposed to be undertaken at the facility will utilise pilot scale production equipment (reactors, blender, tray dryers) in order produce densified metal-organic framework (MOF) materials.

The plant will also be used to undertake and optimise scale up from laboratory scale testing and will also be used to gather Intellectual Property to enable the commercialisation of the proprietary process technologies and products.

The plant is intended to initially produce 6 and 12 tonnes of product per annum, with the potential for increased hours of operation increasing the production capacity up to around 20 tonnes per annum. The materials produced will be sold on for use by third parties for them to use in the development and testing of industrial scale end uses for the materials.

3.2 Project Timeline

The Installation is still within the detailed design phase, and as such there are certain aspects of the proposed design and operation of the plant that are still to be finalised.

This application includes the data available at the time of development of the application.

The Installation is currently intended to commence commissioning in April 2025, with phased operation commencing in June 2025.

3.3 Review Against Regulatory Guidance Note RGN2[1]

There are three (3) tests that must be met in order for an activity defined under Schedule 1 Part 2 of the EPR to be considered to be 'Producing' and hence for an Environmental Permit to be required:

3.3.1 Test 1 - Chemical Processing

The activities proposed to be undertaken at the production facility do involve a chemical reaction, and hence Test 1 for 'chemical processing' is considered to be met.

3.3.2 Test 2 – Chemical Plant

The activities proposed to be undertaken at the production facility are expected to involve the generation of between 6 and 12 tonnes of product per annum, with the potential for increased hours of operation increasing the production capacity up to around 20 tonnes per annum. Hence Test 2 for 'chemical plant' is considered to be met.

3.3.3 Test 3 – Commercial Purposes

The capacity of the production facility will not be sufficient for commercial scale supply of densified metal-organic framework materials to full scale carbon capture or hydrogen storage systems. The facility will be capable of producing sufficient quantities for use in demonstrator/pilot scale units on customer sites so that customers can validate the performance of the systems prior to ordering commercial scale systems i.e. the materials will

[1] Regulatory Guidance Series, No. RGN 2 Understanding the meaning of regulated facility – Version 3.1 May 2015

be produced to supply customers and Immaterial will receive financial payment for the products produced.

Hence Test 3 for 'commercial purposes' is met.

3.4 Exclusions for Research and Development

EPR Schedule 1 Part 1 includes the following statement in relation to activities defined under Schedule 1 Part 2 :

"*3. An activity is not to be taken to be an activity falling within Part 2 of this Schedule if it is –*

(c) carried on at an installation, other than a waste incineration plant or a waste co-incineration plant, or by means of Part B mobile plant, where the installation or plant is used solely for research, development or testing of new products or processes."

The activities proposed to be undertaken at the production facility will be used to undertake and optimise scale up from laboratory scale testing and will also be used to gather Intellectual Property to enable the commercialisation of the proprietary process technologies and products. However, it is intended that the products generated will be sold on for use by third parties for them to use in the development and testing of industrial scale end uses for the materials.

It is therefore considered that the exclusion for research and development activities cannot be fully applied to the proposed activities.

3.5 Test for Low Impact Installation Permit

Operators can apply for a standard rules permit for a low-impact Part A1 installation where the proposed activities will have a low environmental impact, including during normal operation, start-up, shutdown, or abnormal operating conditions.

It is considered that the facility cannot be classified as a low impact installation for the following reasons:

- Potential emissions of VOC e.g. ethanol from the process will be abated using condensers prior to venting to atmosphere; and
- Volumes of ethanol waste are anticipated to be in excess of 10kg (as hazardous waste) per day, averaged over a year.

3.6 Pre-application Engagement with the Environment Agency

A request for pre-application advice was submitted to the Environment Agency on 16th May 2024. The pre-application reference provided by the Environment Agency is EPR/DP3721SD/P001.

3.7 Details of the Permit Being Applied For

This application is therefore for a bespoke Environmental Permit for an Installation to operate a Schedule 1 Part 2 Section 4.1 Part A(1) (a) activity 'Producing organic chemicals such as – (vii) organometallic compounds'.

Table 4: Scheduled Activities

Activity Reference	Activity Listed in Schedule 1 of the EP Regulations	Description of Specified Activity	Limits of Specified Activity
AR1	Section 4.1 A(1)(a)(vii) - Producing organic chemicals such as-organometallic compounds (for example lead alkyls, Grignard reagents and lithium alkyls);	Producing Organic Chemicals such as: densified metal-organic framework (MOF) materials	From receipt of raw materials to storage and despatch of finished product.

3.8 Supporting Documentation

The application package comprises the documents detailed in Table 5.

Table 5: Details of the Documents Comprising the Application Package

Document Reference	Content	Location
Form A	EA Application Form A - Application for an environmental permit - Part A – About you	Application Forms Folder
Form B2	EA Application Form B2 – New bespoke permit	Application Forms Folder
Form B3	EA Application Form B3 –New bespoke installation	Application Forms Folder
Form F1	EA Application Form F1 – Charges and declarations	Application Forms Folder
405.065240.00001	Technical Supporting Document	This Document
Appendix A	Figures	Appendix A
Appendix B	Site Condition Report	Appendix B
Appendix C	Process Information	Appendix C
Appendix D	BAT Assessment	Appendix D
Appendix E	Air Emissions Risk Assessment	Appendix E
Appendix F	Noise Impact Assessment	Appendix F
Appendix G	Qualitative Environmental Risk Assessment	Appendix G

4.0 Site Setting

4.1 Site Location

The site address is: Unit 3, South Cambridge Business Park, Sawston, Cambridge, CB22 3FG.

The site is located on the northern outskirts of Sawston, approximately 8 kilometres (km) southeast of Cambridge city centre. Surrounding land use is a mix of residential, agricultural, commercial and light industrial. A development plot is present to the northeast, light industrial and commercial properties are adjacent to the southeast and northwest and residential properties are present to the southwest.

The site is centred on grid reference TL 49004 50410.

A site location map is presented in Appendix A – Figure 1.

Immaterial is the leaseholder of the site and as such has no responsibility for any existing pollution within the soil or groundwater underlying the site.

4.2 Site Layout

The site is a small industrial / warehouse unit which comprises a steel portal frame warehouse building to the south, which will accommodate the main production area and the site offices, and to the North is a hardstanding area for vehicle parking. No areas of soft landscaping are associated with the site.

A site layout plan and installation boundary is presented in Appendix A – Figure 2.

The proposed plant layout within the building is shown in Appendix A – Figure 3.

4.3 Site Condition Report

A Site Condition Report (SCR) is presented in Appendix B.

This includes historical site soil and groundwater monitoring data which has been proposed to represent the initial baseline for site condition at the commencement of the Environmental Permit and it is proposed that this will be supplemented by additional targeted intrusive investigation to be undertaken either prior to or at commencement of operation.

5.0 Plant and Process Description

5.1 Raw Materials

The types of raw materials used in the process and the indicative maximum inventory and pack size are summarised in Table 6 with a detailed list of all raw materials that may be used at the site presented in Appendix B4.

It is noted that the specific raw materials in use and stored on site will vary depending on the product being produced. Appendix B4 presents a list of all the materials that could credibly be present in site at one time or another, but it is noted that it is unlikely that all of these materials would be present on site simultaneously. The maximum inventories are based upon the maximum storage capacity available on site for each type of material.

It is not possible to estimate annual usage of each material at this time as this will vary significantly dependant on the product being manufactured and the operating hours of the plant.

Table 6: Raw Materials

Raw Material	Pack Size	Maximum Inventory	Storage Location
Metal Salts Based on the following Metals: Cobalt, Zinc, Nickel, Copper, Magnesium, Zirconium, Iron, Aluminium, Calcium, Silicon, Chromium, Cadmium, Titanium, Niobium, Arsenic, As the following salts: Chloride, Nitrate, Acetate, Acetylacetonate, Carbonate, Oxychloride.	Typically in powdered solid form packed into 25kg Sacks / Bags	4,000 kg	On dedicated storage racking within the building over impermeable concrete hardstanding
Organic Materials	Typically in powdered solid form packed into 25kg Sacks / Bags	6,000 kg	On dedicated storage racking within the building over impermeable concrete hardstanding

Raw Material	Pack Size	Maximum Inventory	Storage Location
Metal Hydroxides	Typically in solution stored in 1,000 litre IBC's, 205 litre drums or smaller carboys	2,000 litres i.e. 2 IBC's	Dedicated IBC / drum storage units with integrated bunding Located within the building
Acids	Typically in powdered solid form packed into 25kg Sacks / Bags	250 kg	On dedicated storage racking within the building over impermeable concrete hardstanding
Solvents Ethanol Methanol	Typically in liquid form stored in 1,000 litre IBC's, 205 litre drums or smaller carboys	10,000 Litres of Organic Solvents i.e. 10 IBC's	Dedicated flammable materials IBC storage unit with integrated bunding Located exterior to the building adjacent to the front wall
Non-VOC Solvents	Typically in liquid form stored in 1,000 litre IBC's, 205 litre drums or smaller carboys	As part of the above total solvent inventory	Dedicated IBC / drum storage units with integrated bunding Located within the building
Additives	Either in powdered solid form packed into 25kg Sacks / Bags; or As liquids or in solution typically stored in 205 litre drums or smaller carboys	4,900kg	On dedicated storage racking within the building over impermeable concrete hardstanding
In addition to the Process Raw Materials, the following substances will also be present on site to support the process and maintenance activities:			

Raw Material	Pack Size	Maximum Inventory	Storage Location
Spare Thermal Fluid for the Reactor Heating package Marlothem HS or similar	Typically stored in 25 litre drums or smaller carboys	50 litres Note larger quantities will be present on site within the heating systems – but these will be sealed systems with control systems to identify potential leaks	On dedicated storage racking within the building over impermeable concrete hardstanding Secondary containment portable bunding will be provided
Spare thermal fluid for the Blender	Typically stored in 25 litre drums or smaller carboys	50 litres Note larger quantities will be present on site within the heating systems – but these will be sealed systems with control systems to identify potential leaks	As above
Spare heating fluid for the Tray dryers	Typically stored in 25 litre drums or smaller carboys	50 litres Note larger quantities will be present on site within the heating systems – but these will be sealed systems with control systems to identify potential leaks	As above
Closed loop cooling system – Spare Glycol	Typically stored in 25 litre drums or smaller carboys	50 litres Note larger quantities will be present on site within the cooling systems – but these will be sealed systems with control systems to identify potential leaks	As above
Spare Ion Exchange Resin / cartridges for the water softening plant	Small bags or boxed cartridges	25kg	On dedicated storage racking within the building over impermeable concrete hardstanding

Raw Material	Pack Size	Maximum Inventory	Storage Location
Compressed Nitrogen (for inertisation of the process headspaces)	Within Cylinders	20 cylinders	Gas cylinder storage compound – exterior to the building
Compressed air	Within Cylinders	4 cylinders	Gas cylinder storage compound – exterior to the building
Deionised or Softened Water (for use as a process solvent and in the Cleaning in Place System)	Typically stored within 1,000 litre IBC's	3,000 litres i.e. 3 IBC's	On dedicated storage racking within the building over impermeable concrete hardstanding

5.2 Storage

All non-flammable raw materials, other materials, products and wastes will be stored within the building.

Dry and powdered materials will be delivered to site by road and will be contained within bags, sacks or other suitable smaller containers. All dry and powdered materials will be stored on suitably robust shelving / pallets within the dedicated storage area inside the building which has an impermeable concrete floor lain over a damp proof membrane.

Liquids or solutions will also be delivered to site via road vehicle and will be offloaded into the building (via access through the roller shutter doors). Liquids will be stored in IBC's, drums, carboys or other similar smaller portable containers. The maximum capacity of any single container supplied to site will be 1.2m^3.

All liquids (including liquid wastes) will be stored over portable bunds or within integrally bunded storage cabinets within the dedicated storage area inside the building which has an impermeable concrete floor. There is no floor drainage in this area.

Flammable raw materials i.e. organic solvents (Ethanol / Methanol) will be delivered to site in 1,000 litre IBC's and it is currently proposed that these will be stored in a dedicated secure flammable materials storage unit located outside the front wall of the building. This unit will also be used to store larger volumes of flammable liquid waste e.g. waste solvent.

The siting of this storage unit outside the main building has required Immaterial to submit an application to amend the sites planning permission. Immaterial is still waiting to hear whether this planning consent will be granted. If consent is not granted, then Immaterial will review the options available to relocate the proposed storage inside the building which may require some adjustment to the storage arrangements and layout.

There are no bulk storage tanks at the Installation.

In addition to the physical containment systems proposed at the site, the site activities will also be managed subject to an Environmental Management System which will incorporate procedures which will include consideration of: receipt of deliveries, moving and handling materials, management of storage areas, spill response, Incident response, and logging and follow up of incidents etc..

All storage areas will also be subject to scheduled visual housekeeping checks and inspections to ensure that there are no leaks or losses from primary containment.

5.3 Secondary Containment

All liquid raw materials will be stored over appropriately bunded areas either in the form of portable bunds, dedicated bunded storage cabinets or similar.

All non-flammable liquids will be stored within the building which has an impermeable concrete floor with no floor drains.

The dedicated secure flammable materials storage unit used for the storage of all larger volumes (IBC's) of flammable materials and wastes is constructed with integral bunding.

It is noted that Immaterial is in the process of finalising the location of the flammable materials storage unit (pending planning permission to allow it to be sited outside the building).

Assuming the flammable materials storage unit is located outside the front of the building then the loading and unloading of IBC's will be undertaken outwith the building in an area that currently comprises some concrete and some tarmac hardstanding, with associated surface water (rainwater drains) from these areas (see Appendix A – Figure 6 for the site drainage plan). Immaterial will therefore be reviewing additional options to minimise the risk of loss of material to ground or nearby external surface water drains associated with the storage and handling of bulk flammable materials in IBC's outside the building. This work is currently ongoing and will be reliant on planning consent being granted for the external storage unit. Once the appropriate measures have been identified the details will be communicated to the Environment Agency prior to commencement of operations, and it is requested that this be included as a pre-operational condition in the Permit.

The Environmental Permit application has been developed on the assumption that the flammable materials storage unit will be located outside the main building. Should this change, then Immaterial will inform the EA of the proposed changed and update the application documentation to reflect any changes.

The main process activities will all be undertaken within the dedicated processing area which will be within an enclosed and walled area within the building. The building concrete flooring and the walls around the process area will act to provide containment for any spills within this area.

All materials stored within the building will also be located over impermeable concrete hardstanding which provides an impermeable barrier to pollution entering soil or groundwater.

Any spillages of dry or powdered materials will be cleaned up at point of spillage using dry techniques e.g. brush and dustpan.

Any spillages of liquids or solutions will be cleaned up at point of spillage using adsorbents, spill kits and other suitable clean up measures.

All storage areas will be subject to scheduled visual housekeeping checks and inspections to ensure that there are no leaks or losses into secondary containment systems and that the containment infrastructure remains in good condition.

5.4 Process Description

The processes to be undertaken at site all involve the reaction of metal salts with organic materials and in some cases metal hydroxides in the presence of a solvent (either an organic solvent or water depending on the process), and additives to generate the densified metal-organic framework (MOF) materials with subsequent recovery and purification processes.

The specific details of the reaction chemistry, and the details of the specific chemical reactions proposed are commercially confidential and will vary through the permit lifetime in line with the intended operation of the Installation as a pilot scale production facility which will be utilised to develop and scale up processes developed by research and development activities at laboratory scale.

The manufacturing process may include all or some of the following sequential stages , depending on the product.

- Weighing and preparation of powdered materials to feed into the process;
- Reaction;
- Washing and concentration;
- Solid / Liquid separation;
- Concentration;
- Blending (with additives);
- Extrusion;
- Drying;
- Solvent exchange;
- Activation;
- Packaging;
- Collection of waste solvents;

5.4.1 Preparation of Powdered Materials

Solid powdered reagents are pre-weighed by the operator at a weigh station located within a downflow booth. The materials will be transferred from the sacks / bags etc. into sealable containers which are then used to transfer the materials to the powder charging point to minimise the potential for spillage. The downflow booth has in integrated LEV system which extracts air and filters it through a 3-stage filtration system for particulate abatement comprising:

- A pre-filter - G4 Grade (80 - 90% removal of air-borne particles of size more than 10 micron);
- A medium filter - F8 Grade (90 - 95% removal of air-borne particles of size more than 0.4 micron); and
- A HEPA filtration system - H14 grade HEPA filters (99.995% removal of air-borne particles of size more than 0.2 micron).

Around 90% of the air is recirculated into the downflow booth with around 10% being vented back into the building – there will be no discharge to the external environment from this LEV system.

The sealed containers containing the powdered materials are then taken by the operator to the reactor dosing hopper for direct addition into the reactor. Powders are dispensed from the dosing hopper into the reactor using a high shear pump at the appropriate time as required by the reaction process being undertaken. Due to the design of the system emission of dust / particulate are not anticipated from the dosing hopper.

5.4.2 Reaction

The reaction process is undertaken on a batch basis in one of two jacketed stirred tank reactors (R101, R102).

All reaction processes will be controlled to a pre-determined recipe.

Powdered materials will be added to the reactor as outlined in Section 5.4.1

Liquid reagents are added automatically via pumps from IBCs or smaller containers.

The reactors are each installed with load cells, and these are used to control the addition of materials to the reactors. Once the reactor contains the required materials, the feed transfer pumps cease operation and the automated valves on the feed lines close.

The plant operation will have some automation, with control from the Basic Process Control System (BPCS). Addition of liquids to the reactors will be possible from a menu system with specific 'recipe' requirements preset in the system for each product being manufactured, and powders will be pre-weighed and added manually in accordance with the 'recipe'. Manual operation will also be possible to allow for process development trials. Basic safety interlocks to protect against any hazardous conditions, such as tank overfills, will be provided by the BPCS at all times.

The temperature of the reactor throughout the reaction stage is controlled via the circulation of thermal fluid to the reactor jacket from the heating / cooling package. The reactor temperature, and the set point temperature for the thermal fluid are controlled via the BPCS.

Reactors are held under a nitrogen blanket at all times. The BPCS will ensure that the nitrogen automatic valve is open as soon as the reaction sequence is initiated. Overpressure in the reactor, from addition of liquids, for example, is vented via a conservation vent or breathing valve. Nitrogen is supplied to the reactors via a nitrogen blanketing regulator. Nitrogen will flow in to replace any volume lost due to cooling or product being pumped out.

Any nitrogen vented from each reactor is directed to a dedicated condenser (HX101, HX105) supplied with chilled water to minimise the emissions of VOC from the process. The nitrogen is then vented to atmosphere.

5.4.3 Washing and Concentration

The materials within the reactor can be circulated from the reactor in use via a membrane filtration system (Z101) to remove unwanted materials from the solution and are then returned to the reactor.

The washing / concentration process is manually initiated via the control interface and is controlled via the BPCS and the local control system on the membrane filtration unit. The end point for the process i.e. when the desired product quality has been achieved is monitored by the BPCS.

Filtrate from the membrane filtration unit is collected into a filtrate receiver (T107), the capacity of which is checked via the BPCS to ensure that there is sufficient ullage to receive the filtrate, prior to commencement of flow through the membrane filtration unit.

Additional deionised water can be added (automatically by the BPCS) to facilitate the washing / concentration stage if required.

Once completed, the reactor contents are then transferred to a stirred holding tank (T104)

5.4.4 Solid / Liquid Separation

Dewatering of the materials from the reactor is performed in a decanter centrifuge (D101), the operation of which is manually initiated and controlled through a local control system and operator interface linked to the BPCS.

If required by the batch recipe, the operator has the option to manually add a pre-weighed dose of coagulant directly into holding tank T104 (and would be prompted to do so by the control system interface) and the tank would be mixed to ensure effective distribution of the coagulant through the batch prior to starting the operation of the decanter centrifuge and pumping of materials within holding tank T104 into the decanter centrifuge.

The liquid phase separated from the solid materials is then sent for collection into a waste IBC, whilst the solids phase is collected into containers for transfer to the concentration stage.

5.4.5 Concentration and Blending

Concentration is performed in a blender (BL101) under heat and vacuum. The materials for concentration are loaded into the blender directly from containers. The blender has a charge port through which the materials and any additional solid additives (e.g. pre weighed doses of additives) can be manually loaded.

Nitrogen is fed into the blender to provide inertisation of the atmosphere.

Heat is supplied via the closed loop thermal fluid system from the blender heating package (Z103).

The vacuum is generated using a downstream vacuum pump (VP101). The vacuum pump draws the nitrogen (and any volatile solvent) within the blender headspace via a condenser (HX102) which is used to condense out potential VOC's present e.g. ethanol prior to venting the extracted nitrogen to atmosphere. The condensed VOC materials (e.g. ethanol) are collected into receiver tank T108 prior to being pumped to IBC's for collection as waste solvent. The level within T108 is monitored and has a dedicated high level alarm to prevent overfill.

The solid materials produced by the blender are transferred via a screw discharge into a twin-bore ram feeder which feeds the product directly into the extruder for the formation stage.

The operation of the blender is manually initiated and controlled through a local control system and operator interface linked to the BPCS. This system starts/stops the blender, starts/stops vacuum pump VP101, controls the agitator speed, and performs any safety functions.

The control system prompts the operator to undertake the following tasks and confirm their completion prior to commencement of operation of the blender:

- Empty receiver T108;
- Activate cooling to the condenser and ensure the chilled water package is operating;
- Activate nitrogen flow and ensure that the flow is set to the correct value.

5.4.6 Formation

Formation of the product is undertaken using an extruder (E101). The product from the blender is fed into the extruder by the twin-bore ram feeder, and the product is collected onto trays for transfer to the drying stage.

The extruder has its own standalone controller and requires manual initiation and stopping of operation, the control system controls the speed of operation and performs any safety functions. This is not linked to the BPCS. Operators are also required to supervise the operation and change the product trays as and when they are suitably loaded.

The exit from the extruder will also be installed with an LEV system for operator protection. This LEV system will extract air (and any associated VOC (ethanol) content) and will be installed with carbon filters to abate VOC's if required, the extracted air will then be recycled into the main processing area – there will be no vent to the external environment from this system.

5.4.7 Drying

The trays from the extruder are loaded into a tray rack and then placed into a tray dryer (TD101) which uses heat and vacuum to dry the product.

Nitrogen is fed into the dryer at a pre-determined rate to provide inertisation of the atmosphere.

The dryer is electrically heated.

The vacuum is generated using a downstream vacuum pump (VP102). The vacuum pump draws the nitrogen (and any volatile organic solvent) within the tray dryer headspace via a condenser (HX103) which is used to condense out potential VOC's present e.g. ethanol prior to venting the extracted nitrogen to atmosphere. The condensed VOC materials (e.g. ethanol) are collected into receiver tank T109 prior to being pumped to IBC's for collection as waste solvent. The level within T109 is monitored and has a dedicated high-level alarm to prevent overfill.

The dryer has its own standalone controller which ensures the following prior to commencement of the drying cycle:

- The trays have been loaded and dryer closed;
- Condenser HX103 cooling is enabled;
- Receiver T109 is empty.

The operator is required to undertake certain tasks during the process as alerted by the control system, and subject to the operating procedure.

Once the drying process is complete, the tray racks can be removed from the dryer for further processing.

Note that the tray dryers (TD101 and TD102) can each be used for either drying or activation, however coincident operation of both dryers solely for either drying or activation would not occur. For the purposes of this process description, it has been assumed that TD101 is being used for drying and TD102 for activation.

5.4.8 Solvent Exchange

Certain products will need to be processed through a solvent exchange system.

The dried product would be loaded into mesh baskets (around 8 – 10kg per basket) which are then loaded into individual solvent exchange vessels (V106 A – F) which are then sealed shut.

Ethanol is then pumped from the in-use IBC via heat exchanger HX106 which heats the ethanol to around 50°C and is then circulated through the solvent exchange vessels (which are connected in parallel). This is a closed loop system.

Heat is supplied via the closed loop hot water heating package (Z109).

The solvent exchange process has a local control system with operator interface and is connected into the BPCS.

The operator interface prompts the operator to undertake specific steps and confirm their completion prior to commencement of the process, and also provides similar prompts at the end of the processing time.

Once the process is complete, the ethanol within the solvent exchange vessels is allowed to cool to below 30°C and then drained back to the IBC.

Air is then blown through the vessels (via fan FN101) in order to remove excess ethanol from the product, the solvent laden air passes through a condenser (HX109) which is used to condense out the VOC's present e.g. ethanol prior to venting to atmosphere. The condenser is supplied with chilled water from the closed loop heating and cooling package.

The condensed VOC materials (e.g. ethanol) are collected into a waste ethanol IBC. The level within the waste ethanol IBC is monitored and has a dedicated high-level alarm to prevent overfill.

Once air has been blown through the product baskets for a predetermined duration, the vessels can then be opened and the product removed and placed back onto trays.

5.4.9 Activation

Trays of product may require activation which is undertaken in a Tray Dryer (TD102)

The trays of product are loaded into a tray rack and then placed into a tray dryer (TD102) which uses heat and vacuum to dry and activate the product.

Nitrogen is fed into the dryer at a pre-determined rate to provide inertisation of the atmosphere.

The dryer is electrically heated.

The vacuum is generated using a downstream vacuum pump (VP103). The vacuum pump draws the nitrogen (and any volatile organic solvent) within the tray dryer headspace via a condenser (HX104) which is used to condense out potential VOC's present e.g. ethanol prior to venting the extracted nitrogen to atmosphere. The condensed VOC materials (e.g. ethanol) are collected into receiver tank T110 prior to being pumped to IBC's for collection as waste solvent. The level within T110 is monitored and has a dedicated high-level alarm to prevent overfill.

The dryer has its own standalone controller which ensures the following prior to commencement of the drying cycle:

- The trays have been loaded and dryer closed;
- Condenser HX104 cooling is enabled;
- Receiver T110 is empty.

The operator is required to undertake certain tasks during the process as alerted by the control system, and subject to the operating procedure.

Once the drying process is complete, the tray racks are held within the dryer under a nitrogen sweep, until the packing equipment is ready to process it.

5.4.10 Packing

The product is packed using a dedicated packing machine (PM101) which has its own control system with operator interface.

5.4.11 Ancillary Systems

5.4.11.1 Heating / Cooling Systems

The site heating and cooling systems are made up of:

- The reactors heating / cooling package (Z102).
- The blender heating package (Z103)
- Hot water heating package (Z109)
- Chilled water package (Z104)

- Various thermal oil circulation loops and pipework.
- Pressurisation set, expansion tank and dosing pot.

The reactors heating / cooling package

Will provide either heating or cooling duty to the reactors via a closed loop heating fluid system. The system will be a recirculating thermal fluid system with heat exchangers connecting to the heating or cooling supplies. Heat will be provided by an electric heating unit, and cooling duty will be provided from the site chilled water system.

The system temperature will be controlled by the control loops linked to the reactor control systems.

Blender heating package

The blender heating package will be an electrically heated unit with a closed loop thermal fluid recirculation system. The system temperature will be controlled by the control loops linked to the blender control systems.

Hot Water Heating package

The hot water heating package will be a small natural gas fired boiler unit with a closed loop recirculating hot water system. The unit will be around 170kW net thermal input and therefore does not fall under the classification of medium combustion plant as it has a net thermal input of <1MWth.

This is the only combustion system on site and hence the installation is does not require an Environmental Permit for medium combustion plant.

Chilled Water System

Chilled water will be supplied via a packaged, air-cooled chiller system (Z104). This will have its own control system that will interface with the BPCS as required for start/stop, status, and fault reporting. The chilled water will be supplied via a closed loop system at 6°C.

The chiller unit will be located outside the front of the building.

The refrigerant within the chiller system will be 454B.

5.4.11.2 Clean in Place

The clean in place (CIP) system (Z108) will be used to internally clean the process equipment and comprises a CIP water storage tank, associated pumps, and pipework connections to the process units. The CIP system will be used to clean the reactors, the membrane filtration system and the decanter feed tank. All other units will be manually cleaned.

The CIP system will use water as the cleaning media, no chemicals are expected to be required for routine cleaning. There may be a very infrequent requirement to flush the system with a cleaning solution to remove limescale etc.

All waste from the CIP process will be collected into IBC’s for disposal offsite as waste.

5.4.11.3 Deionised Water System

The deionised water system will be a small lab scale unit (Z107) used to generate deionised water for use in the process.

The system will use replaceable ion exchange resins, expected to be in cartridge form, to process the water with spent cartridges being sent off site as waste for recycling / disposal.

Reject water from the deionised water system will be discharged to municipal sewer.

5.4.11.4 Softened Water System

The softened water system will be a small lab scale unit (Z108) used to generate softened water for use in the process. Softened water will be stored within an IBC.

5.4.11.5 Nitrogen System

Nitrogen is used throughout the process as an inerting gas, as well as to exclude oxygen for product quality reasons.

Nitrogen will be stored and supplied from multi-cylinder pallets (MCPs) via a main pressure regulator. Two MCPs will be connected via an auto-changeover manifold.

The nitrogen main will be controlled to as low a pressure as possible (no more than 2 barg) and will supply all user points.

The BPCS will monitor nitrogen pressure and alarm on low pressure, and will also notify operators when a multi-cylinder pallet is empty and requires replacement.

5.4.11.6 Compressed Air System

Compressed air is required for the centrifuge decanter operation and will be supplied from 2 cylinders. The cylinders will be connected via an auto-changeover manifold. When one cylinder becomes depleted, the system will automatically change to the other and an alarm will be raised on the BPCS to advise the operator that a cylinder requires replacement.

5.4.11.7 HVAC and LEV Systems

A Heating, Ventilation, and Air Conditioning (HVAC) system will be installed to provide a comfortable working environment for personnel, and to ensure that areas where flammable materials are handled there are sufficient air changes per hour to minimise potential hazardous / flammable atmospheres and associated hazardous area zoning for electrical equipment.

The HVAC will be controlled by a dedicated Building Management System (BMS). Operation will be completely automatic.

There will also be 2 Local Exhaust Ventilation (LEV) systems installed to provide personnel protection where exposure to potentially harmful vapours or dusts is considered possible.

These LEV systems are:

- The downflow booth for handling of powdered materials which is installed with multiple stage filtration (including HEPA) for particulate abatement (see Section 5.4.1) ; and
- An LEV located above the exit from the extruder – this will be installed with carbon filters to abate VOC’s if required.

The LEV systems will be controlled by the BMS and operation will be automatic. Visual indication will be provided at the LEV point of use to show the status of the LEV. These LEV systems will be installed with suitable abatement and the air will be recirculated into the main processing area – there will be no direct emission to atmosphere from these LEV systems.

6.0 Best Available Techniques

As the Installation activities are considered to fall under Section 4.1 Part A(1) of the EPR for the production of organic chemicals, the BAT Guidance listed in Table 7 is considered to apply:

Table 7: Applicable BAT Conclusions

EU BAT Conclusions	Applicability to the Installation Activites	Comments	Location of Assessment
OFC - Manufacture of Organic Fine Chemicals August 2006	Applicable	Section 4.1 Part A activity. Assessed against Sector Guidance Note IPPC S4.02 - Guidance for the Speciality Organic Chemicals Sector	Appendix E2 Table E1
CWW Common Wastewater and Waste Gas Treatment / Management in the Chemical Sector May 2016	Applicable	Section 4.1 Part A activity	Appendix E2 Table E2
WGC Common Waste Gas Management and Treatment Systems in the Chemical Sector December 2022	Applicable	Section 4.1 Part A activity	Appendix E2 Table E3

A detailed review of how the Installation will comply with each of the BAT requirements is presented in Appendix D.

7.0 Process Efficiency

The process is divided into a series of batch processing stages each of which can be operated as an independent unit activity.

Whilst the plant will be used for small scale production, it is also intended to be a pilot plant for scale up from laboratory scale product development and is intended to be used to allow further refinement of the processes undertaken to improve and optimise process yield and overall production efficiencies as part of the site operations.

Given the purpose of the site operations, batch processing is preferable to continuous operation at this time.

The processing activities will be undertaken subject to the use of product 'recipe's' which will have specific operating procedures for operator interaction with the process, and be programmed into the control systems, to minimise potential for off-specification batches or processing errors.

Quality assurance testing will be an integrated aspect of the production processes to monitor product quality particularly when refinements in the processes have been made.

8.0 Energy

The site has not entered into a Climate Change Levy Agreement.

8.1 Predicted Energy Use and Greenhouse Gas Emissions

The specific energy usage by the Installation will vary significantly based upon a number of factors including:

- The number of process stages operating;
- The duration of each process stage;
- The target plant throughput;
- The number of operational hours; and
- The product being produced.

It is not therefore possible at this stage to advise exactly what the actual likely power usage at the site will be, and this will be reviewed as the process design progresses, and again on commissioning and initial operations.

The electrical supply into the Installation is limited to 355kW with a power factor of 1. However, the plant could not operate at this level without constantly tripping the supply, so it is estimated that the maximum electrical usage will be limited by design to around 266 kW i.e. 75% of capacity.

There is only one gas user at the site which is the hot water boiler which is rated at around 170kW.

Table 8 presents a calculation of the maximum theoretical energy usage assuming all plant is operating continuously 24 hours per day 7 days per week. – this is not considered to represent a likely operating scenario, but has been provided to give an indication of the theoretical upper envelope of energy use at the site

Table 8: Indicative Energy Usage – Maximum Possible Usage

Energy Source	Estimated kWh per Year	Conversion Factor (1)	CO_2 Equivalent kg
Electricity	2,330,160	0.22535	525,102
Gas	1,489,200	0.20264	301,771
Total			**826,873**

Notes: 1) CO_2 conversion factors taken from UK Government GHG Conversion Factors for GHG Reporting 2024 Greenhouse gas reporting: conversion factors 2024 - GOV.UK :

- 0.20264 kg CO_2e / kWh natural gas,
- 0.20705 kg CO2e / kWh grid electricity generated; plus
- 0.01830 kg CO2e / kWh grid electricity transmission and distribution losses

Table 9 presents a calculation of the more likely theoretical energy usage at the site in the initial phase of operation assuming that the plant operates 5 days per week and for 8 hours per day with up to 50% of the process plant operating at any one time, and the gas boiler only operating at 50% load.

Table 9: Indicative Energy Usage – Estimated Likely Annual Usage

Energy Source	Estimated kWh per Year	Conversion Factor (1)	CO_2 Equivalent kg
Electricity	388,360	0.22535	87,517
Gas	248,200	0.20264	50,295
Total			**137,812**

8.2 Energy Efficiency

Energy efficiency will be managed as part of the EMS and energy usage and reduction will be reviewed periodically.

The following basic energy control measures have also been considered as part of the development of the plant design:

- The process is divided into a series of processing stages each of which can be operated as an independent unit activity, all processing is on a batchwise basis which means that processing units and their associated emissions abatement units that are not in use can be switched off until they are next needed.
- The process reactions have been developed to operate at relatively low temperatures, hence minimising energy demand.
- All initial phase separation processes e.g. dewatering/concentration steps are mechanical/membrane based as far as possible to minimise energy demand.
- The main processing is undertaken in an internal process room which has its own dedicated HVAC / LEV system to maintain the air quality within the processing area. The use of this smaller processing area means that the HVAC / LEV system can be significantly smaller than would be required if the whole building was used for processing hence reducing energy usage.
- The HVAC system will also have a control system such that it will be shut off when not in use.
- The design will specify energy efficient pumps and drives where possible.
- Internal building lighting will be energy efficient.

9.0 Emissions

9.1 Emissions to Air

The point source emission points to air from the process activities are summarised in Table 10.

The exact locations of the emissions points are still to be finalised, but all emission points to air will be routed to the northwestern side of the building and grouped adjacent to each other. The approximate grid reference for all emission points will be TL 48977 50400.

An indicative elevation plan showing the proposed emission points is presented in Appendix A – Figure 4.

The vents will be installed to be 3m above the highest part of the building roof.

In addition to the point source emission points listed in Table 10, the main processing area will be installed with an HVAC / LEV system to provide a suitable number of air changes per hour to maintain the air quality within the processing area. This LEV system will vent to atmosphere via a roof mounted vent – the location of which is yet to be specified. The vented air is not expected to contain any significant concentrations of VOC or other materials, as all main process vents have their own emission points.

Also, in addition to the point source emission points listed in Table 10 there will be 2 LEV systems installed which will provide local area ventilation at key points within the process. These LEV systems will be installed with suitable abatement and the air will be recirculated into the main processing area – there will be no direct emission to atmosphere from these LEV systems.

These LEV systems are:

- The downflow booth for handling of powdered materials which is installed with Multiple stage filtration (including HEPA) for particulate abatement (see Section 5.4.1) ; and
- An LEV located above the exit from the extruder – this will be installed with carbon filters to abate VOC's if required.

Table 10: Point Source Emissions to Air

Emission Point Number	Process Stage	Source of Emissions	Abatement Provided	Vent Contents	Vent Diameter
A1	Reaction	Reactor 101 Breather vent from reactor for filling and heating displacement losses	Emission from process reactor via water cooled guard condenser HX101	Nitrogen Process Solvent /VOC	50mm
A2	Reaction	Reactor 102 Breather vent from reactor for filling and heating displacement losses	Emission from process reactor via water cooled guard condenser HX105	Nitrogen Process Solvent /VOC	50mm

Emission Point Number	Process Stage	Source of Emissions	Abatement Provided	Vent Contents	Vent Diameter
A3	Washing And Concentration	Dewatering buffer tank T104 Breather vent for displacement losses	No Abatement	Nitrogen Process Solvent /VOC	50mm
A4	Concentration	Blender Vent from vacuum pump which draws nitrogen and solvent from the blender headspace through the condenser into tank T108 and from there to atmosphere	Condenser HX102 on flow into tank T108	Nitrogen Process Solvent /VOC	40mm
A5	Drying or Activation	Emission from product tray dryer Vent from vacuum pump which draws nitrogen and solvent from the dryer through the condenser into tank T109 and from there to atmosphere	Condenser HX103 on flow into tank T109	Nitrogen Process Solvent /VOC	40mm
A6	Activation or Drying	Product tray dryer Vent from vacuum pump which draws nitrogen and solvent from the dryer through the condenser into tank T110 and from there to atmosphere	Condenser HX104 on flow into tank T110	Nitrogen Process Solvent /VOC	40mm
A7	Solvent Exchange	Air flow through solvent exchange vessels at end of processing to remove excess solvent (ethanol) from the product	Condenser HX109	Air Ethanol	65mm

Note that the tray dryers that discharge via emission points A5 and A6 can each be used for either drying or activation, however coincident operation of both dryers solely for either drying or activation would not occur. For the purposes of this description of the process emissions, and the associated Air Emissions Risk Assessment, it has been assumed that A5 is being used for drying and A6 for activation.

9.1.1 Predicted Emissions

Table 11 presents a summary of the predicted emissions to air from each if the point source emission points.

The initial estimates of emissions from the process are based upon the theoretical data currently available on site and are based on the assumption that all VOC present in the gaseous phase will be at the vapour phase saturation point, so these calculations are considered to present an over-estimate of the actual emissions that will be experienced.

These calculations will be refined during the ongoing detailed design process for the plant and it is intended that all emission points will achieve total VOC emissions below 100gC/h.

Note that some of the solvents used in the process (e.g. water) are not VOC materials, and hence when these solvents are utilised within the process there will be no emission of VOC's to air. The following sections have been prepared to reflect the theoretical maximum VOC emissions to air from the processes when utilising volatile organic solvents.

The data presented in Table 11 includes currently calculated theoretical maximum emission data for VOC's for emission points A1 – A4, and design target emissions data for emission points A5 – A7. It should be noted that each of the process stages can be operated as an independent unit operation, and as such it is unlikely that all emission points would be venting co-incidentally.

Table 11: Predicted Emissions To Air

Emission Point Number	Process Stage	Flowrate and Duration	Pollutant Species	Predicted Maximum Mass Emission Level
A1	Reaction Reactor 1	Filling and heating displacement losses <2 m^3/h when filling Filling occurs for around 6 mins per batch Otherwise very little venting	Total VOC as Ethanol Acetic Acid	<5 g/h as carbon 7.8 g/h 0.195 g/h
A2	Reaction Reactor 2	Filling and heating displacement losses <2 m^3/h when filling Filling occurs for around 6 mins per batch Otherwise very little venting	Total VOC as Ethanol Acetic Acid	<5 g/h as carbon <8 g/h <0.2 g/h
A3	Washing And Concentration Dewatering Buffer Tank	Filling displacement losses 1 m^3/h when filling, filling occurs for around 45 mins per batch (750 litre capacity vessel)	Total VOC as Ethanol Acetic Acid	<15 g/h as carbon <20 g/h <1.5 g/h
A4	Concentration Blender	Vacuum Pump Vent 4 m^3/hour Running for around 4 hours per batch	Total VOC as Ethanol Acetic Acid	<85 g/h as carbon <154.16 g/h <4 g/h
A5	Drying Tray Dryer	Vacuum Pump Vent 2.3 m^3/hour Running for around 8 hours per batch	Total VOC as Ethanol Acetic Acid	<100 g/h as carbon <190 g/h <2g/h
A6	Activation Tray Dryer	Vacuum Pump Vent 3.4 m^3/hour Running for around 8 hours per batch	Total VOC as Ethanol	<100 g/h as carbon <192 g/h

Emission Point Number	Process Stage	Flowrate and Duration	Pollutant Species	Predicted Maximum Mass Emission Level
A7	Solvent Exchange	Fan 114 m^3/hour Running for around 30 mins per batch	Total VOC as Ethanol Acetic Acid	<100 g/h as carbon <182 g/h <12.5 g/h

9.1.2 Emissions Abatement

The emissions abatement units for each of the point source emissions to air are still undergoing detailed design and will be subject to further review and refinement as the design process continues.

The emissions from emission points A1 – A3 are expected to have relatively low mass emissions of the process solvent and will all be well below a total VOC emission rate of 100gC /hour with the abatement provisions proposed.

- Emission points A1 and A2 are installed with chilled water-cooled condensers to recover process solvent (ethanol).
- Emissions from emission point A3 are very low in VOC and do not require installation of a condenser to achieve the desired target emissions.

The emissions from emission points A4 – A7 each have the theoretical potential to lead to emissions of total VOC in excess of 100gC/hour. However, this will be reviewed during detailed design, and appropriate abatement measures implemented to ensure that the total VOC emissions from each of the emission points does not exceed 100gC/hour.

- Emission point A4 is proposed to be installed with a chilled water-cooled condenser and is expected to achieve compliance with the desired target emissions of <100 gC/hour, however options will be reviewed during detailed design to further optimise the VOC recovery.
- Emission points A5 and A6 (the dryer vents) will each be installed with a chilled water-cooled condenser, but theoretical calculations indicate that there is the potential to exceed the 100gC/hour threshold. This will be reviewed during detailed design to further optimise the VOC recovery and ensure compliance with the 100gC /hour limit.

  If required, additional options that may be considered for the tray dryers include :

  - There will be space and capability to add an additional VOC abatement stage (e.g. a cold trap-style abatement unit) after the condenser if necessary.
  - Procedural controls may also be used to reduce the rate of VOC release e.g.
    - Using a more gradual temperature increase on the dryers to reduce the initial peak in VOC emissions;
    - Reducing batch size in the dryer to reduce the quantity of VOC present.
- Emission point A7 is linked to the solvent exchange process. This process is in the early stages of design, and initial theoretical calculations indicate that there is the potential to exceed the 100gC/hour threshold. However, it is noted that the theoretical calculations have assumed that all VOC present will be in the vapour

phase, whereas in reality much of it will be present in liquid form as entrained droplets. This is considered to represent a significant overestimate of the actual emissions of VOC to air. The proposed 'condenser' has actually been designed to operate as a combined knock-out pot and condenser and so will remove all entrained VOC droplets as well as providing the cooling and condensing duty.

The emissions from A7 will be reviewed during detailed design to refine the VOC emission calculations and also optimise the VOC recovery and ensure compliance with the 100gC /hour limit.

If required, additional options that may be considered for the solvent exchange venting system include :

- There will be space and capability to add an additional VOC abatement stage (e.g. a cold trap-style abatement unit) after the condenser if necessary.
- Procedural controls may also be used to reduce the rate of VOC release e.g.
  - The current calculations are based venting 3 solvent exchange vessels at a time, this could be reduced, or a sequential approach to venting applied to reduce the mass emission rate of VOC.
  - The time allowed for liquid ethanol to drain out of the solvent exchange vessels prior to starting the venting process could be extended to allow more ethanol to be removed by this route.

Immaterial proposes to provide the Environment Agency with an update report on the proposed VOC abatement system designs to confirm exactly what techniques are being applied, and also provide suitable calculations to demonstrate that they will all achieve total VOC emissions below 100gC/hour. This report will be submitted to the EA prior to commencement of plant commissioning, and it is requested that this be included as a pre-operational condition within the permit.

9.1.3 BAT- AEL Compliance for Emissions to Air.

Emissions of VOC via the various plant emission points would be required to meet the BAT-Associated Emission Limit (AEL) for each of the substances released where the mass emission rate exceeds the defined thresholds at which the BAT-AEL would apply.

As shown by Tables 11 and 12, it is anticipated that emissions of Total VOC from each emission point will be below 100gC/hour, and hence the BAT-AEL for Total VOC will not apply.

There are not proposed to be any emissions of CMR substances or particulate dusts from emission points A1 -A7.

Table 12: Applicability of BAT-AEL's

VOC Classification	BAT AEL Range	Notes	Applicability
Total Volatile Organic Carbon (TVOC) (VOC substances that do not have a Carcinogenic, Mutagenic, Reprotoxic (CMR) classification)	<1 – 20 mgC/Nm^3 Limit is applied as a daily average, or average over the sampling period. Note that TVOC is expressed in mgC/Nm^3.	This limit does not apply to minor emissions i.e. where the TVOC mass flow is below e.g. 100 g C/hour – where no CMR substances are present in the waste gas stream.	Not Applicable All emission points will have TVOC emissions <100gC/hour.
Where VOC's classified as CMR substances are present, the following limits would apply to those substances			
Sum of VOC's Classified as CMR1A or 1B	<1 – 5 mg/Nm^3 Limit is applied as a daily average, or average over the sampling period.	This limit does not apply to minor emissions i.e. where the mass flow of the sum of the VOC's classified as CMR1A or 1B is below 1g/hour	Not applicable No CMR 1A or 1B VOC's present
Sum of VOC's Classified as CMR2	<1 – 10 mg/Nm^3 Limit is applied as a daily average, or average over the sampling period.	This limit does not apply to minor emissions i.e. where the mass flow of the sum of the VOC's classified as CMR1A or 1B is below 50g/hour	Not applicable No CMR 2 VOC's present
Particulate / Dust	<1 – 5 mg/Nm^3	This limit does not apply to minor emissions i.e. where the dust mass flow is below e.g. 50 g C/hour – where no CMR substances are present in the waste gas stream.	Not applicable No emission to air from processes handling potentially dusty materials.

9.1.4 Monitoring

The proposed monitoring of emissions from the plant will be undertaken in compliance with the requirements of:

- EU BAT Reference Document – Monitoring of Emissions to Air and Water from Industrial Emissions Directive Installations (ROM)- July 2008.
- Environment Agency Monitoring Stack Emissions: Environmental Permits (19 December 2019) (the formerly the EA's M1 and M5 guidance notes).
- BS EN 15259.

This will include provision of suitable access routes and platforms as required and the siting and installation of suitable sample ports.

Prior to undertaking stack emissions monitoring a Site-Specific Protocol (SSP) will be prepared to ensure the monitoring is carried out in accordance with the EA guidance, referenced note outlined above, to ensure that representative samples are taken. Specifically, the SSP will consider the following aspects:

- Selection of the sampling position, sampling plan and sampling points.
- Access, facilities and services required.
- Safety considerations.

The SSP will ensure that a representative sample is obtained from the stack.

The sampling approach, technique, method, and equipment that are chosen will ensure:

- A safe means of access to the sampling position.
- A means of entry for sampling equipment into the stack.
- Adequate space for the equipment and personnel.
- Provision of essential services such as electricity.

Monitoring will be undertaken by an appropriately accredited third-party stack monitoring company, in compliance with the requirements of MCERTS as a minimum standard.

All of the emission points are anticipated to have VOC emission levels of below 100g of Total VOC as carbon per hour. And so continuous monitoring of emissions is not required.

Periodic monitoring of Total VOC emission is proposed for Emission Points A1 – A7.

It is proposed that periodic monitoring will be undertaken at least once every 6 months for the first year of operation to confirm the emission levels.

The minimum monitoring frequency will then be reduced to once every 3 years if the emission levels are proven to be <100gCarbon/hour.

Monitoring will be planned to align with the operation of each of the process unit operations to ensure that representative data is collated.

Table 13 presents a summary of the proposed monitoring of emissions to air.

Table 13: Proposed Monitoring of Emissions to Air

Substance	Monitoring Required	Frequency Of Monitoring	Monitoring Test Method (Periodic Monitoring)	Data to be Reported
Total Volatile Organic Compounds (TVOC)	Emission Points A1 – A7 The predicted mass emissions of TVOC from all of the emission points will be <1kg/h per emission point. There is no requirement for	Periodic monitoring will be undertaken at least once every 6 months for the first year of operation to confirm the emission levels. The minimum monitoring frequency will then be reduced	EN 12619 extractive sampling and FID analyser. or EN ISO 13199. extractive sampling and a NDIR analyser equipped with a catalytic converter for the	Daily Average / Average over the monitoring period.

Substance	Monitoring Required	Frequency Of Monitoring	Monitoring Test Method (Periodic Monitoring)	Data to be Reported
	continuous monitoring of any of the emission points, and periodic monitoring is therefore proposed.	to once every 3 years if the emission levels from each vent are demonstrated to be <100gC/hour.	oxidation of VOCs to carbon dioxide.	

9.2 Emissions to Water and Sewer

9.2.1 Emissions to Controlled Waters

There are no direct emissions to controlled waters from the Installation.

9.2.2 Emissions to Sewer

There will be no discharge of effluents directly generated by the main process activities to sewer. All process effluent and waste liquids / solutions will be collected into IBC's for disposal offsite as waste or for recycling where possible.

There will however be the following discharges into the municipal sewer from the Installation

- General site sewage from staff welfare facilities e.g. toilets / sinks etc.
- Reject water from the site water deionisation unit.

None of these discharges to sewer will contain potential environmental pollutants.

A site drainage plan is presented in Appendix A – Figure 6.

9.3 Waste

9.3.1 Waste Handling and Disposal

Waste materials from the process will be collected into suitable containers e.g. drums / IBC's etc. within the main processing area within the building and over impermeable concrete flooring.

Waste containers which contain non-flammable materials will be stored within the building in a dedicated storage area

Waste containers containing flammable materials e.g. waste solvent will be stored within the dedicated secure flammable materials storage unit which incorporates integral bunding and will be located outside the front wall of the building. See Sections 5.2 and 5.3 for further details on the siting of this unit.

All liquid waste materials will be stored over appropriately bunded areas either in the form of portable bunds, dedicated bunded storage cabinets or similar.

Waste collection, handling and storage will all be subject to management procedural controls as defined under the Environmental Management System.

All wastes generated by the site activities will be removed from site by appropriate waste contractors for offsite recovery / recycling / treatment / disposal.

The routes for waste removal will be selected in line with the waste hierarchy to maximise reuse / recycling and minimise disposal.

9.3.2 Waste Minimisation and Resource Efficiency

The installation is being designed to operate as a pilot scale processing facility. The activities proposed to be undertaken at the Installation will be used to undertake and optimise scale up from laboratory scale testing and will also be used to gather Intellectual Property to enable the commercialisation of the proprietary process technologies and products.

Hence as part of the scale up activities, there will inevitably be a need to incorporate yield optimisation and waste minimisation considerations in optimising the production processes.

10.0 Environmental Risk Assessment

10.1 Air Emissions Risk Assessment

An air emissions risk assessment has been undertaken and is presented in Appendix E.

10.2 Water Emissions Risk Assessment

As there are no process effluent emissions either direct to controlled waters or to sewer, and the proposed discharges of water to sewer will not contain any potential environmental pollutants, a surface water pollution risk assessment has not been prepared as part of this application.

10.3 Noise Impact Assessment

A noise baseline and impact assessment has been undertaken and is presented in Appendix F.

10.4 Odour

As the installation is not expected to handle particularly odorous raw materials. A detailed odour impact assessment has not been prepared as part of this application.

The reactions undertaken by the process may generate acetic acid which would be emitted to air from the process. Details of the anticipated acetic acid emissions are detailed in the Air Emissions Risk Assessment (Appendix E). Qualitative assessment of the potential odour impacts associated with the emissions of acetic acid are presented in Section 4.3 of the Qualitative Environmental Risk Assessment (Appendix G).

A detailed quantitative odour impact assessment has not been prepared as part of this application.

10.5 Soil and Groundwater Pollution Risk Assessment

The Soil and Groundwater Pollution Risk Assessment is included within the Site Condition report presented in Appendix B.

10.6 Qualitative Environmental Risk Assessment

A qualitative environmental risk assessment of other potential risks has been undertaken and is presented in Appendix G.

11.0 Management Systems

As the Installation is still in the design phase, all of the site operational aspects have yet to be prepared including:

- Development of the overall site management systems including the Environmental Management System (EMS);
- Development of specific operating manuals and operating procedures;
- Development of inspection and maintenance routines and scheduling;
- Development of data monitoring and reporting plans; and
- Staff training.

All of the above design and operational management aspects will be in place prior to commencement of operation.

The EMS will be prepared in accordance with the requirements of ISO14001, and it is envisaged that Immaterial may seek to get the system formally accredited and certified to the standard at the earliest appropriate time.

The management system will include protocols to implement the compliance requirements of the Environmental Permit and to ensure that the required assessments and reporting are undertaken.

The EMS will be developed in alignment with the Environment Agency guidance on 'Develop a management system: environmental permits' and to incorporate all the requirements of BATC 1 of the CWW and WGC BREF Notes as well as Section 1 of the EA Indicative BAT Guidance for the Production of Speciality Organic Chemicals Sector (EPR 4.02) – See Section 6 and Appendix D.

The EMS will include details on:

- Management structure and staff roles and responsibilities;
- Key operating procedures;
- Preventative inspection and maintenance;
- Emissions monitoring and reporting;
- Performance and efficiency monitoring and reporting;
- Competence and training;
- Accidents, incidents and Non-conformance – prevention, incident response etc.;
- Auditing;
- Reporting; and
- Record keeping.

The management systems will be applied to the commissioning and operational phases of the site activities.

In addition to the above aspects the EMS will also incorporate the requirements for the development of a climate change risk assessment and adaptation planning in line with the current EA Guidance[2].

12.0 Site Closure

A site closure plan to cover the management of the cessation of operations and decommissioning of the site activities and removal of pollution risk to allow permit surrender will be maintained at the site and updated periodically.

[2] Guidance - Climate change: risk assessment and adaptation planning in your management system https://www.gov.uk/guidance/climate-change-risk-assessment-and-adaptation-planning-in-your-management-system#why-you-need-to-plan-for-climate-change-impacts

Appendix A Figures

Environmental Permit Application – Supporting Documentation

Sawston Pilot Plant

Immaterial Limited

SLR Project No.: 405.065240.00001

5 December 2024

Figure 1 – Site Location

Figure 2 – Installation Boundary

Figure 3 – Site Building Internal Layout

Figure 4 – Elevation View of Location of Emission Points to Air

Figure 5 – Designated Sites and Habitats Within 2km

Figure 6 – Site Drainage Plan

Appendix B   Site Condition Report

Environmental Permit Application – Supporting Documentation

Sawston Pilot Plant

Immaterial Limited

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Appendix B1 - Desktop Site Condition Report

Appendix B2 – Landmark Envirocheck Report

Appendix B3 – Historical Phase 2 Assessment Report

B3-1 – MLM Phase 2 Report 2007

B3-2 – MLM Phase 2 Supplementary Report 2008

B3-3 – MLM Phase 2 Report 2017

B3-4 – MLM Overall Redevelopment Site Remediation Strategy and Verification Plan 2017

B3-5 – Summary Soil and Groundwater Data – Excel Spreadsheet

B3-6 – Updated Figures

Figure B3-1 - MLM 2007 - Exploratory Hole Location Plan and Location of Historical Potential Sources of Contamination

Figure B3-2 - MLM 2007 - Foundation and Gas Mitigation Plan

Figure B3-3 - MLM 2008 - Exploratory Hole Location Plan

Figure B3-4 - MLM 2008 - Hydrocarbon Hot Spot Location

Figure B3-5 - MLM 2017 - Exploratory Hole Location Plan

Appendix B4 – Soil and Groundwater Pollution Risk Assessment

Appendix C Process Information

Environmental Permit Application – Supporting Documentation

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Appendix C1 – Process Flow Diagram

Appendix D BAT Assessment

Environmental Permit Application – Supporting Documentation

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Appendix D1 – BAT Conclusion Compliance Assessment

Appendix E Air Emissions Risk Assessment

Environmental Permit Application – Supporting Documentation

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Appendix E1 – Air Emissions Risk Assessment

Appendix F Noise Impact Assessment

Environmental Permit Application – Supporting Documentation

Sawston Pilot Plant

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SLR Project No.: 405.065240.00001

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Appendix F1 – Noise Impact Assessment

Appendix G Qualitative Environmental Risk Assessment

Environmental Permit Application – Supporting Documentation

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Appendix G1 – Qualitative Environmental Risk Assessment

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