ROYSTON SITE ENVIRONMENTAL PERMIT VARIATION APPLICATION

Best Available Techniques & Operating Techniques

Prepared for: Johnson Matthey PLC

SLR Ref: 416.063922.00001
Version No: 3
February 2024

BASIS OF REPORT

This document has been prepared by SLR with reasonable skill, care and diligence, and taking account of the manpower, timescales and resources devoted to it by agreement with Johnson Matthey PLC (the Client) as part or all of the services it has been appointed by the Client to carry out. It is subject to the terms and conditions of that appointment.

SLR shall not be liable for the use of or reliance on any information, advice, recommendations and opinions in this document for any purpose by any person other than the Client. Reliance may be granted to a third party only in the event that SLR and the third party have executed a reliance agreement or collateral warranty.

Information reported herein may be based on the interpretation of public domain data collected by SLR, and/or information supplied by the Client and/or its other advisors and associates. These data have been accepted in good faith as being accurate and valid.

The copyright and intellectual property in all drawings, reports, specifications, bills of quantities, calculations and other information set out in this report remain vested in SLR unless the terms of appointment state otherwise.

This document may contain information of a specialised and/or highly technical nature and the Client is advised to seek clarification on any elements which may be unclear to it.

Information, advice, recommendations and opinions in this document should only be relied upon in the context of the whole document and any documents referenced explicitly herein and should then only be used within the context of the appointment.

CONTENTS

DOCUMENT REFERENCES

TABLES

FIGURES

APPENDICES

1.0 Introduction

SLR Consulting Ltd (SLR) has been instructed by Johnson Matthey PLC (JM) to prepare an application for a variation to the Environmental Permit (Ref: EPR/BT7086IJ) (the 'EP') for their Royston Site located at Orchard Road, Royston, Hertfordshire, SG8 5HE (the Site).

This Best Available Techniques and Operating Techniques (BATOT) report describes the proposed changes to the existing operations at the Site, the operating techniques that will be used to carry them out and the measures that will be in place to demonstrate that the activities comply with Best Available Techniques.

1.1 The Site

The Royston Site operates under a multi-activity installation environmental permit. The Site is currently permitted to operate a variety of diverse and complex activities mainly involving the refining of precious metals, development of speciality chemicals and subsequent processing into a diverse range of products. The existing operations include autocatalyst and process catalyst manufacture, precious metal refining and fabrication, chemical production and engine/auto catalyst test facilities.

The main production activities consist of the following business units: Clean Air Operations (CAO)), Refining & Chemicals Europe (R&CE), Noble Metals and Silver Coating Technologies (SCT)

Smaller-scale activities at the site include the Research and Development, Autocatalyst Testing and Metal Joining operational units.

There are also a number of ancillary operations which are generally operated on a site-wide basis and shared by more than one operational unit. These include the Site Effluent Treatment Plant (ETP), Dispensing and Packing, Boiler House, Analytical Laboratories, Engineering, Main Stores, and Combined Heat and Power plant.

The site is located in the north-western part of Royston, within the A505 Royston bypass. A number of residential, commercial and agricultural receptors are located in close proximity to the site. In addition, two SSSIs and several other conservation sites lie within 2km of the site boundary.

1.2 Summary of Proposed Changes

JM are developing a new hydrogen fuel cell manufacturing facility at the Royston Site as part of the company's pledge to invest ca. £1 billion in the research, development and deployment of clean hydrogen technologies by 2030. This will require a variation to the existing EP to include the following changes:

1	Project Apollo	Production of coated membrane with Platinum Group Metals (PGM) (platinum). 2 Directly Associated Activities (DAA) – analytical laboratory and dispensing and packaging.
2	Hydrogen Technology Test Facility	Installation of a Test Stand facility including four Single Cell Test Stands for testing individual fuel cells up to 0.5kW output, and three larger Short Stack Test Stands for testing stacked fuel cells up to 12kW output.
3	Boiler Replacement	Replacement of three existing site boilers with three new boilers of a more efficient specification.

1.3 Regulation of the Activities

1.3.1 Installation activities

Following pre-application advice from the EA is has been confirmed that Project Apollo will be regulated as listed activities under Schedule 1 of the Environmental Permitting (England & Wales) Regulations 2016 (as amended) as follows:

Section 4.2 Inorganic Chemicals Part A(1) (c) any manufacturing facility involving the use of, or the use and recovery of, any compound of any of the following metals (viii) platinum.

And

Section 6.4 Coating activities, printing and textile treatments Part B (a) any process (other than for the re-painting or re-spraying of, or of parts of, aircraft or road or railway vehicles) for applying to a substrate, or drying or curing after such application, printing ink or paint or any other coating material as, or in the course of, a manufacturing activity, where the process may result in the release into the air of particulate matter or of any volatile organic compound and is likely to involve the use in any 12-month period of (i) 20 or more tonnes of printing ink, paint or other coating material which is applied in solid form.

1.3.2 Directly Associated Activities

The following activities will be regulated as directly associated activities (DAA):

- Hydrogen Technology Test Facility.
- Boiler replacement.

1.4 Key Technical Standards

The key technical standards that will apply to the proposed changes at the site are:

- Production of Speciality Inorganic Chemicals Best Available Techniques Reference document (Bref), published August 2007, European IPPC Bureau;
- Common Waste Gas Management and Treatment Systems in the Chemical Sector Bref, final draft published March 2022, European IPPC Bureau;
- Energy Efficiency Best Available Techniques Reference document (Bref), published February 2009, European IPPC Bureau,
- Medium Combustion Plant Directive, 2015 (MCPD) (EU/2015/2193);
- Additional Guidance for the Inorganic Chemicals Sector EPR 4.03, published March 2009, Environment Agency;
- Risk assessments for your environmental permit, last updated 1 April 2022, Environment Agency, gov.uk;
- Control and monitor emissions for your environmental permit, last updated 17 May 2021, Environment Agency, gov.uk; and
- Develop a management system: environmental permits, last updated 4 August 2021, Environment Agency, gov.uk.

1.5 Structure of this report

The Site has an existing Environmental Management System (EMS), and the systems and procedures will be extended to cover all of the proposed new activities. The management of the activities as a whole is described in Section 2 of this report.

The description of operating techniques and BAT / appropriate measures assessments are presented in separate sections for each of the proposed activities as follows:

Section 3 – Project Apollo;

Section 4 – Hydrogen Technology Test Facility; and

Section 5 – Boiler Replacement

Where the new activity makes no change to existing techniques, infrastructure or procedures already permitted, this will be confirmed rather than including information which has already been submitted to the EA as part of previous applications.

1.6 Drawings

This BATOT is supported by the following Drawings:

- 416.063922.00001_001 Site Location Plan
- 416.063922.00001_002 Environmental Permit Boundary & Site Layout
- 416.063922.00001_003 Site Setting & Receptors
- 416.063922.00001_004 Cultural and Natural Receptors

2.0 Management of the Activities

2.1 Management Systems

The separate parts of the proposed variation will be managed by different departments of the JM management system:

- Project Apollo and Hydrogen Technology Test Facility (Hydrogen Technology).
- Boilerhouse (PGMS).

Each JM business sector operates an environmental management system in accordance with ISO14001 (certification held since 1998). Each business sector will also be operated in accordance with ISO 9001 (Business Management System, certification held since 1995) and ISO 45001 (Occupational Health and Safety Management Systems, original ISO 18001 certification held since 2007). These systems will be extended to cover the operation of the new facilities from start-up. New documented procedures will be introduced with full training provided for operators.

Environmental Management System manual (JMC 700 001) gives an overview of how the Environmental Management System works and outlines key requirements including roles and responsibilities for the Hydrogen Technology Department.

The Environmental Management System Scope document (JMC 700 000) defines the activities and the boundaries of scope for R&CE. The Environmental Management System Manual document (EHSMSP 107) defines the activities and the boundaries of scope for CAO.

The management system will ensure that:

- the risks that the activities pose to the environment are identified;
- the measures that are required to minimise the risks are identified;
- the activities are managed in accordance with the management system;
- performance against the management system is audited at regular intervals; and
- the site's environmental permit is complied with.

The management system is reviewed at least once every four years or in response to significant changes to the activities, accidents or non-compliance. The management system will be supplemented by this BATOT document which outlines the proposed changes to the operating techniques at the Site and demonstrates conformance with the requirements of EA guidance.

Copies of JM's existing EMS manual (Reference JMC 700 001 issue 12) and EMS Scope (reference JMC 700 000 issue 6) are presented in Appendix 01 and 02, respectively. These documents will be updated to incorporate the new installation activities and directly associated activities.

2.2 Monitoring, Measuring and Reviewing Environmental Performance

Environmental performance will be monitored, benchmarked and regularly reviewed.

Annual KPI data similar to the current KPIs for the EP will be collated. Changes to KPI will include additional raw material usage and utilities usage.

All environmental improvement plans are incorporated into departmental improvement plans which are followed, monitored, updated and progress reported to senior management at regular EHS management reviews. Departmental improvement plans are reviewed annually, and new targets may be added.

2.2.1 Accident Management

Accident management at the site comprises the following procedures which will be updated to incorporate the new activities:

- EHSMSP 105 Emergency Preparedness and Response.
- EHSMSP 111 Accident and Incident Investigation.

The above procedures will be reviewed every three years as a minimum, and after any reportable incident on Site. The documents will be continually improved in these reviews to include best practice and minimise the risk of accidents occurring.

A qualitative assessment of the risk of accidents, their consequences and risk mitigation is provided for the Apollo activities within the Environmental Risk Assessment (416.063922.00001_ERA). (It is considered that the HTTF and replacement of the boilers will not make a significant change to accident risks at the site.) JM will also carry out detailed Hazard and Operability (HAZOP) Risk Assessments for the Apollo activities to inform the specific operating procedures for minimising the potential causes and consequences of accidents.

The site is an upper-tier COMAH site, so in addition to the above, a Major Accident Prevention Policy will be in place at the site.

3.0 Project Apollo

3.1 Project Description

JM proposes to use the existing building CSF2 at the Royston site be the location for the production of up to 300,000m^2/year of rolled Catalyst Coated Membrane (CCM), for use in fuel cell production. This is achieved by the application of ionomer and inks containing cathode catalyst and anode catalyst onto a membrane. CCM is formed from multiple process stages. Each stage commences with the unrolling of the membrane and ends when the membrane is rolled prior to transportation to the next stage. The sequence of stages is:

- Ionomer is coated onto the membrane in three passes. The ink is coated using a slot die process, and the coating head is in a Clean Room. This is to protect the product from particulates as the coating layer is only approximately 10microns thick. The ionomer mix comprises ethanol, water and ionomer powder.
- The ionomer coated membrane is then heat treated.
- The ionomer coated membrane is slitted to control the membrane's width.
- The cathode catalyst is coated onto the membrane in a single pass whilst the backing is still in place.
- The cathode coated membrane is slitted to control the membrane's width. The resultant membrane is divided into three rolls, approximately one third of the original width.
- The backing is removed, and the other side of the membrane is coated with the anode material in a single pass approximately 10microns thick. The humidity needs to be controlled as the membrane is susceptible to dimensional instability caused by moisture changes when the backing has been removed.
- When the membrane is dried in the dryer sections of the Coating machines the Volatile Organic Compound (VOC) (Ethanol and Propanol) fumes that are generated will be treated in the VOC abatement unit (regenerative thermal oxidiser).

3.1.1 Detailed Process Description

A process flow diagram is provided in Figure 3-1. Specific detail on the ionomer membrane coating and cathode and anode coating lines is presented below.

- Membrane Coating Line

The membrane coating line will be used for coating a solvent-based ionomer containing mix onto a coated backing. The solvents within the ink will be ethanol.

The expected usage of ethanol is approximately 1000kg per month. The Ethanol is expected to be supplied in IBC containers or drums, stored outside the building and pumped into the area. The quantities will be batch dispensed into vessels.

The ionomer powder delivery system will comprise either a vibratory feed system, or screw delivery system. The powder will be dissolved using an overhead stirrer to continually mix the material until it has been fully dissolved. The ionomer solution will then be pumped from the mixing vessel to the intermediate tank on the coating line.

The ink will be coated using a slot die, and then dried in an air floatation dryer. A reinforcement layer (ePTFE - stretched polytrafluoroethylene) is introduced into the wet layer on the middle pass of the membrane. The layers are dried using convection and infra-red lamps at a temperature up to 200°C. The width of the coating will be up to a maximum of 1000mm 950mm (web), and maximum 950mm 900mm (coating). On exiting the oven there will be an in-line inspection system and defect marking. The web will be rewound at the end of the line.

- Heat Treatment Line

Membrane is taken from the coating line and heat treated as a roll in a 12m long oven at a temperature of 160°C. The heating is provided by convection and IR lamps. The web will be unwound prior to passing it through the oven. On exiting the oven there will be an in-line inspection system and defect marking. The web will be rewound at the end of the line.

- Cathode Coating line.

The cathode coating line will be used for coating cathode catalyst 'ink' onto a membrane on a backing. The catalyst is formed of cathode catalyst powder, ionomer and solvent (ethanol). The ink will be coated using a slot die, and then dried in an air floatation dryer. IR lamps will dry the catalyst layers up to a maximum temperature of 180°C. The catalyst will be coated as either patches or continuous dependant on the Customer requirements. The width of the coating will be up to 1000mm 950mm (web), and 900mm (coating). On exiting the oven there will be an in-line inspection system and defect marking. The web will be rewound at the end of the line.

- Anode Coating Line

The anode coating line will be used for coating anode catalyst 'ink' onto a membrane on a backing (delete?). The catalyst is formed of anode catalyst powder, ionomer and solvent (propanol). The ink is loaded into the 15-litre ink tank. The ink is then pumped through to the supply valve to the slot die. There is an in-line filter for removing any large particles in the ink. There is some ancillary equipment associated with the ink circuit, rinse tank, drain tank and beakers. The inks to be utilised are confidential.

The ink will be dried via the heated backing roller, heated using water to 80°C. The process area has an extraction system to remove the solvents evaporated from the layer. The rollers to laminate the polyethylene terephthalate (PET) support film are also heated.

The membrane is unwound and prior to going to the heated vacuum backing roller. The membrane is held in place by vacuum as the backing material is removed over a nip roller and then rewound. The now unsupported membrane has the anode layer coated onto it. The web passes through the drying section of the line. The web passes through under a heated nip roller with PET, which causes the membrane to stick to the PET and act as a support film. The material is then passed through another XR system and vision system prior to being rewound.

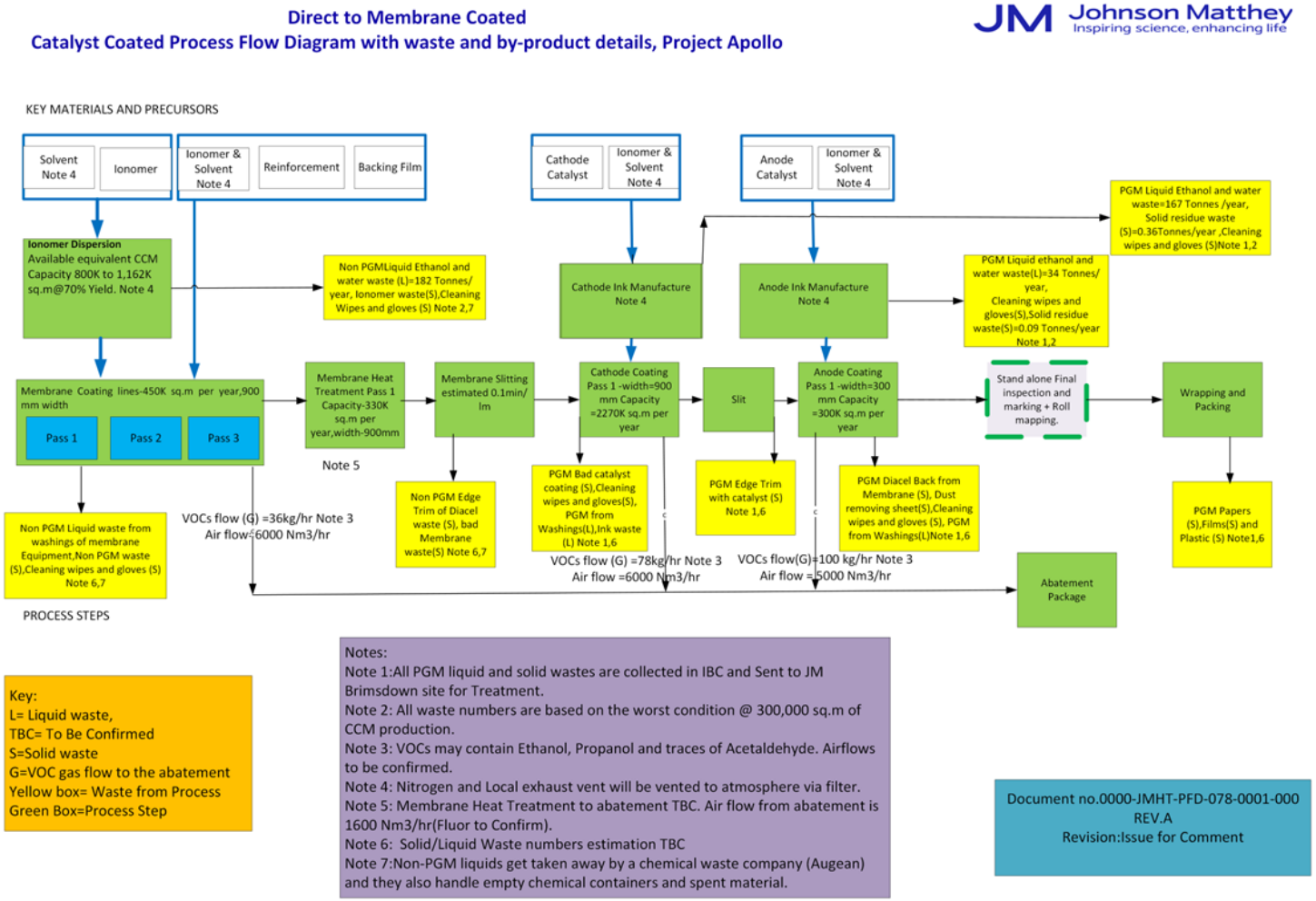
- Slitters

The slitters will be used for correcting widths on incoming raw materials; removing ePFTE edge trim on membrane; slitting of cathode coated membrane; and trimming fully coated CCM.

- Regenerative Thermal Oxidiser (RTO)

Thermally efficient oxidiser with gas fired burner used to abate emissions from the membrane coating line, cathode coating line and anode coating line will be installed.

Figure 3-1
Process Flow Diagram - Project Apollo



Regenerative Thermal Oxidiser

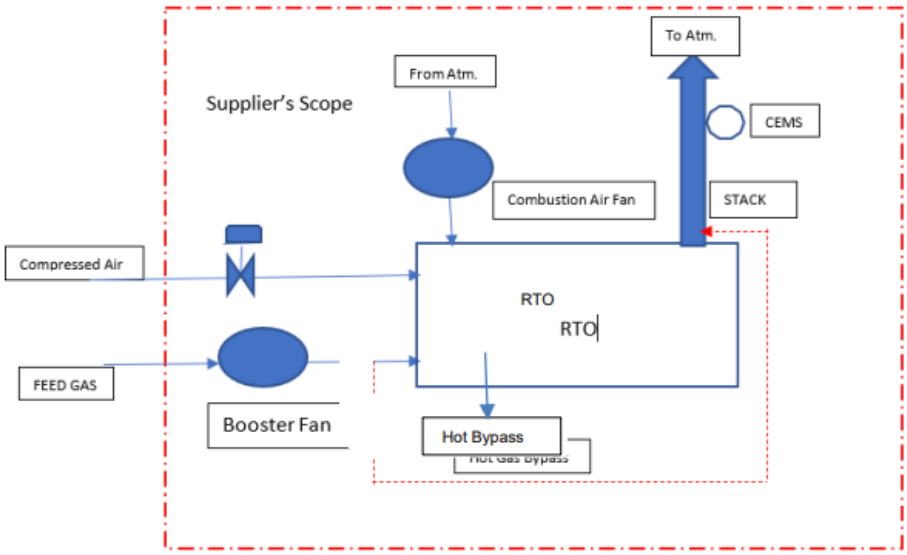
The CCM process generates waste VOC gases consisting of ethanol and propanol. These waste gases are abated through a regenerative thermal oxidiser (RTO) as shown in Figure 3-2.

The output of the RTO has a continuous emission monitoring system (CEMS) for CO, NOx and VOC. Low NOx burners will be utilised at the RTO to minimise NOx concentrations.

The RTO will be fuelled by natural gas. However, there is potential for the facility to burn Hydrogen as a fuel in the future.

The RTO will be fitted with acoustic insulation, silencers and noise hoods. The environmental noise level when measured at site boundary (Approx. 90m) shall not exceed 55dBA.

Figure 3-2
Regenerative Thermal Oxidiser Overview



3.2 Operations & Controls

3.2.1 Process Control

All processes will have a detailed operating procedure that will be followed during production. The operating procedure is a controlled document within an ISO 9001 accredited Quality Management System. People operating the processes will be trained and accredited in the process.

In the event of any abnormal oven temperature conditions, such that the process is at risk of moving outside the designed safe operating envelope, visual and auditable process alarms will activate and ultimately tripping the mixing process. Furthermore, tanks will be also designed to contain explosion and protect the operators in case of oxygen leakage in the flammable environment. The room will be equipped with sprinklers to ensure proper extinction in case a fire develops.

Alarms will be installed in the room to monitor oxygen levels and visual and auditable process alarms will activate if the nitrogen leaks out and goes above the acceptability threshold: in that case, the room will be immediately evacuated.

Operating procedures will have guidance for abnormal situations and process operators and team leaders will be trained to recognise these situations and respond correctly, in accordance with procedures. All staff will be trained in departmental emergency procedures.

3.2.2 Control during Emergency Conditions

There is a three-tier emergency plan in place which includes a departmental plan, a business unit plan and a site plan. A new local Project Apollo departmental emergency plan will be created to cover all parts of the new activity. In the event of an emergency crossing the boundary of Project Apollo, the business unit (R&CE) plan will be enacted. In the event of the emergency crossing the business unit boundary the site emergency plan will be enacted.

Control of the processes in emergency conditions will be the same as in abnormal conditions. Processes will be controlled in line with design parameters outlined in the HAZOP and Engineering Recommendation G12 – Requirements for the Application of Protective Multiple Earthing to Low Voltage Networks (Issue 4, 2005) once completed.

3.3 Energy Requirements

Table 3-1 and 3-2 below outline the estimated energy consumption for Project Apollo.

Table 3-1
Estimated Natural Gas Consumption

Energy Use	Normal running load Nm^3/ hour	Yearly Usage Maximum Nm^3*
Regenerative Thermal Oxidiser (RTO)	60	522,720

*Assuming that the RTO operates 24 hours a day, 363 days a year.

Table 3-2
Predicted Estimation of Energy Consumption – Electricity

Energy Use	Normal Running Load (KW)	Yearly Usage Maximum (MWh)*	Primary Energy Yearly Usage Maximum (MWh)**
Electricity			
Membrane Coating Line (main processing line MCC 1)	60	525.72	1359.07
Cathode Coating Line (main processing line MMC 2)	1037	9034.34	23489.29
Ink making and auxiliaries	361	3145.03	8177.08
Utilities	318	2770.416	7203.08
Utilities for emergency load	189	1646.56	4281.07
Total Electricity	1965	17119	44509.6

Note:* Assuming that the process is running 24 hours a day, 363 days a year.

** A conversion factor of 2.6 has been used to convert electricity to Primary Energy (this assumes all electricity is derived from the National Grid).

Table 3-3 below presents predicted estimation of water use for Project Apollo.

Table 3-3 - Predicted Water Use

Process	Pure Water (normal running) kg/hour	Chilled water (maximum) m3/hour	Heated water (maximum) m3/hour
Ionomer make up	1.49	-	-
Membrane Coating Line	3.22	-	-
Cathode Coating Line	0.91	-	-
Ink making and auxiliaries	1.37	3.7	-
Ethanol pre-heater	-	-	3

3.3.1 Energy Efficiency Measures

Project Apollo will operate under an Energy Efficiency Plan. Specific energy efficiency for Project Apollo will include:

- The RTO will include the following energy saving measures:
- Optimised burner type to allow for maximum efficiency.
- Heat exchange media shall be optimised for maximum heat capacity and lowest pressure drop.
- High efficiency motors.

3.3.2 Using inverters where appropriate to reduce energy consumption.

- Steam condensate recovery from air handling units.
- LED lighting and where safe and practicable, motion sensing may be used to control light fixtures.
- Variable speed drives (VSD) are present on the coating line.
    - The dryer recycles a portion of the hot air back to the dryer. Heat recovery from process streams has been considered during design and will be applied where viable, however it is not generally practicable in process applications. This is because most heating operations are small scale batch processes. As these unit operations take place at the same temperature and are batch in nature there is limited useful waste heat available for recovery from process.
    - The membrane and cathode coating lines have been designed to optimise material flow which will reduce energy consumption due to the unnecessary movement of materials in process. This will also minimise wasted heat due to inefficiencies in design.
    - All processes with heating (electrical or natural gas) will have temperature monitoring and be programmable logic controlled to ensure optimised operations with respect to the use of energy and raw materials. Low energy lighting and use of natural light wherever possible. Automated processes.
    - The building has been designed with energy efficiency in mind and meets all building regulations.

3.4 Efficient Use of Raw Materials and Water

3.4.1 Water

The plant has been designed to measure and control the volumes of water used within the process to keep consumption to a minimum using automated process control.

JM will conduct monitoring of the annual consumption of water, energy and raw materials by recording all inputs to the process. Furthermore, monitoring is also conducted for the annual generation of residues and wastewater via the recording of all process output. To aid this, an inventory and tracking system will be kept of all inputs and outputs.

The following water utilities will be utilised in the production of catalyst coated membrane:

- Deionised ultrapure water from an existing demineralised plant on site.
- Mains water.
- Chilled water.
- Hot water.

A mass balance has been created for water used in the process (JM reference A9DP-225-SUM-001-0001) to allow tracking of all water utilised used.

The process does not utilise a large volume of water. Where product quality permits some water will be recirculated. In order to minimise water usage, heat exchangers using cooling water are designed for optimum heat transfer between process streams.

Spray balls are used within the vessels to aid efficient cleaning. Water will be warmed to increase the efficiency of the cleaning of certain processes. These systems will be automated to ensure efficient use.

3.4.2 Heat

Where possible heat exchangers will be used to preheat feeds (ethanol) with waste heat energy, however these opportunities are limited due to scale of operation and relatively low temperature gradients across processes.

3.4.3 Raw materials selection

Raw materials used in the process include:

- Cathode Catalyst Powder.
- Anode Catalyst Powder.
- Ionomer Powder.
- Inks.
    - The process uses specific materials for which there are no ready alternatives.
    - Both the cathode and anode catalysts contain carbon and platinum and are therefore combustible. Ionomer is a solid material that is very acidic and hygroscopic in nature and the physical appearance is like many mini solid “shards” about 5-10mm long.

The plant has been designed to run using stoichiometric quantities of raw materials and delivering high yields thus minimising waste. The raw materials information will be held within the Site’s Raw Materials list which is reviewed frequently.

Platinum used in the process is predominantly from re-cycled sources.

Raw materials utilised in the process are summarised in Table 3-43-4 which assumes that 300,000m^2 per year of CCM will be generated.

Table 3-4
Raw Material Inputs - Project Apollo

Raw Material	Annual Requirements (kg/yr)
Deionised pure water	61,190
Ethanol	49,416
Propan-1-ol	1,858
Ionomer solids	10,843
Cathode ionomer	6,955
Anode ionomer	2,697
Ionomer solution	54,000
INKs	
CAT0124	4,691
CAT0131	1,031
MIS0044	2.7

3.4.4 Avoidance, recovery and disposal of waste

JM separate PGM and non-PGM waste streams at the site as handling of all materials which contain PGMs require special attention and instructions for their storage and despatch.

The following outlines the anticipated waste streams and volumes from the CCM process per year:

- General Waste, packaging waste and pallets.
- Solid Waste (containing PGM)
  - Slit PGM: 137,049.82 total pt g
  - Weight edge trim Material: 4,420kg
  - Weight of print yield loss on roll: 5,250kg.
  - Burnings Weight: 2,100kg
  - Weight of wet ink washings: 84,000kg

  Total: 96 tonnes / year.
- Solid Waste (Non PGM waste from Membrane Coating):
  - Locked up ionomer: 200kg / year.
  - Solvent: 200litres / year.
- Effluent (PGM)

- PGM liquid waste from cathode ink manufacture: 34 tonnes / year.
- PGM liquid waste from anode ink manufacture: 167 tonnes / year.

- Effluent (Non PGM)
  - Waste from Membrane Coating - Wash volume (mostly water): 10,000 litres / year.
  - Non PGM liquid waste from ionomer mixing: 182 tonnes / year.
  - Small volumes of condensate water form HTTF.
  - Surface water run-off from rainwater.

Johnson Matthey have confirmed that there will be no additional effluent volume or pollutant load from the new activities as all effluent waste generated from the process will be sent offsite to a permitted waste management company for management.

Pallets are re-used on site where possible and also recycled via an offsite contractor.

PGM solid wastes are collected in IBCs and sent to a suitably permitted offsite waste management facility, the Johnson Matthey Brimsdown site for treatment for recovery through their smelting process. Non PGM solid wastes are removed from site by a chemical waste company.

The process will result in 201 tonnes per year of PGM effluent waste. This will be collected via a licensed subcontractor and transferred to Brimsdown for refining.

The process will result in 182 tonnes per year of non PGM effluent waste. This waste will be taken away by a suitably licenced chemical waste company.

The site can discharge 206,000 litres of water per day to sewer under their existing discharge consent. This is managed with assistance from two 450m^3 effluent holding tanks. This volume discharge from the site to sewer and the pollutant load will not change.

Waste volumes are measured and reported to the EA through waste KPIs.

3.5 Operations

3.5.1 Design of a new process

The process will be subject to a full Hazard Study (Hazard Study steps 1-6) and processes will be controlled in line with design parameters as outlined in the HAZOP, once completed. The process has been designed to work at optimum efficiency to reduce electricity use and water use where possible.

3.5.2 Storage & Handling of Raw Materials

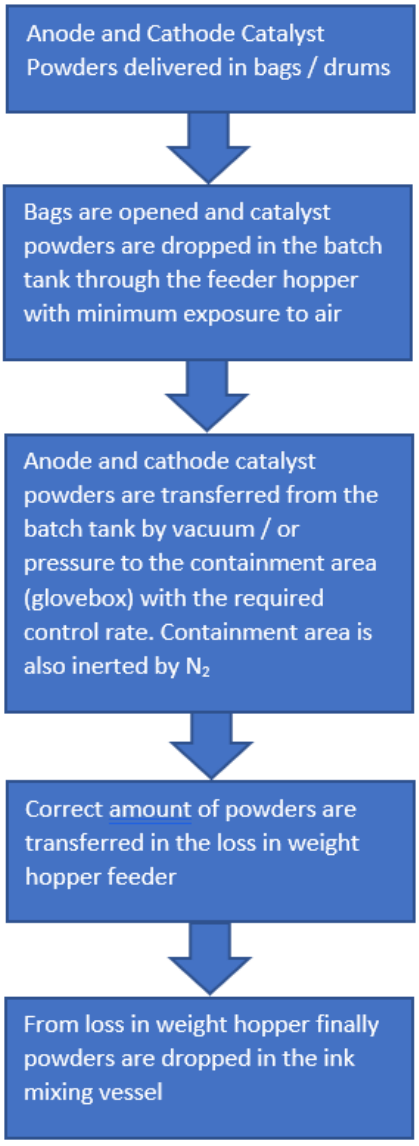
Raw materials used in the process to prepare coating inks include:

- Cathode Catalyst Powder.
- Anode Catalyst Powder.
- Ionomer Powder.
- Inks.
  - Both the cathode and anode catalysts contain carbon and platinum are therefore combustible. Ionomer is a solid material that is very acidic and hygroscopic in nature and the physical appearance is like many mini solid “shards” about 5-10mm long, so it is not a typical ‘powder’ for handling.

Powder Handling System

- JM will use a powder handling system with set procedures to handle cathode and anode catalyst powders (refer to Figure 3-3) on site. Key material handling requirements for the management of cathode and anode catalyst powder include:
- Movement of powder will be designed to limit contact with air as extended contact with air in bulk storage has a risk of causing spontaneous fire.
- The entire powder system from bag opening to ink preparation (mixing vessel) will be under inert condition (atmosphere of nitrogen) so that the catalyst powders do not come into contact with air.
- A high-pressure alarm and O2 detector.

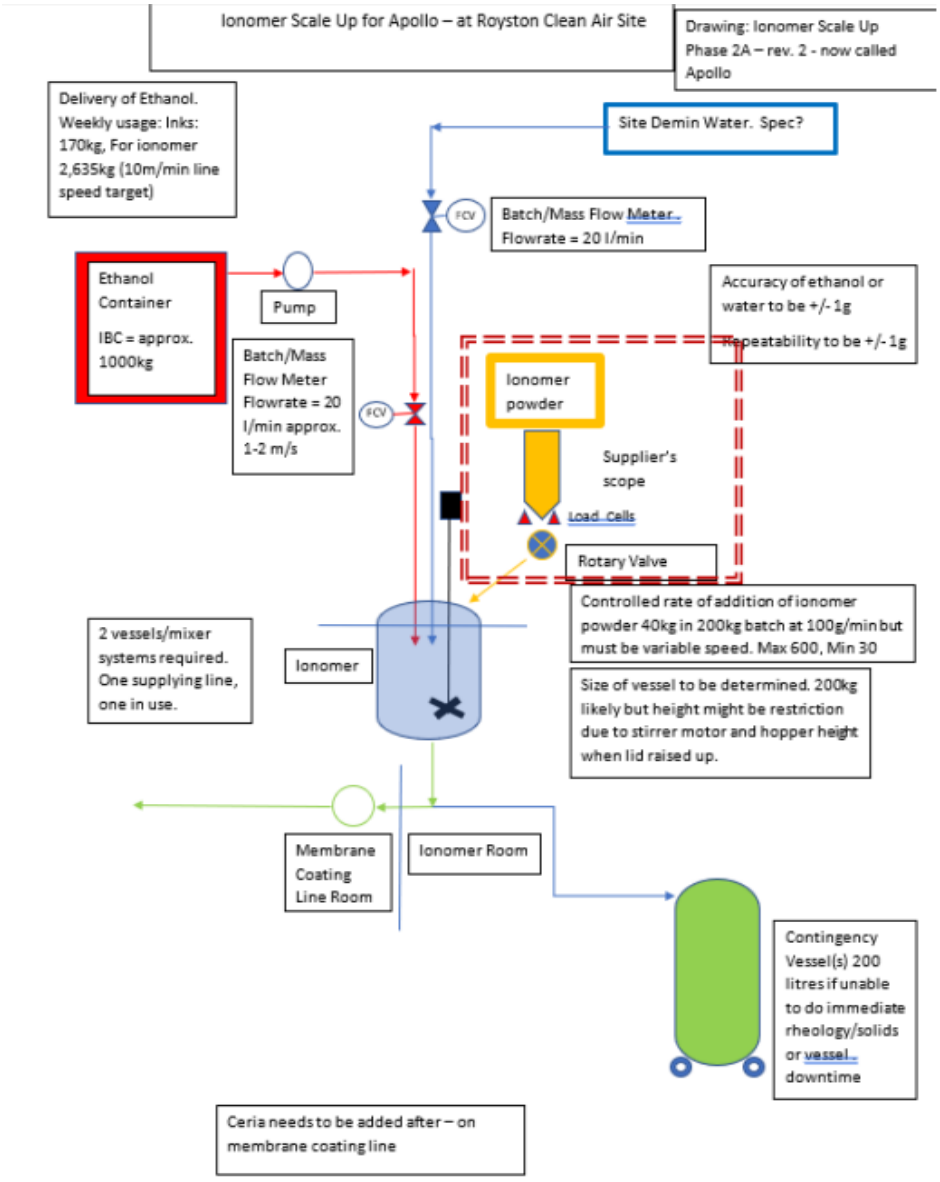
Figure 3-3
Powder Handling System



Ionomer Handling System

- JM will introduce an ionomer handling system with set procedures to handle the ionomer powder (refer to Figure 3-4) on site. Key material handling requirements for ionomer powder include:
- Construction of the delivery system will comprise either Pharma grade (FDA approved) HDPE or PP as the ionomer material in solution has flash point of 17˚C.
- A slow feeding rate to transport the Ionomer from the batch tank to the downstream Ionomer solution mixer vessel.
- Areas where ionomer could become damp will be protected from corrosion.

Figure 3-4
Ionomer Handling System Overview



3.5.3 Storage and Handling of Products

The storage and handling of the CCM will be written into a standard operating procedure to ensure that the product is handled with in its design limits and does not become damaged.

CCM will be kept in a tightly closed and sealed until ready for use. Containers will be labelled and stored on appropriate containment (i.e., a pallet bund). CCM will be stored away from strong oxidising materials.

3.5.4 Storage and Handling of Wastes

PGM and non-PGM liquid wastes are stored separately on impermeable hardstanding with sealed drainage both internally and externally (in a bund) of the CSF2 building. All liquid wastes will be contained within 1,000 L IBCs.

Solid waste will be held internally until loaded into vehicles for offsite removal or placed into a suitable receptacle.

3.5.5 Solid Waste Storage and Transfer

PGM Waste

Handling of all materials which contain Platinum Group Metals require special attention and instructions for their storage and despatch to refining. Solid coated reject materials stored inside within fire retardant bins.

PGM burnings

PGM burnings (material contaminated with catalyst waste) coming into contact with organic solvent is a fire hazard. This fire risk is exacerbated if the PGM burning material has dried out and therefore will be kept moist at all times. PGM waste material and organic solvent waste will be clearly labelled and segregated at all times during disposal. Metal-lidded bins are used for the disposal of PGM Burnings.

As part of the daily shift clean up, burnings will be dampened. PGM burning bins will be emptied once a week or when the bin is more than half full and dropped off to the relevant refining drums. The drums will then be sealed to prepare them for the next refining collection.

Handling of scrap printed catalyst electrodes & monethanol amine (MEA).

Scrap Electrodes, MEA and off cut waste is to be collected in the production works order cabinets. Once the works order is complete the PGM waste materials will be packed into refining drums.

Handling of waste PGM inks

Scrap inks or print line lot ends will be transferred from their pots into a plastic waste container. The plastic containers will be packed into 205 litre drums and sealed so the waste can be transported to a suitably permitted offsite waste management facility for refining.

Catalyst Powder

When catalyst powder is scrapped it is stored in the container it was supplied in or it will be transferred to a generic waste container. A ‘scrap’ label will be stuck to each container to prevent its use.

Scrap catalyst containers will be transferred into a 205Lt drum for transportation to a suitably permitted offsite waste management facility for refining.

Non PGM Waste

Solid waste from the coating process which does not comprise PGM will be collected and stored in covered skips on impermeable hardstanding with a sealed drainage system. Collected solid waste is sent offsite for recovery under the R13 waste classification code.

3.5.6 Waste Gases

The gases from venting and collecting the VOCs from evaporation and chemical reaction will be passed through filters to remove unwanted compounds. Channelled emissions of VOC from the three coating lines will then be forwarded to the RTO for abatement.

3.5.7 Effluent Treatment

Process effluent generated by the Apollo activity will be sent offsite to a permitted waste management company for treatment. Surface water run-off from the existing building which will house the proposed new activity is already collected and treated in the Site Effluent Treatment Plant (SETP). There will be no change to the amount and quality of surface water run-off as a result of the new activity as all parts of the activity takes place in enclosed buildings.

3.5.8 Storage Area Construction

Onsite waste storage areas benefit from impermeable concrete surfacing that drains to a sealed drainage system with connection to the onsite effluent treatment plant.

The CSF2 building is bunded most transfers of materials and dispenses will take place within the confines of the building. All storage areas outside of building holding liquids will on suitable bunds in line with industry standards.

3.5.9 Plant Systems and Equipment

As part of the Hazard study and project management procedures all potential emissions from plant systems and equipment will be considered. If at some point there are some issues found with either noise or substances from the plant system or equipment, improvements to these will be included on the Project Apollo continuous improvement plan.

All coating lines will be manufactured of suitable materials and to the appropriate British standard or national standard for the duty. The vessels will be closed tanks, connected to a local exhaust ventilation system, as necessary. The reactors will also be fitted with agitators incorporating a mechanical seal to retain vapour in the vessel. All vessels will be fitted with control instrumentation to monitor process temperatures and liquid levels.

This existing plant comprises insulated tanks heated and agitated by steam sparge. These tanks are fitted with level / temperature control instrumentation.

The process will involve extraction of waste gases to a regenerative thermal oxidiser to treat waste gases. The ionomer vessel, heat treatment line and ink mixing room will also comprise vents to air.

The floor areas in the plant will be sealed and cambered to a series of gullies and sumps to retain spillage and segregate incompatible substances.

3.5.10 Ventilation Systems

The design concept for the new process is for a high degree of containment to minimise escape of process gases into the workplace. Nevertheless, all process areas will be fitted with adequate ventilation installed and operated as appropriate to ensure that occupational exposure limits (OEL) are not exceeded. Local Exhaust Ventilation (LEV) systems have been designed to comply with HSG258 (2017) C*ontrolling airborne contaminants at work: A guide to local exhaust ventilation (LEV)*.

3.5.11 Over pressure protection systems

Pressure relief systems will be designed in accordance with the JM Pressure relief Engineering Guide JMC 815 013. Details of equipment over-pressure hazard identification process will be found in the ductwork design and

HAZOP. Every line and every vessel in the Process & Instrumentation Diagram (P&ID) will be considered for factors that could cause more pressure in the line or vessel than the design intention.

A high degree of automation and instrumentation will be built into the new plant to minimise operator error (e.g., Level control management).

3.5.12 Vacuum systems, pumps, compressors, valves, pipe joints, agitators

Vacuum systems

Project Apollo will include a new vacuum system. The exhaust gases from the vacuum system will be routed to the new RTO.

Pumps

Plant and process pump designs for harmful liquids will be seal-less and include a magnetic drive, peristaltic pumps, and positive displacement (both air and electrically driven). Larger pumps will be fitted with failure devices to minimise losses when failure occurs but small dosing pumps with manual additions will be continuously monitored by trained operators.

Agitators

The standard for seals on agitator shafts in Project Apollo will be single dry running mechanical seals on tanks and double mechanical seals on reactors, thereby minimising emissions.

Valves

All valves used on plant will be the most reliable available for use in the harsh conditions encountered. They will conform to the business unit piping specifications. Typically, diaphragm valves will be used on process lines and globe and ball valves on service lines.

Pipework

Material of construction of the pipe work will be chosen dependant on the corrosive nature of the process fluid and will conform to site-wide piping specifications.

Vessels

Vessels will generally be of thermoplastic or Glass Reinforced Plastic (GRP) construction and all vessels containing harmful substances will be operated under negative pressure by the site scrubbed draught system.

Specifications for all new equipment purchased will be made by qualified engineers issuing invitations to tender to pre-vetted suppliers.

The plant will be covered by the existing Planned Preventative Maintenance (PPM) procedures, and breakdown maintenance will be coordinated by the Support Engineering Department on a priority basis agreed with the Production department.

3.5.13 Heat Exchangers and Cooling Systems

Table 3-5 below presents the heating and cooling systems which will be employed within the area.

Table 3-5
Heating and cooling systems

Heating and Cooling Systems	Application	Controls
Heating, ventilation and air conditioning (HVAC).	Humidification	Computerised
Ethanol pre-heater	Pre heat ethanol	Computerised
Chilled water	Catalyst cathode line	Computerised

The chilled water system design will ensure that process fluids will not contaminate the cooling water, leaks will cause a shut-off of cooling water to affected areas. This is because the chilled water is always at a higher pressure than the process fluids. Planned maintenance will be implemented to avoid process failure.

3.5.14 Infrastructure and Containment

JM will be utilising the existing infrastructure within the CFS2 building, including the drainage lines to the effluent treatment plant. Containment for the storage of chemicals and waste will be indoors and comprise palletised bunding and a locked chemical storage cabinet.

3.5.15 Analysis

Analysis of process streams at key stages in the refining steps will be used to determine operating conditions and to approve further processing in Project Apollo.

Prior to discharge all effluent streams will be separately analysed to ensure suitability for discharge. This will include any discharge of floor well sumps following wash down or spill. SOPs will be written to ensure non-conforming effluents are quarantined and processed correctly.

3.6 Emissions

3.6.1 Point source emissions to air

The following emission points to air will be added due to the new activity (refer Figure 3-5 for the location):

Channelled Emission Point to Air:

- Regenerative Thermal Oxidiser (RTO) which comprises exhaust gas from the methane burner and abatement (by combustion) of VOCs.

Non-Fugitive Emissions:

- 8 x Ionomer vessel vents from ionomer mixing room connected to the pressure relief system; emission consisting of nitrogen and small amounts of VOCs.
- 1 x heat treatment line vent – hot air relief vent.
- 1 x Vent from the ink mixing room connected to the pressure relief system; emission consisting of nitrogen and small amounts of VOCs .

The non-fugitive emissions vent to air from the CSF2 building roof. Please refer to Appendix 03 for definitions of channelled emission points to air and non-fugitive emissions as defined by the Draft Common Waste Gas Management and Treatment Systems BREF.

The facility will be served by an RTO system to ensure compliance with future Industrial Emissions Directive (IED) limits. Emissions from the stack will include CO, NOx and VOC (ethanol, propanol and aldehydes). All associated vents are detailed on the site stack map refer Figure 3-5.

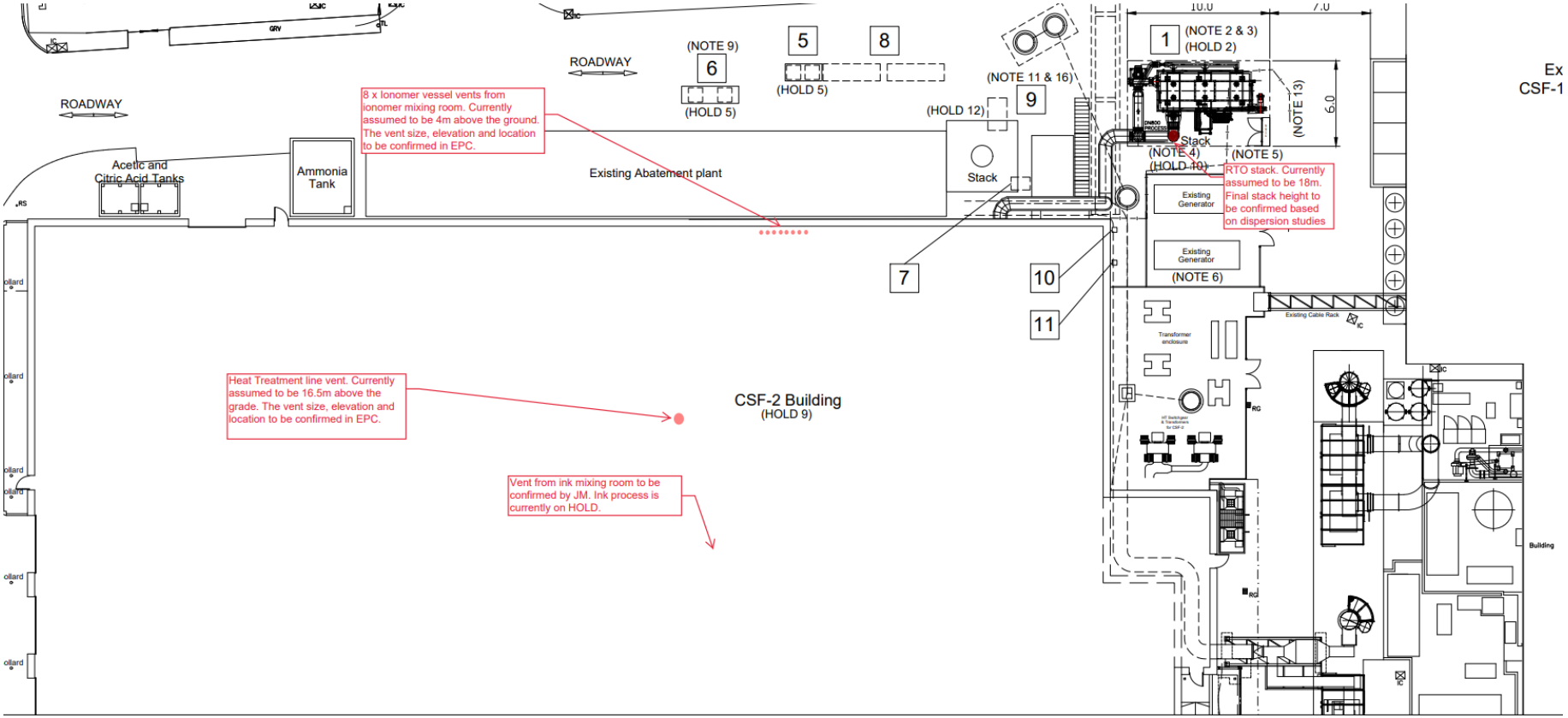


Figure 3-5
Project Apollo Emissions to Air

Table 3-6 below outlines the best available techniques associated emission levels (BAT-AELs) that the RTO will have to meet as per the Draft Common Waste Gas Management and Treatment Systems in the Chemical Sector BREF. The RTO has been designed to meet these emission benchmarks.

Table 3-6
Emissions benchmarks of released substances

Released substance	Draft BREF* BAT-AEL (mg/Nm3) (Daily average or average over the sampling period
CO (from thermal treatment)	No limit set
NOx (from thermal treatment)	5-130[1]
Total VOC	<1-20

Notes: * Draft Common Waste Gas Management and Treatment Systems in the Chemical Sector BREF.

3.6.2 Point source emission to water

Uncontaminated surface water runoff is collected from the CSF2 roof and external hardstanding areas and collected in pits prior to being pumped to the effluent treatment plant discharged to sewer.

Project Apollo will result in no releases to groundwater. Releases from the process to the water environment will be made via the effluent treatment plant prior to discharge to sewer.

JM will neutralise waste streams containing acids and alkalis in the existing effluent treatment plant to achieve the required pH for the receiving Anglian Water Services municipal sewage treatment plant.

There is no anticipated increase to effluent generation from the proposed activities or pollutant load, due to the cessation of existing activities on site.

3.6.3 Point source emission to land

There will be no point source emission to land from this process.

3.6.4 Fugitive Emissions

Fugitive emissions to air

The plant has been designed to minimise fugitive emissions. Foreseeable sources of fugitive emissions have been identified and will be suitably draughted and ducted to the RTO.

JM have designed the plant and storage vessels to minimise fugitive emissions from the plant. All vessels which may give rise to fugitive emissions are attached to a suitable draught system including their own vent systems.

Fugitive emissions to surface water, sewer and groundwater

There will be no fugitive emissions to surface water, sewer and groundwater under normal operating conditions.

To avoid fugitive emissions to surface water, sewer and/or groundwater, all floors internally and externally associated with the plant will be constructed from impermeable materials. Planned preventative maintenance will ensure regular observational checks of all surfacing.

[1] The upper end of the BAT-AEL range may be higher and up to 200 mg/Nm3 if the process off-gas(es) contain(s) high levels of NOX precursor.

All floors internally and externally associated with the plant will be cambered to direct any spills or leaks into sumps for recovery or treatment as appropriate to avoid contaminated surface run-offs discharging to ground.

Spill kits will be provided at strategic locations as required. The used spill-kits will be disposed of in leak-proof containers before final disposal offsite.

All process line including effluent will be piped above ground and sumps and bunds will be checked weekly. Secondary containment bunds and sumps are inspected by the site services engineer on a 6-monthly basis in line with bund specifications and CIRIA C736 guidance.

3.6.5 Odour

To prevent the release of any odours, all process vessels will be suitably draughted and ducted to the RTO. Odour releasing raw materials will not be stored within the building unless appropriate extraction to the RTO and bunding facilities are in place.

The plant is designed to ensure that no odours are detectable outside of the building. The raw materials will be stored in an existing permitted facility. Furthermore, this building is situated remotely from site boundaries.

In the event of suspected odour issues from Apollo these will be investigated and reported in accordance with R&CE accident and indecent investigation and reporting procedures.

3.6.6 Noise and Vibration

A noise survey was undertaken by Industrial Noise and Vibration Centre in October 2020 (reference R9706). The report concluded that JM operates 24 hours a day, 7 days a week and therefore the noise from the site is therefore almost constant, although there will be some small fluctuation in level as individual noise sources are turned on and off. Many of the main noise sources on site are shielded from the surrounding area by acoustic screens and/or other buildings, so the noisiest sources may not necessarily be audible at the boundary.

Potential sources of noise that may impact the site boundary from Project Apollo are listed below:

- Pumps (both located inside CSF2 building and external)
- RTO : process fan, combustion fan, furnace & Stack (External)
- Chiller (external)

These elements will be designed to ensure no increase of noise will be detectable at the installation boundary.

All fans will be fitted with anti-vibration mounts. The site carries out noise monitoring every two years and reports this to the EA as part of the current EP requirement; the survey will be reviewed and extended to ensure no noise from the Project Apollo building is present at the boundary.

3.7 Monitoring

3.7.1 Monitoring and reporting emissions to air

There will be one new channelled emission point from the RTO. The Stacks and Vents location are shown in Figure 3-5. The RTO will be monitored in line with the Draft Common Waste Gas Management and Treatment Systems BREF (refer Appendix 04).

The emission benchmarks that will be followed are described in Table 3-7. The frequency of monitoring will depend on the flow rate through the RTO.

Table 3-7
Monitoring techniques and frequency

Parameter	Flow Rate	Monitoring technique	Frequency
CO	Greater than 2kg/h	Generic EN standards	Continuous
	Less or equal to 2kg/h	EN15058	Once every six months
NOx	Greater than 2.5kg/h	Generic EN standards	Continuous
	Less or equal to 2.5kg/h	EN14762	Once every six months
Total VOCs	Greater than 2kg/h	Generic EN standards	Continuous
	Less or equal to 2kg/h	EN12619	Once every six months

* Draft Common Waste Gas Management and Treatment Systems in the Chemical Sector BREF.

3.7.2 Monitoring and reporting waste disposal

The waste from this plant will be included within the scope of the existing waste management system for the R&CE and includes, but is not limited to, monitoring and recording:

- the physical and chemical composition of the waste.
- its hazard characteristics.
- handling precautions and substances with which it cannot be mixed.

3.7.3 Environmental Monitoring (beyond the installation boundary)

This plant will be included within the scope of the existing environmental monitoring systems for the installation including 2-yearly noise survey and 6-monthly groundwater monitoring.

An air emissions risk assessment has been completed as part of this variation application (416.063922.0001_ERA, Appendix 2 Air Emissions Risk Assessment).

3.7.4 Monitoring of Process Variables

The process variables that will be monitored include:

- RTO abatement.
- Process control - level, pressure and temperature of critical parts of the process.
- Water flow – water will be monitored to the processes.
- Electricity - consumption of the building will be monitored to allow for energy efficiency tracking. Smart meters will be used and will communicate with the R&CE online dashboard.

All these variables will be monitored and recorded on the Supervisory control and data acquisition (SCADA) system (the computer process management and monitoring system).

3.8 Plans in the event of site closure

The CSF2 building has been included in the site closure plan. Installation issues (E.g.: multi-operator or changes to boundary) are not applicable to this variation as there are no changes to boundary or multiple operators.

3.9 Environmental Impacts

An environmental risk assessment from potential environmental impacts from Project Apollo has been prepared as part of this variation application (416.063922.0001_ERA).

3.10 BAT Assessment.

Refer to Appendix 04 for the Project Apollo BAT Assessment.

3.11 Closure & Decommissioning

Project Apollo will be added to the JM site closure plan with details on how the coating lines will be decommissioned on closure.

3.12 Information & Reporting

Project Apollo will be managed with the site's ISO14001 environmental management system with key information on raw materials, energy and utility use, monitoring reported to the regulator where required.

4.0 Hydrogen Technology Test Facility

4.1 Project Description

A dedicated UK Hydrogen Technology Test Facility (HTTF) will be installed in the Clean Air TC2 building.

The facility will provide a testing facility for testing single fuel cell membranes manufactured in CSF2.

The HTTF footprint consists of an ante room used for make-up and pre-testing of the test cell, plant room and a laboratory area containing dedicated test equipment for quality control quick release testing of manufactured components (CCM) and membrane electrode assembly (MEA) products as produced by Project Apollo.

The test stands will have the capability to support diagnostic tests and accelerated test protocols (including cold start).

The quantity of test stands in the project scope are as follows.

- 3 (plus one) single cell test stands for operation of single cell hardware between 5 and 50cm^2.

4.2 Control during Emergency Conditions

There is a three-tier emergency plan in place which includes a departmental plan, a business unit plan and a site plan. A new local HTTF emergency plan will be created to cover all parts of the new directly associated activity. In the event of an emergency crossing the boundary of the HTTF, the business unit (R&CE) plan will be enacted. In the event of the emergency crossing the business unit boundary the site emergency plan will be enacted.

Control of the processes in emergency conditions will be the same as in abnormal conditions. Processes will be controlled in line with design parameters as approved by HAZOP.

4.3 Energy Requirements

The HTTF will be powered by electricity on '3 phase' at 415 volts. The expected electricity use per year (on installation of fourth G60 test stand) is 743 GJ.

The HTTF will operate under an Energy Efficiency Plan to ensure maximum efficiency.

4.3.1 Efficient Use of Raw Materials and Water

Water Consumption

Water consumption at the HTTF comprises mains water and will comprise 600 l per day.

Raw materials

Raw materials will comprise manufactured components (CCM) and membrane electrode assembly (MEA) products from Project Apollo. Only the amount of product that requires testing will be utilised to minimise waste.

4.3.2 Avoidance, recovery and disposal of waste

Minimal waste will be generated by the HTTF, limited to a small volume of water condensation that is discharged to sewer via the effluent treatment plant.

Solid waste will comprise spent hydrogen fuel cells sent for PGM recovery at a to a suitably permitted offsite waste management facility.

4.4 Operations

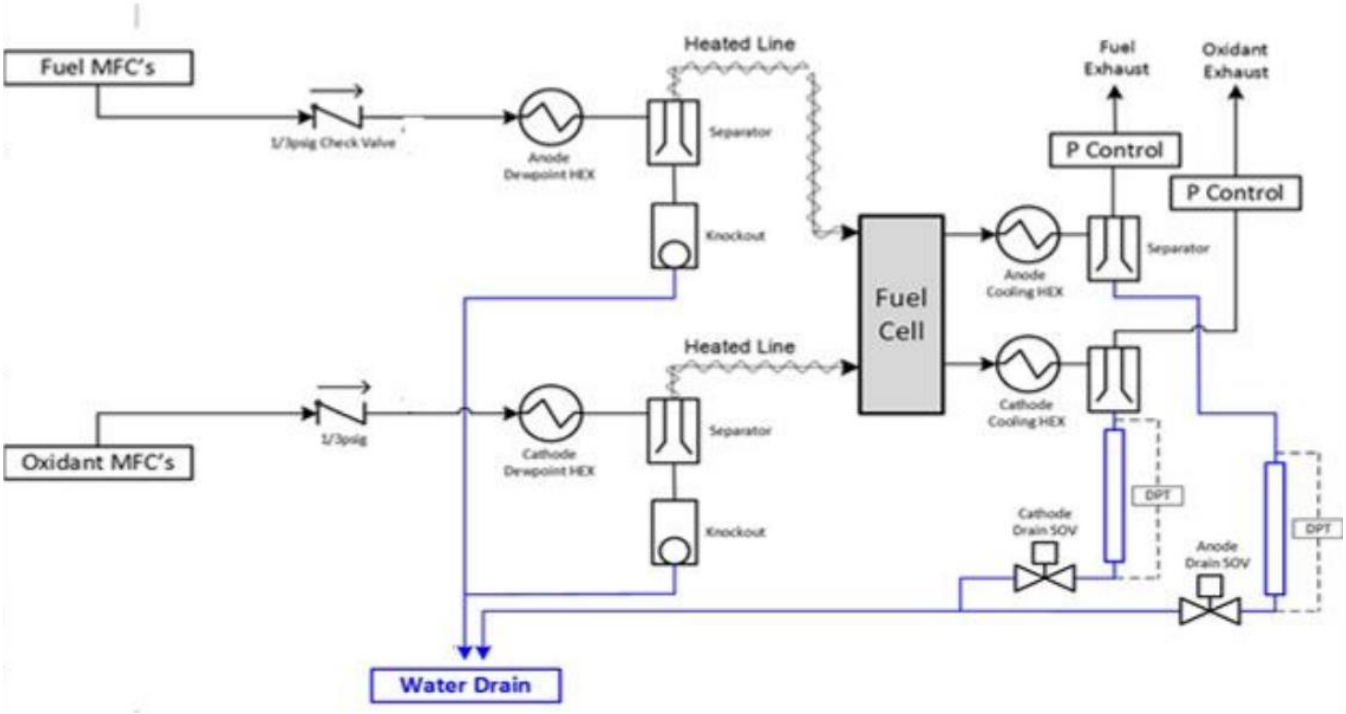
4.4.1 Design

The test stands supply test gases to the anode and cathode of hydrogen fuel cells providing a controlled composition, flow rate, pressure, temperature and humidification of the test gases. The temperature of the fuel cell is actively controlled using a separate cooling loop. The fuel cell's performance is monitored while the electrical output is controlled with a load bank.

Most of the hardware in the test stand is geared towards controlling the environment of the fuel cell, including its temperature, pressure and the properties of the gases supplied to it.

The gas control systems for the anode and the cathode are the same, but the gases supplied to both gas control systems differ. Each Test Stand has separate exhausts for anode (fuel - H_2 and N_2) gases and cathode (oxidant – air and O_2) gases.

Figure 4-1
Flow diagram of the hydrogen technology test stand facility



4.4.2 Storage & Handling of Raw Materials

Raw materials used in the operation of the HTTF includes:

- Hydrogen fuel cells including CCM and MEA from the coating lines.

4.4.3 Plant Systems and Equipment

The HTTF will be subject to regular maintenance and calibration by adequately trained experienced and competent personnel, in accordance with manufacturers recommendations.

4.4.4 Infrastructure and Containment

The HTTF will be installed in building CA TC2. Waste will be stored on an impermeable surface linked to a sealed drainage system. Effluent drains to the effluent treatment plant prior to discharge to sewer.

4.5 Emissions & Monitoring

4.5.1 Emissions to Air

Small amounts of excess hydrogen, oxygen and nitrogen will be emitted via vents in the roof of the CSF2 building. Expected emissions from each of these vents is presented in Table 4-1 below.

Table 4-1
Expected Emissions from HTTF Vents

Parameter	Stack 1 – Canopy	Stack 2 – Cathode	Stack 3 – Anode	Total (g/s)
Expected flow rate (m3/s)	2.4	0.73	0.91	-
Expected emissions (g/s)				
0_2	-	32	-	32
N_2	-	23	14	37
H_2	-	-	0.36	0.36
Air	-	821	1075	1896
H_20	-	19	-	19

No abatement is planned on the HTTF vents due to the low expected gas emissions.

4.5.2 Emissions to Water

The process will not discharge to surface water.

4.5.3 Emissions to Sewer

Only a small volume of water condensation (3 litres per day) will be discharged to sewer via the effluent treatment plant. It has been confirmed that the cessation of other production lines at the site will mean that the HTTF will not result in additional effluent throughput. The condensation will not comprise any polluting substances and at such low volume will have no discernible impact.

4.5.4 Emissions to Land

There are no expected emissions to land from the proposed operation of the HTTF.

4.5.5 Noise and Vibration

The HTTF will be designed in accordance with European noise standards; the equipment will be subject to regular preventative maintenance in accordance with the manufacturer's requirements. It is considered unlikely that the proposed changes will give rise to noise or vibration nuisance at the site boundary due to the small scale of the activity and its operation within an enclosed building.

Potential sources of noise from the HTTF are listed below:

- 3 No. vents and process fans.

These elements will be designed to ensure no increase of noise will be detectable at the installation boundary.

All fans will be fitted with anti-vibration mounts. The site carries out noise monitoring every two years and reports this to the EA as part of the current EP requirement; the survey will be reviewed and extended to ensure no noise from the HTTF building is present at the boundary.

4.6 Environmental Impacts

An environmental risk assessment from potential environmental impacts from the HTTF has been prepared as part of this variation application (416.063922.0001_ERA).

4.7 BAT Assessment

The HTTF will result in a small increase in the quantity of hydrogen, oxygen and nitrogen emitted as a result of operations in the test facility process. These gases are diluted with air before going to a local exhaust stack. This has been assessed as being insignificant and is considered to be 'diffuse' emissions rather than channelled emissions to air.

As no channelled emission points to air exist for the HTTF and it is a directly associated activity, no BAT assessment has been undertaken against the Common Waste Gas Management and Treatment Systems in the Chemical Sector Bref, final draft published March 2022.

There will be electricity use however this is expected to be offset by some of the reduction in energy use for Clean Air Technology Centre Soot Rig Lab as operation is discontinued. No BAT assessment is deemed necessary against the Best Available Techniques for Energy Efficiency Bref published February 2009.

4.8 Closure & Decommissioning

The HTTF will be added to the JM site closure plan with details on how the process will be decommissioned on closure.

4.9 Information & Reporting

The HTTF will be managed with the site's ISO14001 environmental management system with key information on raw materials, energy and utility use, monitoring reported to the regulator where required.

5.0 Replacement Boilers

5.1 Project Description

JM will replace the three existing boilers in the main boiler house with up-to-date state of art boilers and burners. This will improve efficiency and remove the requirement to manage wet steam. The boilers are considered to be a directly associated activity. Only one of the boilers will be in operation and the remaining boilers will be on standby.

5.2 Control during Emergency Conditions

There is a three-tier emergency plan in place which includes a departmental plan, a business unit plan and a site plan. The boiler house departmental emergency plan will be updated to cover the new boilers. In the event of an emergency crossing the boundary of the boiler house, the business unit (R&CE) plan will be enacted. In the event of the emergency crossing the business unit boundary the site emergency plan will be enacted.

Control of the processes in emergency conditions will be the same as in abnormal conditions. Processes will be controlled in line with design parameters as approved by HAZOP.

The boiler house is currently managed under the accident management plan. This will be updated to account for the new boilers. The boiler house is a high security area with CCTV and secure entry by electronic control.

The boiler house has fire detection heads; an E-stop at the main exit and a gas slam shut that is activated by the fire alarm. All boilers and boilers systems will be periodically tested by a competent person to ensure that they fail safe in the event of a power failure.

5.3 Energy Requirements

The average boiler energy requirements over the past two years is 16,000 MWh per year for all three existing boilers. The estimated energy requirements for the new boilers has not been calculated but is estimated by JM to be approximately 13,500 MWth per year for all three boilers.

The boilers will operate under an Energy Efficiency Plan to ensure maximum efficiency.

5.3.1 Efficient Use of Raw Materials and Water

Water Consumption

Process water is taken from the Braithwaite tank and pumped to the water softener at 4 barg pressure, from the water softener the water flow through the carbon filter to the RO (reverse osmosis) plant, from there it is stored in the hot well for use in the boilers.

Water consumption for the boilers will comprise:

- Softener 200L water and 50L of brine per regeneration, once per day.
- Carbon filter 200L water per back wash every third day.
- RO plant, 1500L of concentrate water every hour up to 12 hours per day.
- Operational water 5500L of water per hour up to 12 hours a day.

Steam used in onsite processes, heating and condensate will be returned to the hotwell to be used again, recycling the water.

Steam production

Gas fired boiler thermal input of 2.95MWth. The boilers will operate intermittently dependant on steam demand. Electricity required to operate the boiler and the combustion fan will be approximately 15kK.

5.3.2 Avoidance, recovery and disposal of waste

Minimal waste will be generated by the boilers, limited to boiler blowdown and waste containers from boiler dosing chemicals. The boilers will be operated in order to optimise efficiency and generate less effluent and use minimal amounts of dosing chemicals.

5.4 Operations

5.4.1 Design

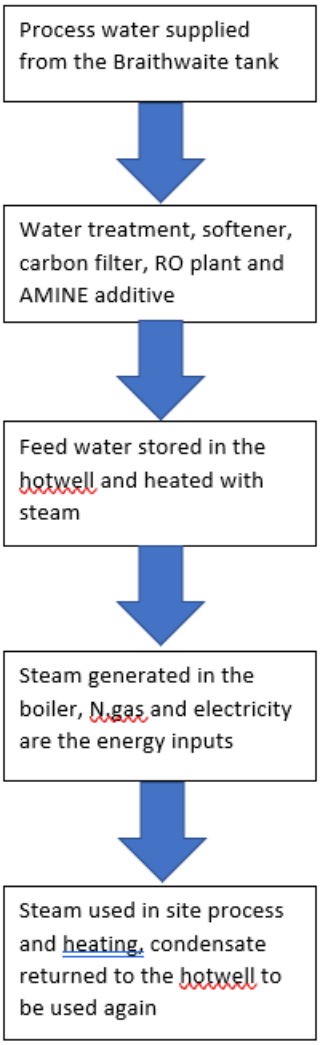
The boilers will be Yorkshireman model XSX4000LN-59. The engines will be fuelled by natural gas. The boilers that JM will install are presented in Table 5-1 below.

Table 5-1
Boiler Specification

Boiler Reference	Brand	Type /Model	Thermal Input (MWth)*	Existing or Future Planned
Boilers 1,2 & 3	Yorkshireman	XSX4000LN-59	2.95	Future Planned
TOTAL			8.85	

The total thermal input for all the generators on site is 8.85MWth. Each boiler discharges to its own stack separately, stacks A13, A15 and A16, respectively. The boilers do not have to be aggregated and considered together as they comprise three individual stacks. Figure 5-1 outlines the boiler house process flow.

Figure 5-1
Boiler House Process Flow



5.4.2 Water Treatment

Daily water treatment analysis will be undertaken on the boilers; in line with British/European standards for boiler water treatment; BS EN 12953-10 2003 and BS 2486 1997.

Periodic monitoring of boiler water is also undertaken by a specialist water treatment company to ascertain correct chemical treatment of the boiler water for the prevalent conditions.

5.4.3 Storage & Handling of Raw Materials

Raw materials used in the operations of the boilers include:

- Natural Gas.
- Chemicals to treat boiler blowdown. Chemicals will be stored within a bunded area located on impermeable hardstanding.

5.4.4 Storage and Handling of Wastes

The following outlines the anticipated waste streams from operations of the boilers:

- Effluent
  - Boiler blowdown which discharges to the ETP then sewer. The amount of effluent generated will not exceed that generated by previous boilers.
- Solid waste
  - General waste from empty chemical containers that are used to treat boiler blowdown. This waste is stored in a bunded area prior to removal offsite as hazardous waste due to the previous contents.

Waste volumes will be measured and reported through waste KPIs.

5.4.5 Plant Systems and Equipment

The boilers will be subject to regular maintenance and calibration of pressure gauges by adequately trained experienced and competent personnel, in accordance with manufacturers recommendations.

Weekly tests of flame detection photocell on burners will be undertaken. The boilers will be run at the correct combustion settings with regular combustion analysis by trained boiler operators.

5.4.6 Infrastructure and Containment

The boilers will be installed into the existing boiler house. Chemicals are stored within a bunded area. Effluent is drains to the ETP prior to discharge to sewer.

5.5 Emissions & Monitoring

5.5.1 Emissions to Air

The boilers, in accordance with the Environmental Permitting (England and Wales) (Amendment) Regulations 2018, will be considered as an 'excluded generator' as the proposed boilers will be part of an Industrial Emissions Directive (IED) Chapter II permitted facility. However, emissions from the boilers (specifically the gas-fired engine) will be required to meet the NO_x emission limit value (ELV) as stated in the Medium Combustion Plant Directive (MCPD), specifically Annex II, Part 2, Table 2 Emission Limit Values for new engines and gas turbines as summarised in Table 5-2 below.

Table 5-2
MCPD Emission Limit Values

Type of Plant	Pollutant	Emission Limit Value (mg/m^3)	Conditions
New combustion plant other than engines or gas turbines	NOx	100	273.15K 101.3kPa 3% O_2

CERC (Cambridge Environmental Research Consultants) have modelled the NOx emissions to be 0.0444g/s for each boiler. No other pollutants apart from NOx are listed in the MCPD for new gas engines. Refer to 416.063922.00001 ERA Appendix 02 for the full air emission risk assessment.

5.5.2 Emissions to Water

There will be no expected emissions to water from the proposed boilers as steam used in site process and heating, condensate will be returned to the hot well to be used again.

5.5.3 Emissions to Sewer

The boilers will generate blowdown; this will be discharged into the on-site effluent water drainage system and will be discharged under the existing discharge consent to the municipal sewer system.

Monitoring and control will be undertaken on hot well levels and temperatures.

5.5.4 Emissions to Land

There are no expected emissions to land from the proposed operations of the boilers.

5.5.5 Noise and Vibration

The boilers will be designed in accordance with European noise standards; the equipment will be subject to regular preventative maintenance in accordance with the manufacturer's requirements. It is considered unlikely that the proposed changes will give rise to noise or vibration nuisance at the site boundary. The new boilers are considered to be less noisy than their predecessors as the equipment is brand new.

A noise survey was undertaken by Industrial Noise and Vibration Centre in October 2020 (reference R9706). The report concluded that JM operates 24 hours a day, 7 days a week and therefore the noise from the site is therefore almost constant, although there will be some small fluctuation in level as individual noise sources are turned on and off. Many of the main noise sources on site are shielded from the surrounding area by acoustic screens and/or other buildings, so the noisiest sources may not necessarily be audible at the boundary.

Potential sources of noise that may impact the site boundary from the boilers are listed below:

- Fans and blowers from the boilers.

These elements will be designed to ensure no increase of noise will be detectable at the installation boundary.

All fans will be fitted with anti-vibration mounts. The site carries out noise monitoring every two years and reports this to the EA as part of the current EP requirement; the survey will be reviewed and extended to ensure no noise from the boiler house is present at the boundary.

5.6 Environmental Impacts

An environmental risk assessment from potential environmental impacts from the proposed boilers has been prepared as part of this variation application (416.063922.0001_ERA).

5.7 BAT Assessment

The following documents have been referenced in compiling this BAT assessment:

- Energy efficiency standards for industrial plants to get environmental permits, 1st February 2016.
- Reference Document on Best Available Techniques for Energy Efficiency, February 2009.
- Medium Combustion Plant Directive, 2015 (MCPD) (EU/2015/2193);
- Medium combustion plant and specified generators: environmental permits, July 2019; and
- Medium combustion plant (MCP): comply with emission limit values, July 2019.

5.8 Medium Combustion Plant BAT

The MCPD defines combustion plant as '*any technical apparatus in which fuels are oxidised in order to use the heat thus generated, engine means a gas engine, diesel engine or dual fuel engine, gas turbine means any rotating machine which converts thermal energy into mechanical work.'*

Gas Engines benefit from lower NOx emissions than diesel engines and can utilise gas delivered by the national gas grid, avoiding the additional transport and fuel storage issues associated with diesel systems. The natural gas fuel will be obtained directly from the mains gas supply from the National Grid. This removes the need for storage of fuels and stock management on site and eliminates environmental risks including containment failures, leaks and spills that are associated with the storage of liquid fuels.

The choice of natural gas fuelled gas engines is considered BAT.

JM will meet the emission limits for new engines and gas turbines defined by the Medium Combustion Plant Directive (2015) as outlined in Section 5.5. Operation of the boilers to meet emission limits is considered to be BAT.

5.9 Energy efficiency BAT

'Energy efficiency standards for industrial plants to get environmental permits' states that a facility must operate an *installation within an energy management system like ISO 50001 or using the techniques in section 2 of the Reference Document on Best Available Techniques for Energy Efficiency*.

Whilst JM does not have a formal energy management system, there are processes in place to ensure that energy efficiency is considered when procuring new plant and equipment. Energy KPIs are in place at the site and the monitoring of energy usage at the site is undertaken.

JM report energy KPIs as a part of the annual EA annual reporting. Energy reduction targets are present in each department (R&CE, fuel cells and CAO) under the ISO14001 and departmental improvement plans. Each department has a net Zero and sustainability coordinator who leads sustainability improvement plans.

BAT as stated in the Reference Document on Best Available Techniques for Energy Efficiency, February 2009 is summarised in Appendix 05. Overall, the proposed changes with respect to energy efficiency are considered to be BAT.

5.10 Closure & Decommissioning

The new boilers will be added to the JM site closure plan with details on how the process will be decommissioned on closure.

5.11 Information & Reporting

The new boilers will be managed with the site's ISO14001 environmental management system with key information on raw materials, energy and utility use, monitoring reported to the regulator where required.

APPENDIX 01

EMS Manual (Reference JMC 700 001 Issue 12)

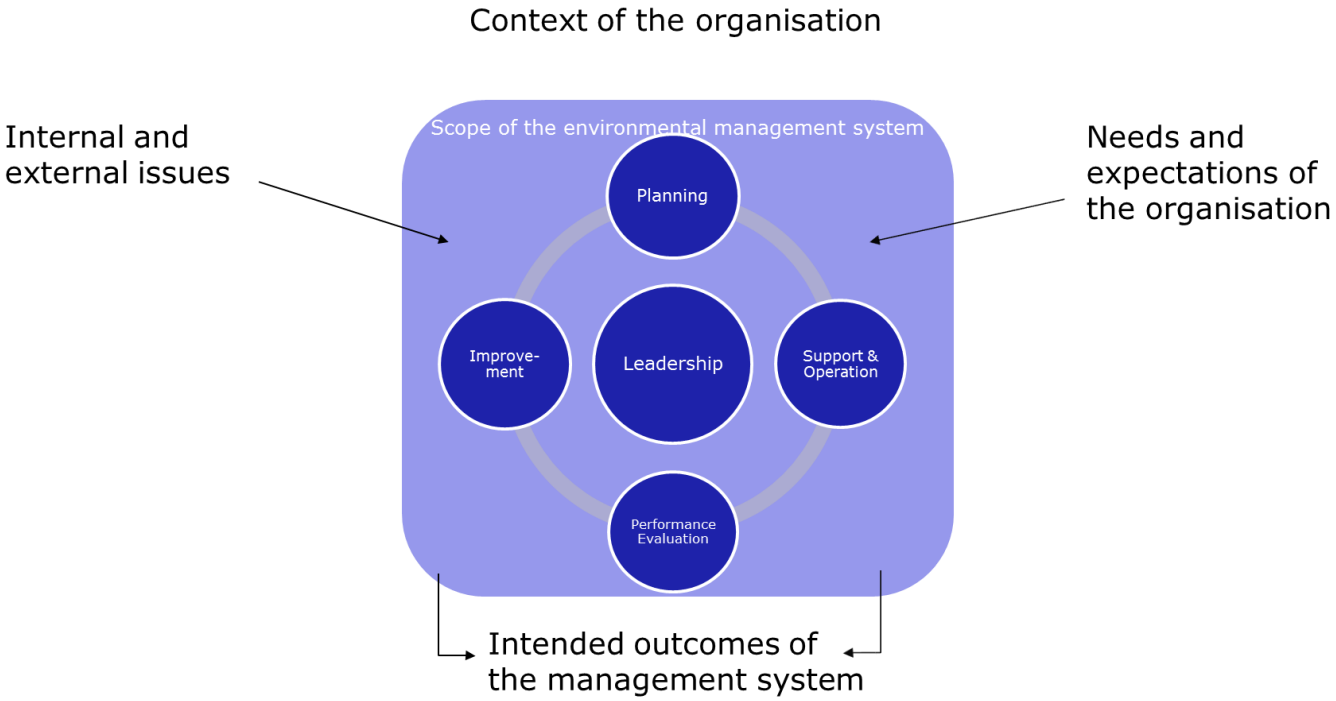
R&CE Environmental, Health and Safety Management System

Environmental Management System Manual

1 INTRODUCTION

This Management System covers the Refining & Chemicals UK (R&C UK) Business Unit at Royston and Brimsdown sites. For the purposes of this management system these operations may be termed 'the company'.

The EMS follows the continuous improvement PDCA model as set out in the ISO14001:2015 standard:



2 CONTEXT OF THE ORGANISATION

Johnson Matthey Plc is a multinational speciality chemicals company with over 200 years of operation which operates in a diverse range of industries including; Environmental, Automotive, Chemical, Pharmaceutical, Recycling, and Oil, Gas and Refineries.

We are a technology leader in four fundamental areas of science

- Precious metals chemistry and metallurgy
- Surface Chemistry
- Materials characterisation and testing
- Material design and engineering

Our vision is for a world that's cleaner and healthier; today and for future generations.

Our Vision, Strategy and Values are defined in our corporate JM website.

Refining and Chemicals Europe sits within the recycling Efficient Natural Resources division of JM and spans the Recycling, Chemical industry sectors utilising precious metals chemistry and metallurgy with the purpose to refine secondary precious metals and produce chemical products.

The external and internal issues that are relevant to the purpose of R&CE and which affect the ability to achieve its outcomes are defined by PESTLE analysis which is completed by representatives from the EHS, Quality and strategic Management team. The output of the review is recorded in document JMC 700 003. This is reviewed on an annual basis.

2.1 Understanding the Organisation and Its Context

The context of the organisation is assessed by the strategic management team, led by the R&CE Site Director and with input from the EHS Managers and Environmental Coordinators.

The review assesses:

- whether the issue is positive or negative
- whether it is internal or external
- how it affects the company in achieving its aims
- The significance, with:
  - 0 for No identified impact
  - +/-1 for a Minor impact
  - +/-2 for a Significant impact
- The appropriate action:
  - C to control
  - I to influence indirectly
  - M for issues to monitor

The PESTLE analysis is recorded in document JMC 700 003 and is reviewed on an annual basis at the management review, or as deemed necessary by Site Director, EHS Managers or Environmental Coordinators.

Reference ISO14001:2015 Clause 4.1
Understanding the organisation and its context

2.2 Understanding the Needs and Expectations of Interested Parties

The interested parties relevant to the organisation, the needs and expectations are defined assessed by the strategic management team, led by the R&CE Site Director and with input from the EHS Managers and Environmental Coordinators. This is reviewed on an annual basis at the management review, or as deemed necessary by the management team, and are recorded in the table below.

Interested Party	Internal / External	Needs & Expectations	Regulatory Compliance obligations
Customers	Internal & Internal	Delivery of products or services within specification, on time. To meet compliance obligations.	None
End Users	External	Reliable performance of downstream environmental technology products which use JM and R&CE products.	None
Employees	Internal	Job security and the opportunity develop and learn. Consultation in matters which may affect them and the business. A safe and environmentally friendly work place.	None
Investors	External	Sustained return on investment. Continued growth of the company. Ethically, Environmentally and Socially responsible business practices.	None
Regulators– Environment Agency	External	Maintain compliance with Environmental Permits through compliance with BAT. Submit requests for variations or surrender of permits Report environmental performance. Report permit breaches and preventative/corrective action. Report hazardous waste consignment. To ensure continuous improvement in Environmental performance and report these.	Yes
Regulator – Local Water Authorities	External	Maintain compliance with trade effluent consents. Report trade effluent consent breaches and preventative/corrective action. Notify of changes that affect trade effluent discharges.	Yes
Regulators – Local Authorities	External	Submit planning requests for new buildings. Provide information on new processes which may impact on local air quality (via EA).	Yes
Site EHS (Royston only)	Internal	To maintain compliance with Regulatory requirements on Royston site: To communicate R&C compliance for external regulators in line with Environment Agency, Local Authority and Local Water Authority requires as above.	Yes

Interested Party	Internal / External	Needs & Expectations	Regulatory Compliance obligations
Group EHS	Internal	To Provide Annual Corporate Social Responsibility Reporting, including Energy, Waste and Carbon Emissions for GRI. To Provide Waste Packaging data. To provide production data for EU ETS and to Agree energy data for both sites EU ETS submission.	Yes
Public	External	Ethically, Environmentally and Socially responsible business practices.	None
Local Community	External	To Engage with the local community To eliminate or reduce local nuisance issues associated with the To prevent local pollution	None
Certification Bodies	External	Notification of change of scope Provide environmental compliance evidence in audits Report environmental data for certification purposes	None
Trade Association (TA) bodies. (Chemicals Industries Association Royston) (Non-Ferrous Metals Sector Association Brimsdown)	External	Share environmental performance information to effectively represent the industry sectors in consulting with regulatory bodies during revision of legislation.	None
Service Providers (Waste)	External	Notification of quantity, composition and hazard of wastes.	None
Service Provides (Freight carriers Hauliers)	External	Notification of quantity, composition and hazard of wastes.	None
Routine contractors on site (QAS cleaning, Tonners, Micrormain, JHE, SE Cooling, etc)	External/Internal	Job security. A safe and environmentally friendly work place. Consultation in matters which may affect them and their business.	None
Suppliers (Energy)	External	Notification of change to energy requirements.	None
Suppliers (Water)	External	Notification of change to water use requirements.	None
Suppliers (Reagents)	External	Notification of change to reagent use requirements	None

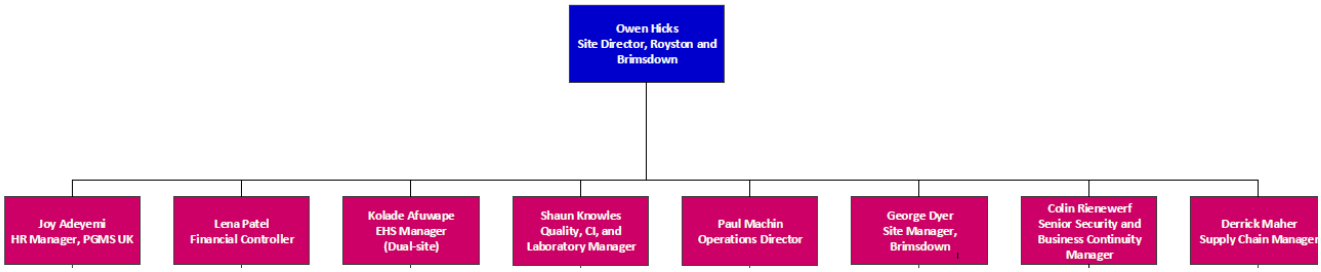
Reference ISO14001:2015 Clause 4.2
Understanding the needs and expectations of interested parties

2.3 Determining the Scope of The Environmental Management System

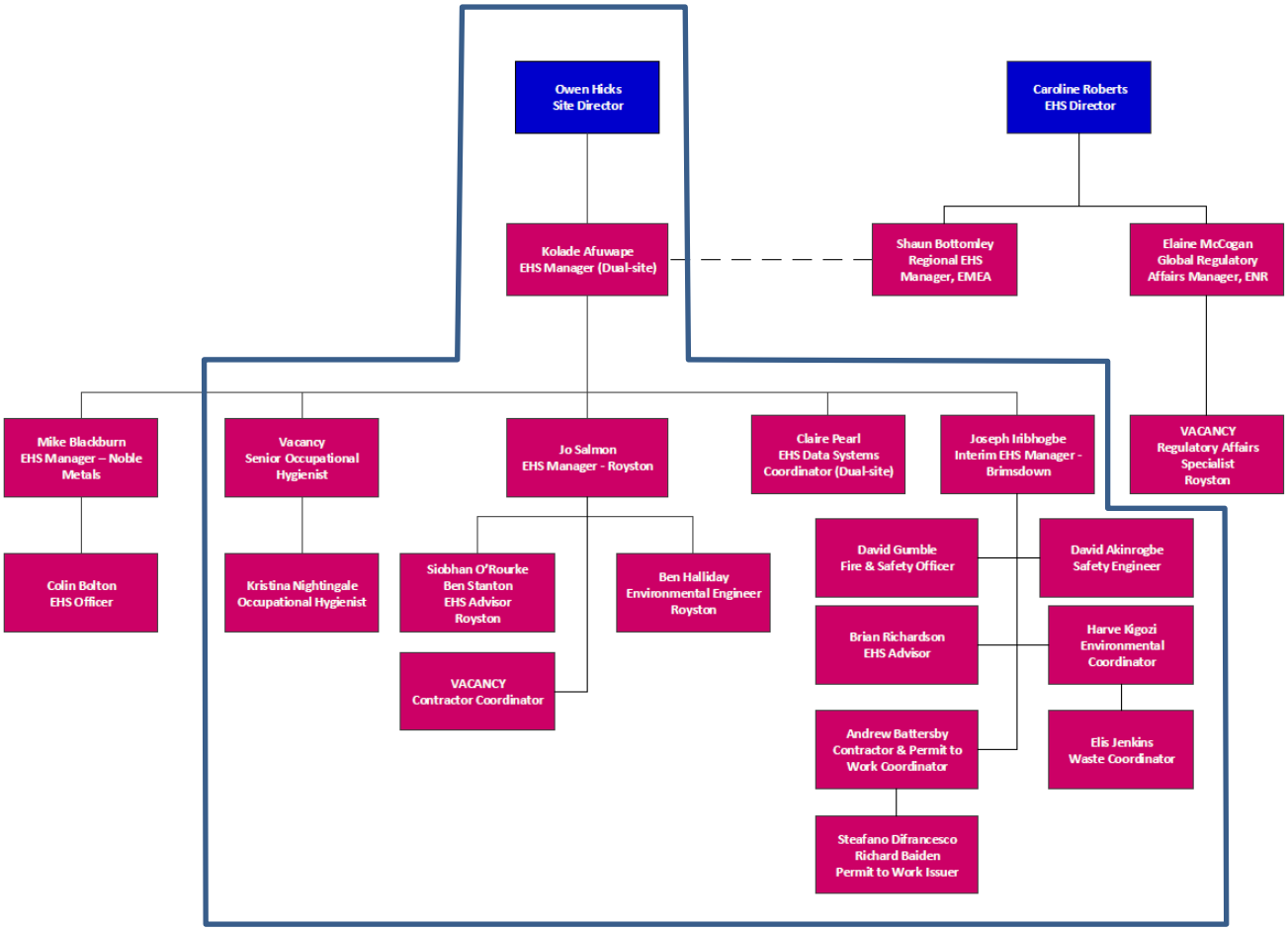
This Management System covers the Refining & Chemicals UK (R&C UK) Business Unit at Royston and Brimsdown sites. For the purposes of this management system these operations may be termed 'the company'.

The scope document JMC 700 000 describes the boundaries of the Environmental Management System (EMS) and describes the location

A full organisational chart is available from the R&CE HR department upon request, an overview of R&CE structure and an overview of the EH&S structure in R&CE are given below:



R&CE /PGMS Organisational Chart



R&CE EHS Structure inside box

The EMS is managed by the E, H & S Department and the Environmental Engineers/Coordinators at Royston and Brimsdown are the environmental representative for communications at the respective sites in accordance with BS EN ISO14001 Section 7.4.1.

The on-going work of continuous environmental improvement is managed by the EMS Reviews at the site EHS management meetings.

Reference: *ISO14001 Clause 4.3*
Determining the Scope of the organisation

2.4 Environmental Management System

The implementation of the EMS is defined this EMS manual JMC 700 001.

The maintenance of the EMS is managed by the Environmental Engineers/Coordinators and EHS Managers in accordance with section 3.3 of this manual.

The knowledge gained from the company's context review and interested parties review, as defined in section 2 of this manual, are considered when maintaining the EMS.

Reference: *ISO14001 Clause 4.4*
Environmental Management System

3 LEADERSHIP

3.1 Leadership and Commitment

The R&CE Site Director and senior management team take accountability for the EMS and demonstrate leadership and commitment though; regular reviews at steering committee meetings and EMS review meetings; ensuring that an environmental policy is established; setting top level objectives and targets aligned to strategic business needs; reviewing progress against strategic divisional sustainability targets; Ensuring the resources needed for the EMS are available; Communicating the importance of effected Environmental Management and conforming to EMS requirements; Ensuring the EMS achieves its intended outcomes; directing and supporting persons to contribute to the effectiveness of the EMS; promoting continual improvement; supporting other relevant management to demonstrate their leadership as it applies to their areas of responsibility.

3.2 Environmental Policy

The Environmental, Health & Safety Policy Statement (Royston and Brimsdown Sites) is a declaration of the principles for maintaining and improving environmental performance.

It provides a framework for action and for the setting of environmental objectives and targets.

The policy is appropriate to the purpose and context of the company, including the nature, scale and environmental impacts of the Company's activities and is endorsed by senior management.

The policy is communicated to all employees and available to the public upon request.

At least once a year, the policy is reviewed and revised to reflect any changes.

Paper copies of the Environmental, Health & Safety (EHS) Policy Statement are available on request and it is also available on the Intranet.

All paper copies should be regarded as uncontrolled. Confirmation of the controlled version content can be obtained from Royston's Quality Assurance Department.

Reference: ISO14001 Clause 5.2
Environmental Management System

3.3 Organisational Roles and Responsibilities

The R&C UK – Royston and Brimsdown structure, together with management roles, responsibilities and authorities under the BS EN ISO9001 quality system are described in the Quality Assurance Management Manual.

Roles, responsibilities and authorities are defined, documented and communicated in order to facilitate effective environmental management.

The roles, responsibilities and authorities relating to the Environmental Management System (EMS) are communicated at all levels.

Appropriate human resources, specialised skills, technology and financial resources are provided by R&C UK – Royston and Brimsdown to ensure implementation and maintenance of the EMS.

The EMS is managed from E, H & S Department and the E, H & S Manager is the Environmental Management Representative.

All Johnson Matthey employees are responsible for minimising environmental impacts in all areas of their work.

In addition, some key personnel have been assigned further responsibilities in terms of the development of the EMS:

The Site Director (R&C UK) has overall responsibility for all environmental issues in R&C UK – Royston and Brimsdown and is responsible on a day to day basis for ensuring that:

- Adequate resources are made available and that an effective programme of improvements is implemented.
- A continuing programme of environmental improvement is part of the overall business strategy.
- Clear and effective policies and objectives are provided to ensure compliance with the Corporate Environmental Policy.
- Reviewing the EMS at least annually and authorising Objectives and Targets as appropriate.

The Operations Director (R&C UK) is responsible for ensuring that:

- The Management team have a clear understanding of their environmental responsibilities and are adequately trained and know and understand what must be done.
- All plant and equipment is designed, operated and maintained to minimise the environmental impact.
- Environmental issues form part of Departmental performance targets.
- There is an effective programme of measurement to determine the improvement in environmental performance and the reduction of the environmental impact from all forms of emissions, waste and energy.
- EMS Review Team meets as required to maintain the on-going programme of work for continuous environmental improvement.

The Operations, Department and Production Managers are responsible for ensuring that:

- Their operations comply with the environmental policies and statutory obligations.
- Operations under their control do not cause a nuisance to the public.
- All employees under their control are adequately trained, equipped, instructed and supervised.
- All plant, equipment, processes and procedures are, so far as is reasonably practicable, adequately maintained.
- All persons under their control are aware of their responsibilities to prevent, minimise and/or render harmless significant environmental impacts.
- Environmental aspects and for their Department are identified and reviewed annually or following significant changes to their Department.
- Improvement Plans (DIPs) are set annually in line with Site Improvement Plan (SIP).
- Resources are applied efficiently to the areas of greatest need.
- They report any environmental concerns to the Operations Manager.
- Planned Preventative Maintenance procedures are in place and that they are adhered to.

Technical Support staff are responsible for:

- Ensuring that compliance monitoring and reporting is undertaken in accordance with the Environmental Permitting Regulations 2010.
- Ensuring local compliance with the Environmental Permitting Regulations 2010.
- Reviewing Departmental Environmental Aspects.
- Maintaining process optimisation with respect to reagent use, energy use and waste minimisation.
- Ensuring environmental issues are appropriately accounted for in process instructions and subsequent revisions
- Training of operators in key environmental aspects of processes.

Environmental, Health and Safety Champions are responsible for:

- Communicating to management any proactive or positive idea that can improve EH&S performance
- Communicate with employees any EHS initiatives from either the Department Manager or the EHS Department.
- Attend departmental EHS meetings and provide support to the Department Manager/Team Leader
- Undertake workplace inspections as per agreed schedule with the Department Manager.
- Co-ordinate environmental monitoring, including monitoring the segregation of waste, basic energy monitoring, bund inspections and LEV checks where required with in departments
- Assist in the investigation of accidents and incidents where appropriate
- Meet with the HSE/Environment Agency

The Managers responsible for the Effluent Plants at Royston and Brimsdown are responsible for:

- Liaison with sewerage provider in conjunction with the Environmental Adviser with respect to revision and compliance with Trade Effluent Consents.
- Investigation of trade effluent excursions
- Reporting of excursions to the Environment Agency/Thames Water at the Brimsdown site or Anglian Water, via the (Royston) Site EHS team, if the Environmental Adviser or site EHS Managers are not available.

The Quality and Continuous Improvement Manager is responsible for:

- Coordinating the completion of the Divisional Sustainability budgets for R&C UK.
- Ensuring that Manufacturing Excellence savings with sustainability benefits communicated to Departmental Managers, EHS managers and Environmental Engineer to ensure benefits are captured in the divisional sustainability improvement targets and Site Improvement (SIP) and Departmental Improvement (DIP) Plans

The Head of Engineering and Engineering Managers are responsible for ensuring that:

- All plant, processes and equipment are maintained and calibrated under an effective planned preventative maintenance system to ensure optimum performance.
- All employees and contractors under their control are adequately trained, equipped, instructed and supervised.
- All persons under their control are aware of their responsibilities to prevent, minimise and/or render harmless significant environmental impacts.
- Adequate resources are assigned to the installation and maintenance of environmental control and monitoring equipment
- Any modifications to plant, processes or equipment do not compromise their environmental performance and that where appropriate such changes are notified (in advance) to the EHS Department in line with Management of Change policy requirements.
- Energy efficiency improvements are identified, scoped, prioritised and delivered in line with EMS continuous improvement plans/improvement programmes in support of divisional sustainability targets.

The Process Safety Manager is responsible for ensuring that:

- A programme of process safety review is established and implemented
- A plan of Process Safety Management review actions is coordinated on the Mirashare action tracking database
- Major accident hazard reviews are completed, and that findings and actions are raised and tracked on Mirashare.

The Project Management Manager is responsible for ensure that:
The R&C UK Project Management Procedure (JMC 133 001) is used when starting a project and an Environmental Impact Assessment is undertaken (JMC 710 004)

- Statutory Environmental and legal requirements are understood and included when developing a new project.
- Ensuring that adequate monitoring equipment is installed where appropriate.
- All employees under their control are adequately trained, equipped, instructed and supervised including having a high level of awareness of the latest techniques for environmental control
- All persons under their control are aware of their responsibilities to prevent, minimise and/or render harmless significant environmental impacts.
- Operations under their control do not cause a nuisance to the public.

The Dual Site Analytical Manager is responsible for:
Ensuring the timely analysis of environmental samples as required

The personnel responsible for Quality Assurance are responsible for:

- Maintaining control of EMS documentation (Publishing and releasing copies of EMS documentation)

The Security personnel are responsible for:

- Receiving and responding, as appropriate, to public complaints received out of normal working hours

The Purchasing Manager is responsible for:

- Monitoring conformance to environmental purchasing policies
- Approving the environmental credentials of all suppliers and contractors
- Supporting the DOC audit programme

The Royston and Brimsdown Environmental, Health and Safety Managers are the designated Management Representatives for the EMS (BS EN ISO14001 Clause 4.4.1) and is responsible for ensuring that:

- The EMS is implemented and managed, and the Managing Director is kept informed of its continuing performance.
- The overall Environmental, Health and Safety performance/activities are monitored.
- A formal review of the EMS is conducted annually covering all sections of the standard. In addition, an assessment of monitoring for emissions to atmosphere and effluent against OMA criteria.
- Advice and support on local policies and procedures is provided.
- Relationships with Environment Agency (EA), Health & Safety Executive (HSE), local authorities and other regulatory bodies are maintained.
- Changes in legislation are reviewed and a Register of Legislation maintained.
- The links between the EMS, Energy Plan and the Corporate Policy are maintained.
- Ensuring that an effective emergency response plan is in place and maintained which ensures a co-ordinated course of action in the event of an emergency.
- The co-ordination of all environmental training activities and the maintenance of environmental training records
- Effluent excursions are reported to the Environment Agency/Thames Water or Anglian Water
- MCerts Management System is maintained.

The Environmental Engineers and Coordinators are responsible for advising on all day to day matters of the environment in R&C UK – Royston and Brimsdown. Duties include:

- Co-ordination of an effective monitoring service for stack emissions, ground water quality and boundary noise.
- Monitoring compliance with statutory obligations and acting if these are breached.
- Advising and liaising with other Business Units on environmental issues.
- Monitoring compliance with the Environmental Permit Regulations and ensuring reports are provided as required.
- Co-ordinating all environmental audit programmes and managing Internal EMS Audit teams
- Being the main point of contact for third party assessors, environmental enforcement agencies and for public complaints during normal working hours
- Identifying and providing access to legal and other requirements which are applicable to the environmental aspects of the company's activities, products and services
- Effluent excursions are reported to the Environment Agency/Thames Water or Anglian Water
- Ensuring compliance with Packaging Waste obligations.

The Regulatory Affairs Adviser is responsible for:

- Maintaining an information system for the classification and labelling of hazardous materials for supply
- Fulfilling the requirements of the Dangerous Goods Safety Adviser.
- Determining waste classifications
- Managing the organisation of the movements of trans-frontier shipments of waste
- Ensuring pre-acceptance review of new hazardous wastes at the Brimsdown site. –

The EHS Data Systems Coordinator is responsible for:

- Administrative support of the EMS and Environmental Permitting reporting requirements
- Coordination activities in support of EMS
- Coordinating EMS internal auditor training
- Coordination of external EMS audit
- Coordination of the internal audit programme at Royston and Brimsdown
- Completing Brimsdown EA hazardous waste returns

The Group Environment and Energy Coordinator is responsible for:

- Ensuring that the requirements of the Energy Plan are met
- Ensuring that energy data is disseminated to Environmental Representatives on a regular basis
- Producing submissions for the Climate Change Agreement (CCA), EU Emissions Trading Scheme (EU ETS) and Combined Heat and Power Quality Assurance (CHPQA) programme, as required.

The Group Environmental Coordinator is responsible for:

- Coordinating the Royston site Environmental Action plan in support of Environmental Permit compliance
- Coordinating the Duty of Care audit programme in conjunction with R&C UK purchasing for the Royston and Brimsdown sites.

The Business Development Director is responsible for:

- Ensuring environmental considerations are appropriately considered during products, processes and service development.

<u>All employees</u> are responsible for:

- Complying with all statutory and local obligations.
- Co-operating with Departmental management to enable them to comply with statutory and local obligations.
- Working with management in developing effective waste minimisation projects.
- Prompt reporting to management of all environmental incidents

Further responsibilities are clearly outlined in company procedures where appropriate.

4 PLANNING

4.1 Actions to Address Risk and Opportunities

4.1.1 General

When undertaking Planning activities as defined in section 4.1.4 of this manual company considers:

- Issues identified in the Organisation and Context review (PESTLE) as defined in section 2.1 of the manual
- The needs of interested parties, and specifically those needs which form the company's compliance objectives
- The scope of the EMS, as defined in section 2.3 of this manual, and the EMS scope document JMC 700 000.

The company considers Risks and Opportunities relevant to the organisation and context, the compliance needs of interested parties and the Environmental Aspects, as defined in section 4.1.2 of this manual, based on significance. This information is held on a *Risks and Opportunities Register* on the company's Legal Update Service (LUS) website.

LUS is available to all employees by selecting the LUS link from the R&CE webpage.

Username: refining&chemicals

Password: johnsonmatthey

4.1.2 Environmental Aspects

Environmental Aspects of the company are identified by responsible managers following documented procedure JMC 710 002. When identifying Aspects Normal, Abnormal and Emergency issues are considered.

The significance of Environmental Aspects and Impacts are identified by the Environmental Engineer/ Coordinator and EHS managers on the LUS system in accordance with JMC 710 002.

The criteria for selection of significance is stated in JMC 710 002.

4.1.3 Compliance Obligations

The company's compliance obligations are determined and recorded in the LUS legal register. Access to LUS is available to all Employees following the guidance in section 4.1.1 of this manual.

The legal compliance obligations related to its Environmental Aspects are determined and listed in the LUS Aspects and Impacts register.

Consideration of how these compliance obligation s apply to the organisation is give in the organisation and context review and in the compliance needs of Interested parties as defined in sections 2.1 and 2.2 of this manual. These compliance obligations are considered when determinised the EMS Scope, EHS Policy and Improvement plans as defined in Sections 2.3, 3 and 4.

4.1.4 Planning Actions

The actions to address significant Aspects, Compliance obligations and Strategic Issues Identified in the *Risks and Opportunities Register* are recorded and tracked in the *R&CE Risks and Opportunities Register*. This includes what the actions are, who is responsible for the actions and the timeframes for delivery.

The *Risk and Opportunities Regi*ster is managed by a senior management representative appointed by the R&CE site director. The *Context of the Organisation (PESTLE)*, the *Risks and Opportunities Register* and the planning actions are reviewed on a 2-monthly basis at every other senior management meeting.

4.2 Environmental Objectives and Planning to Achieve Them

4.2.1 Environmental Objectives

Environmental Objectives are specified by the Site Director and R&CE Top management teams. When setting environmental Objectives, the strategic issues identified in the Organisation and Context review (PESTLE), the organisations Compliance Obligations, and the organisations Significant Environmental Aspects are considered. The environmental objectives are also aligned to the Johnson Matthey corporate commitments and divisional objectives.

The strategic environmental objectives are recorded at the divisional level through the divisional sustainability budget process. In this process the commitments for key sustainability targets are agreed by the Site Director and submitted by the EHS team to the Divisional Sustainability team via shared excel files on the divisional sustainability SharePoint site. These targets include Energy reduction and water usage reduction, and the normalising production metrics are currently set as production figures for the Brimsdown Site, and Production and Sales figures for the Royston site.

The progress of each measurable is recorded on the JM Enablon system for each site on a monthly basis by the EHS teams at the Royston and Brimsdown sites.

The Environmental Objectives are measurable and normalised against production metrics to ensure a true reflection of the impact of improvements is measured.

4.2.2 Planning Actions to Achieve Environmental Objectives

The local departmental improvement plans have an Environmental Sustainability section where the individual department actions are recorded. These DIPs have an Environmental/Sustainability section which a strategic link to the top-level targets and Objectives agreed by the site director in the sustainability budget process.

The predicted savings are calculated in the DIPs and these are used by the Site EHS team to calculate the total normalised sustainability values for R&CE.

The DIPs and progress against plans are reviewed every 2 months, at the EHS management meeting by the Department managers and the EHS team.

Further information on the continual improvement planning process is included in procedure JMC 1202 025

5 SUPPORT

5.1 Resources

R&CE will provide the necessary resources to support the business unit environmental Management system.

Any gaps in resource requirements for any reason from strategic, planning activities, risks or opportunities, compliance obligations, interested parties' complaints or issues, staff succession or organisational change may be identified by anyone in the organisation and communicated to local management, the EHS department and senior management either directly or via structured communications channels such as the EHS management meeting or the EHS steering committee.

Requests for additional resources are made by the responsible manager with support by the EHS department. Where resources involve recruitment Human Resources policies and procedures, located on the ISO9001 Quality Management System, govern this process.

Any proposed changes in resources affecting the EMS, including restructuring or removal of a key job roll, will be subject to the R&CE management of change policies and procedures, located on the QMS, with approval from the relevant EHS manager to ensure the resource requirements to manage the EMS are not compromised.

Resource requirements to maintain the internal audit programme are reviewed on an annual basis by the Environmental Engineers and EHS Managers as stated in section 7.2.2 of this manual.

5.2 Competence

R&CE Royston and Brimsdown ensure that all employees performing tasks which can cause significant environmental impact are competent on the basis of appropriate education, training and/or experience.

R&CE Royston and Brimsdown have documented procedures for identifying the training needs of all employees whose work may create a significant impact on the environment to ensure they receive the appropriate training.

The training needs of individuals are identified within the R&CE Learning Management System (LMS) through Job role specifications.

In general, the Job Role specification will be made from core elements including Environmental Awareness and EHS induction, to role specific training which may include task-based training and role specific run-based training. Competence and effectiveness of training is demonstrated through a combination of ways as stated in L&D policies and procedures:

a) Assessment test with pass criteria LMS after the training completion.
b) Practical assessment and observation by assessor trainer for task-based training
c) Use of externally accredited training organisation
d) Audit programmes

5.3 Awareness

The company has documented procedures to make all employees aware of:

a) the importance of conformance to all aspects of the EMS
b) the potential or actual significant environmental aspect of their work activities and the environmental benefits of improved personal performance.
c) their roles and responsibilities in achieving conformance to all aspects of the EMS including emergency preparedness and response requirements.
d) potential consequences of departure from specified processes or operating procedures.

The LMS is used to provide employee declaration of awareness and understanding for key EMS documents including EHS policy and department specific environmental aspects.

5.4 Communication

5.4.1 General

The company has documented procedures for dealing with internal and external communication of environmental issues and aspects. The procedures include a documented communications plan which details all forms of communications to internal and external interested parties.

5.4.2 Internal Communication

The company has documented procedures for dealing with internal communication of environmental issues and aspects.

All communications to internal interested parties are detailed in the JM communication plan including team briefings to employees, structured EHS management meetings and use of other media to internally communicate EMS information.

5.4.3 External Communication

The company has documented procedures for dealing with internal and external communication of environmental issues and aspects. The procedures include receiving, documenting and responding to relevant interested external parties.

All communications to external interested parties are detailed in the JM communication plan including regulatory reporting requirements.

5.5 Documented Information

5.5.1 General

R&CE maintains a documented system detailing the core elements and the interactive structure of the Environmental Management System (EMS).

5.5.2 Creating and Updating

EMS documentation is controlled and issued in the same way as for the Quality Management System.

The EMS is integrated with the Quality Management System and it is therefore important that where appropriate, requirements of the EMS are dealt with using common procedures, work instructions, forms and checklists.

5.5.3 Control of Documented Information

R&CE maintains procedures for controlling all documentation required by the Environmental Management System.

The procedures ensure that:

- Documentation can be located
- Documentation is reviewed, revised and approved by authorised personnel
- The latest issue of documents is available, issued at all appropriate locations
- Documentation is promptly withdrawn when obsolete
- Obsolete documents retained for legal and/or knowledge preservation purposes are suitably identified

Documented procedures are maintained for the creation and modification of documentation.

All procedures and work instructions carry issue status and issue dates, any forms will carry issue status.

6 OPERATION

6.1 Operational Planning and Control

All activities will be planned to include maintenance associated with identified significant environmental aspects and in line with policy, objectives and targets.

This is achieved by having documented procedures, which specify operating criteria, to cover activities where their absence could lead to deviations from the environmental policy, objectives and targets.

Documented procedures are also maintained to communicate relevant procedures and requirements to suppliers and contractors who supply goods or services associated with identified significant aspects.

6.2 Emergency Preparedness and Response

The company maintains documented plans and procedures to identify potential for and respond to accidents and emergency situations and for preventing and mitigating environmental impacts associated with them.

The company reviews and revises, if necessary, relevant response procedures following accidents or emergency situations.

Effectiveness of emergency plans and procedures are ensured though periodic testing in accordance with local site regulatory requirements.

7 PERFORMANCE EVALUATION

7.1 Monitoring, Measurement, Analysis and Evaluation

7.1.1 General

The company maintains documented procedures to monitor and measure characteristics of the operations having significant impact on the environment.

Performance measures are based on recording information on relevant processes/operations, and assessment against environmental objectives and targets.

All monitoring/measuring equipment is evaluated, calibrated and maintained as necessary.

Records of calibration are held in the company calibration system.

Documented procedures are maintained to ensure monitoring measurement analysis and evaluation is competed in accordance with R&CE compliance and other requirements. A dual site compliance matrix is maintained which determines R&CE monitoring, measurement, analysis and evaluation requirements; the frequencies, the responsible people, and any interested parties that require updating.

7.1.2 Evaluation of Compliance

Documented procedures are maintained to ensure periodic evaluation for compliance with relevant environmental legislation and regulation and other needs.

The compliance obligations of both the Royston and Brimsdown sites are maintained though the Legal Update Service, which is a contracted out legal register service. The legal register is a combined Royston and Brimsdown Register which allows R&CE to specify whether individual legislation applies to one or both of the sites. In addition, other non-regulatory compliance obligations are added to the register by the Environmental Engineers or EHS managers as applicable.

All legislation within the site is review continually, on an ongoing basis, by LUS regulatory subject matter experts. Any changes to the legislation due in the next 6-months is featured in and “On the Horizon” section of the register. Monthly updates are sent to all R&CE LUS system subscribers which details all changes to the legislation which have passed into force, and which are due on the horizon in the next 6 months.

Evaluation of compliance is ensured though a third-party audit by the LUS audit team. The audit team visits site on an annual basis, with the Royston site and Brimsdown site hosting the audit on alternate years. The legal audit is shown on the combined ISO9001/14001 Audit programme.

Any issues found with the audit are raised as internal actions on the LUS system. Equivalent actions or Non Conformities (NCs) are raised on Mirashare as appropriate to ensure site of compliance issues through the R&CE NC management processes.

Access details for the LUS system are found in section 4.1.1 of this manual.

7.2 Internal Audit

7.2.1 General

R&CE Royston and Brimsdown maintain internal audit programmes for the assessment of the Environmental Management System

The audits are used to determine:
a) conformance to the management system
b) conformance with BS EN ISO14001
c) correct implementation and maintenance

Results of the internal audit provide information to the EMS Review team.

The audit programme is based on:
a) Environmental importance of an activity
b) Results of previous audits

Audit procedures address full scope, frequency and methodology together with defined responsibility for conducting and reporting audits

Internal auditors will not audit their own departments or processes to maintain independence of the audit process.

7.2.2 Internal Audit Programme

The R&CE Royston and Brimsdown internal ISO9001/14001 audit programme is set by the EHS team, Environmental Engineers and EHS managers as applicable in conjunction with the Quality team who coordinate the ISO9001 of the audit programme and support the ISO14001 programme.

All areas of the EMS scope are audited on a risk basis with the intention to cover all higher risk areas at least once a year and loss risk areas of scope cover at least once every 3 years. The Audit programme runs for three years.

At the start of each year the ongoing audit plan is reviewed and adjusted in line with Risks and Opportunities. The resources to undertake internal audits are also reviewed at this point to determine whether any additional auditors need to be trained and added to the R&CE internal auditors.

With regards to specific compliance obligations:

Internal MCerts audits at Brimsdown for effluent flow meters are completed annually.

Audits of periodic monitoring consultants will be undertaken on both sites at least every 2 years. Audits of continuous emissions monitor operation will be undertaken at least every two years in alternate annual cycle to the monitoring consultant audit.

The criteria for each audit is set by the Environmental Engineer and laid down in the three-year audit clause criteria planner document. Core requirements of the standard, e.g. aspects, continuous improvement etc are covered in every audit, the remaining clauses of the standard are covered as necessary on a three-year rolling cycle with the intent to cover all areas of scope fully with the standard over a 3-year period.

7.3 Management Review

Top management shall formally review the organisation's environmental management system annually, within 1 month of the continuous improvement year end date, to ensure its continuing suitability, adequacy and effectiveness. Reviews shall include assessing opportunities for improvement and the need for changes in the environmental management system, including environmental policy and environmental objectives and targets. The Environmental, Health & Safety Manager shall retain records of the management review.

The as a minimum the agenda will include, but not be limited to:

1.0 Status of actions from previous management reviews
2.0 Review of changes in R&CE:
  2.1 External and internal issues that are relevant to the EMS;
  2.2 The needs and expectations of interested parties, including compliance obligations;
  2.3 Significant Environmental Aspects
  2.4 Risks and opportunities
3.0 Environmental Policy and & Manual
4.0 Extent of achievement of Objectives and Targets
  4.1 SIP
  4.2 DIPs
5.0 Review of R&CE Environmental Performance review:
  5.1 Non-conformities and corrective actions;
    5.1.1 Accidents and Incidents
  5.2 Monitoring and measuring results;
  5.3 Fulfilment of compliance obligations;
    5.3.1 EPR Breaches
    5.3.2 TE Consent Breaches
  5.4 Audit results;
    5.4.1 Internal;
    5.4.2 External;
  5.5 Adequacy of resources, people, training;
  5.6 Relevant communications from interested parties;
    5.6.1 Complaints
    5.6.2 Regulatory CAR reports
    5.6.3 Communications
  5.7 Opportunities for continual improvement
6.0 Legal and Other requirements review
7.0 Actions
8.0 AOB

The outputs from management review shall include any decisions and actions related to possible changes to environmental policy, objectives and targets and other elements of the environmental management system, consistent with the commitment to continual improvement.

The Management Review is attended by (as a minimum)

- Site Director (R&C UK)
- Operations Director (R&C UK)
- Royston EHS Manager (R&C UK)
- Brimsdown EHS Manager (R&C UK)
- Environmental Engineer (R&C UK)
- EHS Data Systems Coordinator (R&C UK)

Any of the following may optionally attend:

- EHS Advisor – Royston (R&C UK)
- EHS Adviser – Brimsdown (R&C UK)
- Operations Manager (Chemical Products UK)

Reference: ISO14001 Clause 9.3
Management Review

8 IMPROVEMENT

8.1 General

8.2 Nonconformity and Corrective Action

R&CE maintains procedures for dealing with non-conformity which identify responsibilities and authority for investigation and initiating corrective/preventative action. Corrective action is focussed on identifying and addressing the root cause.

Records of non-conformity actions are held on the Mirashare action tracking database. Progress on action completion against target dates are reviewed on a regular basis at the EHS management meeting and the steering committee meeting.

R&CE has a process to identify and escalate issues with overdue EHS related actions, including EMS non-conformities. Where corrective actions have not been addressed in time due to resource issues or complexity of root causes, the escalation of these issues will allow senior management to effectively resource and support the proposed corrective action.

8.3 Continual Improvement

R&CE maintains processes and documented policies and procedures to ensure continual improvement, as defined in this EMS Manual.

Document Admin

DO NOT PRINT THESE PAGES

(*) Required - *Failure to complete required sections below will result in the rejection of the document by QA*

Document Owner & Deputies (*)

The owner should be the department manager. Responsibilities can be delegated as listed below.

Title	Name
Environmental Engineer	Ben Halliday
Waste Coordinator	Elis Jenkins
EHS Manager Royston	Jo Salmon
EHS Manager Brimsdown	TBC

Document History (*)

Issue	Date	Person	Change Details
1	17/07/02	D Hill/A Newton	New document
2	11/02/04	A Newton	Change Chem BU to PCT. Job title changes
3	17/12/04	A Newton	Update to include org changes in Structure & Responsibility, Management Review
4	24/03/05	A Newton/D Hill	Wording change to description of internal audits
5	14/06/06	D Hill	Update of Structure & Responsibility section
6	18/01/07	I Downie	Amend ISO references to match new standard ISO14001:2004
7	10/02/11	D Hill/N Cross/K Murray	Add description of Alfa Aesar activities, where applicable. Define scope. Amend responsibilities for Effluent Plant, Engineering, Reg. Affairs. Amend reporting for effluent excursions. Revise definition of Management Review
8	12/12/12	N Cross/K Murray	Reference Environmental Permitting Regulations 2010. Reference EH&S Champions + accountabilities Update EHS Managers Responsibilities, EMS audit, Management review
9	21/04/15	N Cross/K Murray	Amended CCR to R&CE Amended ISO references to match new standard ISO14001:2011 General Requirements: amended ISO9001 standard Structure & responsibility: added Department Managers Management Review: amended to Refining/Products Reason: Internal audit action
10	14/01/19	B Halliday	Total re-write to comply with ISO14001:2015 standard. Amended ISO references to match existing standard Structure and responsibility: Amended for new roles; Site Director, Operations Director, Head of Engineering and Site EHS Managers. Amended responsibilities for Site EHS Managers, Environmental Engineer and Regulatory Affairs Advisor. Added new role EHS Data Systems Coordinator. COMAH responsibilities. Process Safety. Management Review: Updated content with requirement for review within month of end of continuous improvement year, updated agenda requirements and attendance list in line with External and internal Audit findings.

11	18/2/2020	B Halliday	Minor revision to clarify independence of auditor to area or process of audit, and role of Quality Team in supporting the ISO14001 internal audit programme. Removed reference to 2018-20 years' Improvement plan. Added new document admin pages and completed content. Updated R&CE/PGMS Organisation Chart.
12	11/08/2020	Z Laird	Minor admin changed – moving QMS location

Change Authorisation (*)

List everyone who is required to approve the content of and/or changes to the document in the QMS website.

Title	Name
Environmental Engineer	Ben Halliday
Waste Coordinator	Elis Jenkins
EHS Manager Royston	Jo Salmon
EHS Manager Brimsdown	TBC
QA	Helen Gilchrist

Document Admin Review (*)

The document owner/reviewer/author has checked the information on the pages below and updated it as required.

Title	Name	Date
Environmental Engineer	Ben Halliday	24 Feb 2020

Is signoff and/or training and competency assessment required for this new/changed document?

Link to decision tree.

If a competency assessment is required, the owner of this document must provide the questions for the competency assessment and send to L&D.

Notify/Sign off/Assess decision (*)

This must be completed, including providing the questions if relevant, before the new/changed document is sent for approval.

What is required?	Yes	No	N/A
Nothing	☐	☐	☒
Notification only (e.g. email).	☐	☐	☒
Signoff to acknowledge changes in LMS.	☒	☐	☐
Training and Competency Assessment in LMS.	☐	☐	☒
Questions written & sent to L&D?	☐	☐	☒
Personnel selected in the table below?	☒	☐	☐

Terms	Meaning
Notify	The document reviewer/author required to send notification of document/change by email.
Sign off	Required to sign off to acknowledge that they have read the document or change, via LMS
Assess	Required to complete training via LMS and take a quiz to assess competency/understanding.
Quiz	To assess competency/understanding
Who?	See below

(*) Required - *Failure to complete required sections below will result in the rejection of the document by QA*

Assignment of personnel for Notification/Signoff/Assessment (if required)

Choose the job titles for those who need to be notified or sign off against or be trained and competency assessed against this new document or document change.

SITE	Notify	Sign off	Assess
Royston	☐	☐	☐
Brimsdown	☐	☐	☐
Dual Site only	☐	☒	☐
OPERATIONS	Notify	Sign off	Assess
Operational	☐	☒	☐
Non-Operational	☐	☒	☐
Senior MANAGER	Notify	Sign off	Assess
Site Director/Manager	☐	☐	☐
Operations Director	☐	☐	☐
Labs, Quality & CI Manager	☐	☐	☐
HR Manager	☐	☐	☐
Supply Chain Manager	☐	☐	☐
Dual Site EHS Manager	☐	☒	☐
OTHER ROLE	Notify	Sign off	Assess
P to W Issuers (General)	☐	☐	☐
P to W issuers (Hot)	☐	☐	☐
P to W Issuers (Confined space)	☐	☐	☐
P to W issuers (High Voltage)	☐	☐	☐
First Aiders	☐	☐	☐
EHS Champions	☐	☐	☐
ISO14001 Auditors	☐	☒	☐
ISO9001 Auditors	☐	☐	☐
Main Site Controller	☐	☐	☐
Incident Controller	☐	☐	☐
Add more if required	☐	☐	☐
Department LEVEL	Notify	Sign off	Assess
All	☐	☒	☐
Operator/Analyst	☐	☐	☐
Deputy Team Leader	☐	☐	☐
Supervisor/Team Leader	☐	☐	☐
Department Manager	☐	☐	☐
Admin	☐	☐	☐
Other (specify)	☐	☐	☐

DEPARTMENTS	Select
Chemicals	☐
Smelting	☐
Evaluation	☐
Labs – Brimsdown	☐
PGMR	☐
VRP/Effluent	☐
Fine Chemicals	☐
Process Catalyst	☐
Dispensing	☐
Logistics – Reception	☐
Logistics – Stores	☐
Shipping	☐
Purchasing	☐
Finance	☐
HR	☐
L&D	☐
QA	☐
CI	☐
Sales	☐
Technical	☐
Maintenance – Royston	☐
Maintenance (Brims)	☐
Process Safety	☐
EHS	☒
Weighing Technology	☐
Maintenance Planning	☐
Compliance Engineering	☐
Production Controllers	☐
Supply Chain (other)	☐
AgT	☐
Other (specify)	☐

(*) Required - *Failure to complete required sections below will result in the rejection of the document by QA*

Change Note

Process document/SOP change/initiation Record (*)
To be completed by Change/Document Initiator

Date the Change Note information was reviewed	N/A

Does this change:		Action required if answer is YES
Fall within scope of the Management of Change procedure (JMC 815 050)	☐ Yes ☑ No	Raise Management of Change Assessment form (JMC 814 050) MOC Reference No:
Represent a change that may be significant and require customer notification (Procedure JMC 216 008): (*e.g. are new raw materials being used, new plant being used, new methods of manufacture etc.*). Has the change been assessed?	☐ Yes ☑ No ☐ Yes ☑ No	Notify Customer Services, who should inform customer using form JMC 114 020 (or JMC 114 010 for IATF16949) Complete a Control of change and Customer Notification Decision Record (RC 114 038)

If related to this change, have the following documents been reviewed?		Action required if answer is YES *(reference specific document number)*
Risk assessments	☐ Yes ☐ No ☑ N/A	
COSHH assessments	☐ Yes ☐ No ☑ N/A	
Manual Handling assessments	☐ Yes ☐ No ☑ N/A	
Batch Records	☐ Yes ☐ No ☑ N/A	
Procedures/Work Instructions	☐ Yes ☐ No ☑ N/A	
Product Labels/Bar Codes	☐ Yes ☐ No ☑ N/A	
Specifications/LIMS	☐ Yes ☐ No ☑ N/A	Complete Form RC 114 016
SWES	☐ Yes ☐ No ☑ N/A	
PFMEA*	☐ Yes ☐ No ☑ N/A	
Control Plan*	☐ Yes ☐ No ☑ N/A	
PPAP Package*	☐ Yes ☐ No ☑ N/A	
Audit Plan	☐ Yes ☐ No ☑ N/A	

**IATF16949 specific: notify Customer Services, who should inform customer using form JMC 114 010*

APPENDIX 02

EMS Scope (Reference JMC 700 000 Issue 6)

Environmental

Environmental Management System Scope

Introduction
Refining and Chemicals Europe (R&CE) is a business unit within the Efficient Natural Resources (ENR) sector of Johnson Matthey Plc (JM). JM is a speciality chemical company focussed on its core skills in catalysts, precious metals and fine chemicals.

The Group's principal activities are the manufacture of auto catalysts and pollution control systems, catalysts and component for fuel cells, pharmaceutical compounds, process catalysts and fine chemicals; the refining, fabrication and marketing of precious metals; and speciality chemicals; and the manufacture of colours and coatings for the glass and ceramics industries.

Johnson Matthey has continued to develop its technology for almost 200 years, demonstrating the company's ability to maintain world leadership by adapting constantly to rapidly changing customer needs. Many of Johnson Matthey's products have a major beneficial impact on the environment and enhance the quality of life for millions around the world.

Johnson Matthey has operations in 34 countries and employs around 9,000 people. Its products are sold across the world to a wide range of advanced technology industries.

Organisation and Context
The JM Values and Safety Principles set out by the JM executive team are universally adopted throughout JM and drive improvements in behavioural excellence to support best environmental and safety practices. R&CE has the ability to control the adoption of behavioural excellence within its organisation through leadership commitment, training and communications.

R&CE is facing several significant changes in key relevant regulations which present both risks to the business and its compliance commitments, and opportunities to drive process improvements in pollution prevention, hazard mitigation and sustainability. Specific legislation changes include; implementation New BAT standards at the Brimsdown site by 2020 and the Royston site in 6-years; Transition to Upper tier COMAH at the Royston and Brimsdown sites; potential change to Brimsdown Trade effluent consent. R&CE is monitoring the development of new legislation which will impact the business and has very limited authority to influence the creation of new legislation through membership and participation with trade association bodies and contact with regulators.

R&CE has aging plant and facilities, at both the Royston and Brimsdown sites, which are carefully managed to ensure compliance obligations are met and pollution risks are mitigated. The business has invested in a new chemical products production facility at Royston and has made a strategic commitment to develop new refining and production techniques on both sites to replace aging plant. This commitment will deliver opportunities for ongoing pollution prevention and sustainability improvements. R&CE has the ability to exercise control in implementing these improvement plans and in monitoring the ongoing effectiveness to ensure regulatory compliance and other strategic requirements are achieved

Organisational Units, functions and physical boundaries
The Environmental Management System (EMS) covers the activities of the Refining and Chemicals Europe (R&CE) Business Unit. The R&CE Business Unit is part of the Precious Metals Division and operates on two sites;

Brimsdown
Brimsdown in North London and Royston in North Hertfordshire, employing a total of around 500 people. The Business is recognised as one of the world's largest Secondary refiners of precious metals and its expertise in the analysis, recovery

and recycling of precious metals is noted world-wide. A diverse range of precious metal containing materials are recovered for refining from industries including; the chemicals, pharmaceuticals, petroleum, electronics, and mining sectors.

At Brimsdown a wide range of materials from industry sectors including containing platinum group metals, gold and silver is received, evaluated for precious metals content and refined to a concentrate. The nearest residential housing is 0.3km to the west of site. Mossops Creek, which is in hydraulic continuity with the Lee Navigation River, is immediately adjacent to the east of the site. The nearest SSSI are the Chingford Reservoirs, including the King George's Reservoir which is 0.2km to the east of site.

Aerial view of the Brimsdown site and physical boundaries.

Royston

Final refining is undertaken at Royston where a variety of precious metal chemicals and catalysts are also produced. The site is situated immediately adjacent to residential housing to the east of site. Arable farmland is 0.5km to the north of site and the nearest SSSI is Therfield Heath, 0.4km to the Southwest.

Aerial view of the Royston site and physical boundaries.

The Royston site is the headquarters of the R&CE Business Unit and is one of several Business Units on the site all employing precious metals to manufacture a diverse range of products.

All R&CE operations on the two sites are included within the scope of this Environmental Management System namely:

- The evaluation and refining of precious metal bearing materials.
- The development and manufacture of precious metal bearing salts
- Precious Metals Refining and Products Business Unit activities associated with the refining of precious metal bearing material.
- The development and manufacture of chemicals, supported catalysts, precious metal electrodes and pastes, powder and flakes for the electronics industry.
- Support service on both sites including; Engineering Functions, projects; purchasing; ; analytical laboratories; development teams; goods reception & transfer.

Outsourced Business Processes

R&C outsources business processes to regular contractors as defined in the list below. R&C has the ability to influence these contractors through policy, procedures, contractor inductions and contractor review meetings.

Onsite cleaning and waste services are contracted to Incentive QAS. This team has a permanent office and management representative on both the Royston and Brimsdown sites

Transport of precious and non-precious metals products and wastes, between sites, is contracted out to Brinks. This company is not based on site but their transport activity forms part of the key business process.

END OF DOCUMENT

The following pages are for document administration purposes only

Document Admin

DO NOT PRINT THESE PAGES

(*) Required - *Failure to complete required sections below will result in the rejection of the document by QA*

Document Owner & Deputies (*)

The owner should be the department manager. Responsibilities can be delegated as listed below.

Title	Name
Environmental Engineer	Ben Halliday
Waste Coordinator	Elis Jenkins
EHS Manager Royston	Jo Salmon
EHS Manager Brimsdown	TBC

Document History (*)

Issue	Date	Person	Change Details
4	14/01/19	B Halliday	General re-write
5	28/5/19	B Halliday	Removed reference to restructuring and rebranding as this is not such a recent global action. Added reference to Efficient Natural Resources.
6	11/08/2020	Z Laird	Minor admin changes

Change Authorisation (*)

List everyone who is required to approve the content of and/or changes to the document in the QMS website.

Title	Name
Environmental Engineer	Ben Halliday
Waste Coordinator	Elis Jenkins
EHS Manager Royston	Jo Salmon
EHS Manager Brimsdown	Sue Lee
QA	Helen Gilchrist

Document Admin Review (*)

The document owner/reviewer/author has checked the information on the pages below and updated it as required.

Title	Name	Date
Environmental Engineer	Ben Halliday	24 Feb 2020

Is signoff and/or training and competency assessment required for this new/changed document?

Link to decision tree.

If a competency assessment is required, the owner of this document must provide the questions for the competency assessment and send to L&D.

Notify/Sign off/Assess decision (*)

This must be completed, including providing the questions if relevant, before the new/changed document is sent for approval.

What is required?	Yes	No	N/A
Nothing	☐	☐	☒
Notification only (e.g. email).	☐	☐	☒
Signoff to acknowledge changes in LMS.	☒	☐	☐

Terms	Meaning
Notify	The document reviewer/author required to send notification of document/change by email.
Sign off	Required to sign off to acknowledge that they have read the document or

					change, via LMS
Training and Competency Assessment in LMS.	☐	☐	☒	**Assess**	Required to complete training via LMS and take a quiz to assess competency/understanding.
Questions written & sent to L&D?	☐	☐	☒	**Quiz**	To assess competency/understanding
Personnel selected in the table below?	☒	☐	☐	**Who?**	See below

(*) Required - *Failure to complete required sections below will result in the rejection of the document by QA*

Assignment of personnel for Notification/Signoff/Assessment (if required)
Choose the job titles for those who need to be notified or sign off against or be trained and competency assessed against this new document or document change.

SITE	Notify	Sign off	Assess
Royston	☐	☐	☐
Brimsdown	☐	☐	☐
Dual Site only	☐	☒	☐
OPERATIONS	Notify	Sign off	Assess
Operational	☐	☒	☐
Non-Operational	☐	☒	☐
Senior MANAGER	Notify	Sign off	Assess
Site Director/Manager	☐	☐	☐
Operations Director	☐	☐	☐
Labs, Quality & CI Manager	☐	☐	☐
HR Manager	☐	☐	☐
Supply Chain Manager	☐	☐	☐
Dual Site EHS Manager	☐	☒	☐
OTHER ROLE	Notify	Sign off	Assess
P to W Issuers (General)	☐	☐	☐
P to W issuers (Hot)	☐	☐	☐
P to W Issuers (Confined space)	☐	☐	☐
P to W issuers (High Voltage)	☐	☐	☐
First Aiders	☐	☐	☐
EHS Champions	☐	☐	☐
ISO14001 Auditors	☐	☒	☐
ISO9001 Auditors	☐	☐	☐
Main Site Controller	☐	☐	☐
Incident Controller	☐	☐	☐
Add more if required	☐	☐	☐
Department LEVEL	Notify	Sign off	Assess
All	☐	☒	☐
Operator/Analyst	☐	☐	☐
Deputy Team Leader	☐	☐	☐
Supervisor/Team Leader	☐	☐	☐
Department Manager	☐	☐	☐
Admin	☐	☐	☐
Other (specify)	☐	☐	☐

DEPARTMENTS	Select
Chemicals	☐
Smelting	☐
Evaluation	☐
Labs – Brimsdown	☐
PGMR	☐
VRP/Effluent	☐
Fine Chemicals	☐
Process Catalyst	☐
Dispensing	☐
Logistics – Reception	☐
Logistics – Stores	☐
Shipping	☐
Purchasing	☐
Finance	☐
HR	☐
L&D	☐
QA	☐
CI	☐
Sales	☐
Technical	☐
Maintenance – Royston	☐
Maintenance (Brims)	☐
Process Safety	☐
EHS	☒
Weighing Technology	☐
Maintenance Planning	☐
Compliance Engineering	☐
Production Controllers	☐
Supply Chain (other)	☐
AgT	☐
Other (specify)	☐

Change Note

Process document/SOP change/initiation Record (*)

To be completed by Change/Document Initiator

Date the Change Note information was reviewed	N/A

Does this change:		Action required if answer is YES
Fall within scope of the Management of Change procedure (JMC 815 050)	☐ Yes ☑ No	Raise Management of Change Assessment form (JMC 814 050) MOC Reference No:
Represent a change that may be significant and require customer notification (Procedure JMC 216 008): (*e.g. are new raw materials being used, new plant being used, new methods of manufacture etc.*). Has the change been assessed?	☐ Yes ☑ No ☐ Yes ☑ No	Notify Customer Services, who should inform customer using form JMC 114 020 (or JMC 114 010 for IATF16949) Complete a Control of change and Customer Notification Decision Record (RC 114 038)

If related to this change, have the following documents been reviewed?		Action required if answer is YES *(reference specific document number)*
Risk assessments	☐ Yes ☐ No ☑ N/A	
COSHH assessments	☐ Yes ☐ No ☑ N/A	
Manual Handling assessments	☐ Yes ☐ No ☑ N/A	
Batch Records	☐ Yes ☐ No ☑ N/A	
Procedures/Work Instructions	☐ Yes ☐ No ☑ N/A	
Product Labels/Bar Codes	☐ Yes ☐ No ☑ N/A	
Specifications/LIMS	☐ Yes ☐ No ☑ N/A	Complete Form RC 114 016
SWES	☐ Yes ☐ No ☑ N/A	
PFMEA*	☐ Yes ☐ No ☑ N/A	
Control Plan*	☐ Yes ☐ No ☑ N/A	
PPAP Package*	☐ Yes ☐ No ☑ N/A	
Audit Plan	☐ Yes ☐ No ☑ N/A	

**IATF16949 specific: notify Customer Services, who should inform customer using form JMC 114 010*

APPENDIX 03

Common Waste Gas Management and Treatment Systems BREF Definitions

Relevant Definitions

Waste Gas Streams

The BREF note introduces the following definitions for emissions to air. JM must consider these in applying the BREF.

- Channelled Emissions

Emissions of pollutants to air through an emission point such as a stack. The BREF note defines channelled emissions to air to include:

- Process emissions released through a vent pipe by process equipment and inherent to the running of the plant;
- Flue-gases from energy-providing units, such as process furnaces, steam boilers, combined heat and power units, gas turbines and gas engines;
- Waste gases from emission control equipment, such as filters, incinerators/oxidisers or adsorbers, likely to contain unabated pollutants or pollutants generated in the abatement system;
- Tail gases from reaction vessels and condensers;
- Waste gases from catalyst or solvent regeneration;
- Waste gases from vents, storage and handling (transfers, loading and unloading) of products, raw materials and intermediates;
- Exhaust air from vents or captured diffuse emissions, e.g., sources of diffuse emissions installed within an enclosure or a building
- Diffuse Emissions

Non-channelled emissions. Diffuse emissions include fugitive and non-fugitive emissions.

- Emissions to Air

Generic term for emissions of pollutants to air including both channelled and diffuse emissions.

- Fugitive Emissions

Non-channelled emissions to air caused by loss of tightness of equipment which is designed or assembled to be tight. Fugitive emissions can arise from:

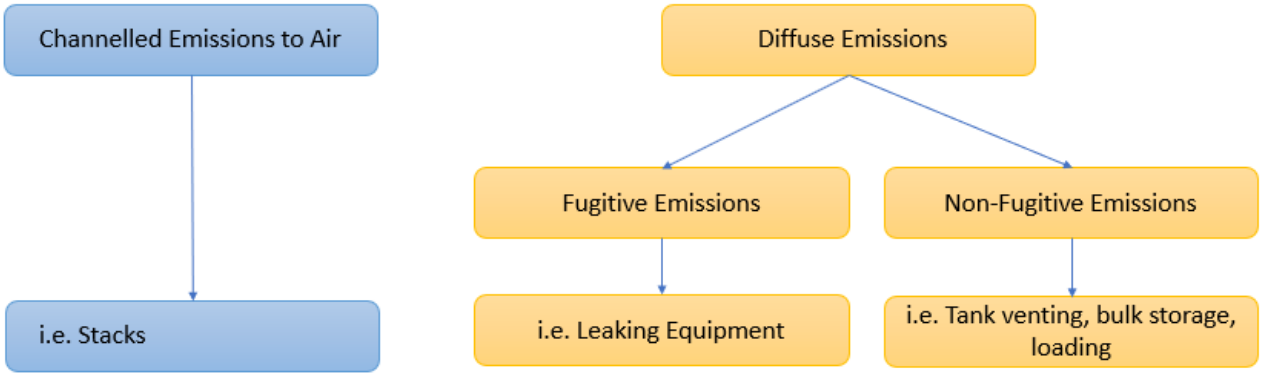
- moving equipment, such as agitators, compressors, pumps, valves (manual and automatic).
- static equipment, such as flanges and other connections, open-ended lines, sampling points.

- Non-fugitive Emissions

Diffuse emissions other than fugitive emissions.
Non-fugitive emissions can arise from atmospheric vents, bulk storage, loading/unloading systems, vessels and tanks (on opening), open gutters, sampling systems, tank venting, waste, sewers and water treatment plants.

Figure App3-1 below outlines the hierarchy of the emissions to air outlined in the BREF note.

Figure App3-1
Types of Emission Points



APPENDIX 04

BAT Assessment for Project Apollo

Table App04-1
Project Apollo: Production of Speciality Inorganic Chemicals BREF BAT Assessment

BAT Requirement	Specific Measures
General BAT conclusions	
Raw and auxiliary materials supply, storage, handling and preparation	
BAT 5.1.BAT is to reduce the amount of packaging materials disposed of by, e.g., recycling 'hard' and 'soft' used packaging materials (see Sections 4.2.1 and 4.2.2), unless safety or hazard considerations prevent it.	JM recycling packaging material (i.e., Plastic / cardboard) where possible. Wooden pallets are also returned to the supplier for re-use.
Synthesis/reaction/calcination	
BAT 5.2. BAT is to reduce emissions and the amount of residues generated by implementing one or more of the following measures: a. using high purity feedstock (see Section 4.3.1) b. improving reactor efficiencies (see Section 4.3.2) c. improving catalyst systems (see Section 4.3.3).	JM work with a supplier to use high quality feedstock. The Apollo Project does not involve a reactor. Coatings and inks are prepared on site by JM utilising cathode and anode catalysts. JM therefore control the chemical make-ups and physical characteristics of the coating to reduce emissions to air and waste generation. The catalysts are created with platinum (a noble metal) which improves catalyst systems and reduces the amount of heavy metals discharged to effluent.
BAT 5.3. For discontinuous processes, BAT is to optimise yields, lower emissions and reduce waste by sequencing the addition of reactants and reagents (see Section 4.3.4).	JM use computer-controlled systems which analyse the process continuously to allow optimisation of the coating lines and greater control over when the process finishes.
BAT 5.4. For discontinuous processes, BAT is to minimise cleaning operations by optimising the sequences for addition of raw and auxiliary materials (see Section 4.3.4).	The production of CCM is a batched process that is computer controlled. The addition of raw materials is strictly controlled under inert conditions due to a

BAT Requirement	Specific Measures
	combustion risk if the product comes into air. As such, cleaning is carefully planned and only undertaken when necessary.
Product handling and storage	
BAT 5.5. BAT is to reduce the number of residues generated by, e.g., using returnable product transportation containers/drums (see Section 4.2.1).	JM return containers and drums to suppliers where possible.
Waste gas emissions abatement	
BAT 5.6. BAT is to minimise emissions of total dust in off-gases and achieve emission levels of 1 – 10 mg/Nm^3 by using one or more of the following techniques: a. cyclone (see Section 4.4.2.1.2) b. fabric or ceramic filter (see Section 4.4.2.1.5) c. wet dust scrubber (see Section 4.4.2.1.3) d. ESP (see Section 4.4.2.1.4). The lower end of the range may be achieved by using fabric filters in combination with other abatement techniques. However, the range may be higher, depending on the carrier gas and particle characteristics (see Section 4.4.2.1). Using fabric filters is not always possible e.g., when other pollutants have to be abated (e.g., SO_x) or when the off gases present humid conditions (e.g., presence of liquid acid). The particulate matters recovered/removed are recycled back into production when this is feasible. The scrubbing medium is recycled when this is feasible.	• Cathode and anode catalyst powders may explode when they come into contact to air. As such a powder handling system will be put in place for Project Apollo. • The process will be a wet process and movement of powder will be designed to limit contact with air as extended contact with air. • The entire powder system from bag opening to ink preparation (mixing vessel) will be under inert condition (atmosphere of nitrogen) so that the catalyst powders do not come into contact with air. • Additional dust abatement is not required as dust and powder are tightly controlled within the process.
BAT 5.7. BAT is to reduce HCN emissions and achieve emission levels of <1 mg/m^3 by scrubbing with an alkaline solution. The scrubbing medium is recycled when this is feasible (see Section 4.4.2.2.5).	Not applicable. HCN is not generated in the Project Apollo process.
BAT 5.8. BAT is to reduce NH_3 emissions and achieve emission levels of <1.2 mg/m^3 by scrubbing with an acidic solution. The scrubbing medium is recycled when this is feasible (see Section 4.4.2.2.5).	Not applicable. NH_3 is not generated in the Project Apollo process.

BAT Requirement	Specific Measures
BAT 5.9. BAT is to reduce HCl emissions, e.g., by wet gas scrubbing under alkaline conditions (see Section 4.4.2.2.4). If HCl is the main pollutant to be treated and alkali scrubbing is used, BAT is to achieve 3 – 10 mg/Nm^3 HCl.	Not applicable. HCl is not generated in the Project Apollo process.
Wastewater management and water emissions abatement	
BAT 5.10. BAT is to allocate contaminated wastewater streams according to their pollutant load. Inorganic wastewater without relevant organic components is segregated from organic wastewater and ducted to special treatment facilities (see Section 4.4.1 and Figure 4.1).	The existing process ensures that effluent waste streams are segregated into PGM and non-PGM waste streams. PGM effluent is transferred offsite to enable recovery of metals. Non-PGM effluent is discharged to sewer via the onsite effluent treatment system. The Apollo activity will use the same approach.
BAT 5.11. For rainwater, BAT is to minimise pollution to receiving watercourses by applying all of the following measures: a. minimising the contamination of rainwater from activities carried out at the installation in particular by applying measures for reducing fugitive and diffuse emissions (see BAT 5.12 and BAT 5.13 and BAT 5.17) b. ducting and storing rainwater (see Section 4.7.4) expected to be contaminated from activities carried out at the installation and treating it if necessary. Other rainwater may be directly discharged (see Section 4.7.4) c. monitoring the discharge of this other rainwater as outlined in Section 4.7.4. Rainwater found to be contaminated is treated as in b. above (see Section 4.7.4). In some cases, the use of rainwater as process water to reduce freshwater consumption may be environmentally beneficial.	a. waste and chemical storge areas will be covered to minimise the contamination of rainwater. b. Where rainfall enters areas served by the onsite drainage system it will be captured by the effluent drainage system and treated prior to discharge to sewer. c. All water flowing to the effluent treatment plant is monitored prior to discharge.
Infrastructure	
BAT 5.12. For diffuse emissions, BAT is to minimise diffuse dust emissions where dust may arise (in particular from the storage and handling of materials/products) by applying one or more of the following techniques: a. storing materials in closed systems (e.g., silos, see Section 6.3.4.1) b. using covered areas protected from rain and wind (see Section 6.3.4.1)	• a. Cathode and anode catalyst powders and ionomer powders will be stored in enclosed systems with powder dispensing systems that dispenses the correct amount of powder. • For the catalyst powders the entire powder system from bag opening to ink preparation (mixing vessel) will be under inert

BAT Requirement	Specific Measures
c. having production equipment, e.g., conveyors, totally or partially enclosed (see Section 2.2) d. having equipment designed with hooding and ducting to capture diffuse dust emissions (e.g., during loading into storage) and abating it (e.g., using a fabric filter, see Section 6.3.4.1) e. carrying out housekeeping regularly, e.g., by vacuuming (see Section 4.7.6).	condition (atmosphere of nitrogen) so that the catalyst powders do not come into contact with air. • These procedures will reduce the amount of dust that escapes to air. b. Raw materials and waste storage areas will be protected from rain and wind. c. Production equipment will be totally or partially enclosed. d. dust emissions will be captured and abated where generated utilising high efficiency particulate air (HEPA) filters. • e. JM will carry out housekeeping regularly including in areas where powder is handled.
BAT 5.13. BAT is to minimise fugitive gaseous and liquid emissions by applying (according to the substances that may require controlling) one or more of the following techniques: a. having periodic leak detection and repair programmes (see Sections 4.7.1 and 2.6.6) b. operating equipment at slightly below atmospheric pressure (see Section 6.3.4.16) c. replacing flanges by welded connections (see Section 2.6) d. using seal-less pumps and bellow valves (see Section 2.6) e. using high performance sealing systems (e.g., effective gaskets and flanges, valves and pumps with high integrity packing, see Section 2.6) f. carrying out housekeeping regularly (see Section 4.7.6).	a. JM will operate a leak detection and repair programme as part of their PPM on liquid and gas pipework. b. Equipment with possibility to release diffuse VOCs will be all running below atmospheric pressure. c. Where possible apart form at removable interfaces welded fixed pipe work will be used. d. Seal pumps and bellow valves will be utilised. f. Daily checks and housekeeping will be undertaken on equipment.
BAT 5.14. For new installations, BAT is to: 5.14 use a computerised control system to operate the plant (see Section 4.5.2). However, this does not apply where	Onsite processes are controlled by programmable logic controlled (PLC) systems and will be monitored and recorded on the Supervisory control and data

BAT Requirement	Specific Measures
safety issues do not permit automatic operations (e.g., in the production of SIC explosives).	acquisition (SCADA) system (the computer process management and monitoring system).
BAT 5.15. For installations where solid hazardous compounds can build up in pipelines, machines and vessels, BAT is to have in place a closed cleaning and rinsing system (see Section 4.5.1).	JM will have a closed cleaning and rinsing system for equipment and pipework where hazardous compounds may build up along the coating lines. Clean in place operations are present on the Ionomer Dispersion Mixing Process. Following the emptying of any of the tanks (mixing and storage) they will be cleaned. The tanks will still be under nitrogen inertion at this stage. Cleaning requires water and ethanol to be added to the mixing tanks using the same feed lines as for the batch. 50% ethanol/water mix required. Volume to be determined. This mix is to be recirculated around the tank using spray balls in the tank and a separate pump. Once several recycle loops have occurred the flow is to be sent to a waste IBC. A final wash with water through same system might be required. In order to inspect the inside of the tank and clean particular areas the tank lid will have the ability to be lifted. A water spray will be made available to direct flow to particular areas.
Energy	
BAT 5.16. BAT is to reduce the consumption of energy by optimising plant design, construction and operation, e.g., by using pinch methodology, except if safety issues prevent it (see Section 4.6.1).	JM will use their computerised systems to undertake assessment of the 'pinch point' on the coating line process to enable the most efficient heat exchange.
Cross-boundary techniques	
BAT 5.17. BAT is to minimise soil and groundwater pollution by designing, building, operating and maintaining facilities, where substances (usually liquids) which represent a potential risk of contamination of ground and groundwater are	a. Indoor and outdoor areas associated with the CSF2 building comprise an impermeable surface. Secondary containment and bunding will be in place and designed to specification

BAT Requirement	Specific Measures
handled, in such a way that material escapes are minimised (see Section 4.7.1). This includes all of the following: a. having facilities sealed, stable and sufficiently resistant against possible mechanical, thermal or chemical stress. This is particularly important for highly toxic substances – e.g., cyanides, phosphorus compounds b. providing sufficient retention volumes to safely retain spills and leaking substances in order to enable treatment or disposal c. providing sufficient retention volume to safely retain firefighting water and contaminated surface water d. carrying out loading and unloading only in designated areas protected against leakage run-off e. storing and collecting materials awaiting disposal in designated areas protected against leakage run-off f. fitting all pump sumps or other treatment plant chambers from which spillage might occur with high liquid level alarms or having pump sumps regularly inspected by personnel g. establishing programmes for testing and inspecting tanks and pipelines including flanges and valves h. providing spill control equipment, such as containment booms and suitable absorbent material i. testing and demonstrating the integrity of bunds j. equipping tanks with overfill prevention k. storing materials/products in covered areas to keep rainfall out.	b & c. Should a spill of raw materials / product occur, or firewater be required onsite then they will enter the drainage system and drain to the effluent treatment plant and end up in one of two 450m^3 effluent holding tanks d. Loading and unloading will only occur in designated areas protected against leakage run-off. Strict handling procedures are in place for handling the catalyst powders due to the combustion risk. e. Waste storage areas will be on an impermeable surface and drain to the sealed drainage system which discharges to the effluent treatment plant prior to release to sewer. f. High level alarms will be present on sumps and other process chambers associated with the CCM coating line. These pieces of equipment will also be inspected daily. g. The Apollo Project will be operated under the PPM service at site and regularly maintained. h. Spill kits will be available in areas that handle raw materials, waste and product. i.No sumps or process chambers will be on the CCM coating lines. On the rare occasion that may be a small drip of ink this will be captured via a drip tray. Such drip trays are regularly inspected. j. There are no sumps or other process chambers which need to have high level alarm. k. Raw materials, waste and finished products will be stored indoors or undercover to prevent rainfall ingress. UN approved containers will be used to store raw materials.
BAT 5.18. BAT is to have a high level of education and continuous training of personnel (see Section 4.7.2). This includes all of the following: a. having personnel with sound basic education in chemical engineering and operations	Personnel with qualifications in chemical engineering will operate the CCM lines. Training is recorded under the EMS and will be evaluated on a regular basis to ensure that the equipment is operated by knowledgeable personnel.

BAT Requirement	Specific Measures
b. continuously training plant personnel on the jobs c. regularly evaluating and recording the performance of personnel d. regularly training personnel on how to respond to emergency situations, health and safety at work, and on product and transportation safety regulations.	Training on how to reduce accidents and minimise the impact of the installation on the environment is provided to onsite personnel annually.
BAT 5.19. BAT is to apply, if available, the principles of an Industry Code (see Section 4.7.3). This includes all of the following: a. applying very high standards for safety, environmental and quality aspects in the production of the SIC substances b. carrying out activities such as auditing, certification, training of plant personnel (related to BAT number 5.18 and 5.22).	Project Apollo will be operated to the following UK industry codes: • S.I. 2016/1091 Electromagnetic Compatibility Regulations 2016 (UK) • S.I. 2016/1153 Measuring Instruments Regulations 2016 (UK) • S.I. 2016/1107 Equipment and Protective Systems Intended for use in Potentially Explosive Atmospheres Regulations 2016 (UK) • S.I. 2016/1101 Electrical Equipment (Safety) Regulations 2016 (UK) • S.I. 2008/1597 Supply of Machinery (Safety) Regulations 2008 (UK) • S.I. 2001/ 3958 Noise Emission in the Environment by Equipment for use Outdoors Regulations 2001 • S.I. 2016/ 1105 UK Pressure Equipment (Safety) Regulations 2016 (PER) • S.I. 2010/2617 Eco-design for Energy Related Products Regulations 2010 • S.I. 2004/ 107 The Solvent Emissions(England and Wales) Regulations 2004 Additional standards i.e., BS EN / EU will also be adhered to where required. Regular internal and external audits occur which include review of the training procedure.
BAT 5.20. BAT is to carry out a structured safety assessment for normal operation and to take into account effects due to deviations of the chemical process and deviations in the operation of the plant (see Section 4.7.5).	HAZOP assessment will be undertaken for Project Apollo.
BAT 5.21. In order to ensure that a process can be controlled adequately, BAT is to apply one individual or a combination of the following techniques (without ranking, see Section 4.7.5): a. organisational measures	Project Apollo will comprise the following to ensure control over CCM line production: a. A structured safety assessment. b. f. The CCM line will be constructed to G13J JM Pressure Relief Standards.

BAT Requirement	Specific Measures
b. concepts involving control engineering techniques c. reaction stoppers (e.g., neutralisation, quenching) d. emergency cooling e. pressure resistant construction f. pressure relief.	
BAT 5.22. implement and adhere to an Environmental Management System (EMS) that incorporates, as appropriate to individual circumstances, the following features (see Section 4.7.6): a. definition of an environmental policy for the installation by top management (commitment of the top management is regarded as a precondition for the successful application of other features of the EMS) b. planning and establishing the necessary procedures c. implementation of the procedures, paying particular attention to: • structure and responsibility • training, awareness and competence • communication • employee involvement • documentation • efficient process control • maintenance programmes • emergency preparedness and response • safeguarding compliance with environmental legislation d. checking performance and taking corrective action, paying particular attention to:	The site have an EMS accredited to ISO 14001 for each department. The Fuel Cell department's EMS will be updated to include all the features in BAT 5.22 relating to the Apollo Project.

BAT Requirement	Specific Measures
• monitoring and measurement (see also the Reference Document on General Principles of Monitoring) • corrective and preventive action • maintenance of records • independent (where practicable) internal auditing in order to determine whether or not the environmental management system conforms to planned arrangements and has been properly implemented and maintained e. review by top management. Three further features, which can complement the above stepwise, are considered as supporting measures. However, their absence is generally not inconsistent with BAT. These three additional steps are: f. having the management system and audit procedure examined and validated by an accredited certification body or an external EMS verifier g. preparation and publication (and possibly external validation) of a regular environmental statement describing all the significant environmental aspects of the installation, allowing for year-by-year comparison against environmental objectives and targets as well as with sector benchmarks as appropriate h. implementation and adherence to an internationally accepted voluntary system such as EMAS and EN ISO 14001:1996. This voluntary step could give higher credibility to the EMS. In particular EMAS, which embodies all the above-mentioned features, gives higher credibility. However, non-standardised systems can, in principle, be equally effective provided that they are properly designed and implemented.	
Production of speciality inorganic pigment BAT conclusions – Not applicable	
Production route for the manufacture of iron oxide pigments – Not applicable	
BAT for the production of phosphorus compounds – Not applicable	

BAT Requirement	Specific Measures
BAT for the production of silicones – Not applicable	
BAT for the production of SIC explosives - Not applicable	
BAT conclusions generally applicable to the production of cyanides – Not applicable	

Table App04-2
Project Apollo Common Waste Gas Management and Treatment Systems BREF.

BAT Requirement	Specific Measure
General BAT conclusions	
EMS	
BAT 1. In order to improve the overall environmental performance, BAT is to elaborate and implement an environmental management system (EMS) that incorporates all of the following features: i. commitment, leadership, and accountability of the management, including senior management, for the implementation of an effective EMS; ii. an analysis that includes the determination of the organisation's context, the identification of the needs and expectations of interested parties, the identification of characteristics of the installation that are associated with possible risks for the environment (or human health) as well as of the applicable legal requirements relating to the environment; iii. development of an environmental policy that includes the continuous improvement of the environmental performance of the installation; iv. establishing objectives and performance indicators in relation to significant environmental aspects, including safeguarding compliance with applicable legal requirements; v. planning and implementing the necessary procedures and actions (including corrective and preventive actions where needed), to achieve the environmental objectives and avoid environmental risks; vi. determination of structures, roles and responsibilities in relation to environmental aspects and objectives and provision of the financial and human resources needed; vii. ensuring the necessary competence and awareness of staff whose work may affect the environmental performance of the installation (e.g., by providing information and training); viii. internal and external communication; ix. fostering employee involvement in good environmental management practices; x. establishing and maintaining a management manual and written procedures to control activities with significant environmental impact as well as relevant records; xi. effective operational planning and process control; xii. implementation of appropriate maintenance programmes;	The Site have an EMS accredited to ISO 14001. The site's EMS will be updated to include all the features in BAT 1 relating to the Apollo Project.

BAT Requirement	Specific Measure
xiii. emergency preparedness and response protocols, including the prevention and/or mitigation of the adverse (environmental) impacts of emergency situations; xiv. when (re)designing a (new) installation or a part thereof, consideration of its environmental impacts throughout its life, which includes construction, maintenance, operation and decommissioning; xv. implementation of a monitoring and measurement programme; if necessary, information can be found in the Reference Report on Monitoring of Emissions to Air and Water from IED Installations; xvi. application of sectoral benchmarking on a regular basis; xvii. periodic independent (as far as practicable) internal auditing and periodic independent external auditing in order to assess the environmental performance and to determine whether or not the EMS conforms to planned arrangements and has been properly implemented and maintained; xviii. evaluation of causes of nonconformities, implementation of corrective actions in response to nonconformities, review of the effectiveness of corrective actions, and determination of whether similar nonconformities exist or could potentially occur; xix. periodic review, by senior management, of the EMS and its continuing suitability, adequacy and effectiveness; xx. following and taking into account the development of cleaner techniques. Specifically for the chemical sector, BAT is also to incorporate the following features in the EMS: xxi. an inventory of channelled and diffuse emissions to air (see BAT 2); xxii. an OTNOC management plan for emissions to air (see BAT 3); xxiii. an integrated waste gas management and treatment strategy for channelled emissions to air (see BAT 4); xxiv. a management system for diffuse VOC emissions to air (see BAT 19); xxv. a chemicals management system that includes an inventory of the hazardous substances and substances of very high concern used in the process(es); the potential for substitution of the substances that are listed in this inventory, focusing on those substances other than raw materials, is analysed periodically (e.g., annually) in order to identify possible new available and safer alternatives, with no or lower environmental impacts.	
BAT 2. In order to facilitate the reduction of emissions to air, BAT is to establish, maintain and regularly review (including when a substantial change occurs) an inventory of channelled and diffuse	All waste gas streams for the project have been identified, these comprise:

BAT Requirement	Specific Measure
emissions to air, as part of the environmental management system (see BAT 1), that incorporates all of the following features: i. information, as comprehensive as is reasonably possible, about the chemical production process(es), including: a. chemical reaction equations, also showing side products; b. simplified process flow sheets that show the origin of the emissions; ii. information, as comprehensive as is reasonably possible, about channelled emissions to air, such as: a. emission point(s); b. average values and variability of flow and temperature; c. average concentration and mass flow values of relevant substances/parameters and their variability (e.g., TVOC, CO, NOX, SOX, Cl2, HCl); d. presence of other substances that may affect the waste gas treatment system(s) or plant safety (e.g., oxygen, nitrogen, water vapour, dust); e. techniques used to prevent and/or reduce channelled emissions to air; f. flammability, lower and higher explosive limits, reactivity; g. monitoring methods (see BAT 8); h. presence of substances classified as CMR 1A, CMR 1B or CMR 2; the presence of such substances may for example be assessed according to the criteria of Regulation (EC) 1272/2008 on classification, labelling and packaging (CLP). iii. information, as comprehensive as is reasonably possible, about diffuse emissions to air, such as: a. identification of the emission source(s); b. characteristics of each emission source (e.g., fugitive or non-fugitive; static or moving; accessibility of the emission source; included in an LDAR programme or not); c. the characteristics of the gas or liquid in contact with the emission source(s), including: 1) physical state; 2) vapour pressure of the substance(s) in the liquid, pressure of the gas; 3) temperature; 4) composition (by weight for liquids or by volume for gases); 5) hazardous properties of the substance(s) or mixtures, including substances or mixtures classified as CMR 1A, CMR 1B or CMR 2; d. techniques used to prevent and/or reduce diffuse emissions to air; e. monitoring (see BAT 20, BAT 21 and BAT 22).	• 1 x channelled emission point to air from the thermal oxidiser. • 10 x non-fugitive diffuse emissions from the following vents: ○ 8 x Ionomer vessel vents. ○ 1 x heat treatment line vent. ○ 1 x Vent from the ink mixing room. Refer to Appendix 03 for definitions of emission points in the common waste gas management and treatment systems BREF. These emission points to air will be kept in an inventory of emissions to air that incorporates all of the applicable features listed in BAT 2.

BAT Requirement	Specific Measure
Other than normal operating conditions (OTNOC)	
BAT 3. In order to reduce the frequency of the occurrence of OTNOC and to reduce emissions to air during OTNOC, BAT is to set up and implement a risk based OTNOC management plan as part of the environmental management system (see BAT 1) that includes all of the following features: i. identification of potential OTNOC (e.g., failure of equipment critical to the control of channelled emissions to air, or equipment critical to the prevention of accidents or incidents that could lead to emissions to air (critical equipment)), of their root causes and of their potential consequences; ii. appropriate design of critical equipment (e.g., equipment modularity and compartmentalisation, backup systems, techniques to obviate the need to bypass waste gas treatment during start-up and shutdown, high-integrity equipment, etc.); iii. set-up and implementation of a preventive maintenance plan for critical equipment (see BAT 1 xii.); iv. monitoring (i.e., estimating or, where this is possible, measuring) and recording of emissions and associated circumstances during OTNOC; v. periodic assessment of the emissions occurring during OTNOC (e.g., frequency of events, duration, amount of pollutants emitted as recorded in point iv.) and implementation of corrective actions if necessary; vi. regular review and update of the list of identified OTNOC under point i. following the periodic assessment of point v.; vii. regular testing of backup systems.	JM will prepare an 'operation other than normal conditions' OTNOC plan incorporating the Apollo Project including the coating lines and RTO.
Channelled emissions to air	
BAT 4. In order to reduce channelled emissions to air, BAT is to use an integrated waste gas management and treatment strategy that includes, in order of priority, process integrated recovery and abatement techniques.	The site will prepare an integrated waste gas treatment strategy that comprises the only channelled emission point to air from the coating lines at Project Apollo, the RTO. The RTO abates VOC concentrations emitted from the coating lines.
BAT 5. In order to facilitate the recovery of materials and the reduction of channelled emissions to air, as well as to increase energy efficiency, BAT is to combine waste gas streams with similar characteristics, thus minimising the number of emission points.	Vents will not be piped to RTO but released to atmosphere.

BAT Requirement	Specific Measure
The combined treatment of waste gases with similar characteristics ensures more effective and efficient treatment compared to the separate treatment of individual waste gas streams. The combination of waste gases is carried out considering plant safety (e.g., avoiding concentrations close to the lower/upper explosive limit), technical (e.g., compatibility of the individual waste gas streams, concentration of the substances concerned), environmental (e.g., maximising recovery of materials or pollutant abatement) and economic factors (e.g., distance between different production units)	
BAT 6. In order to reduce channelled emissions to air, BAT is to ensure that the waste gas treatment systems are appropriately designed (e.g., considering the maximum flow rate and pollutant concentrations), operated within their design ranges, and maintained (through preventive, corrective, regular and unplanned maintenance) so as to ensure optimal availability, effectiveness and efficiency of the equipment.	The channelled emission point to air will be managed under the JM Waste Gas Management and Treatment Strategy. Standard Operating Procedures (SOP) will also be in place for the RTO to ensure that it is operated within its optimum design ranges. The RTO will also be operated under a schedule of preventative maintenance in line with the manufacturer's recommendations. Daily inspections will also be undertaken at the site to identify operational problems allowing corrective actions to be put in place quickly.
Monitoring	
BAT 7. BAT is to continuously monitor key process parameters (e.g., waste gas flow and temperature) of waste gas streams being sent to pre-treatment and/or final treatment.	Waste gas flow and temperature will be monitored continuously on the RTO.
BAT 8. BAT is to monitor channelled emissions to air with at least the frequency given below and in accordance with EN standards. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.	The chemicals released to air from the RTO (channelled emission point),will include: • Ethanol & Propanol (assessed as Total VOCs).

<table>
<tr><th>BAT Requirement</th><th>Specific Measure</th></tr>
<tr><td></td><td>• CO
• NOx

JM will undertake monitoring for the chemicals outlined above in accordance with the directions provided in BAT 8.</td></tr>
<tr><td>Organic compounds</td><td></td></tr>
<tr><td>BAT 9. In order to increase resource efficiency and to reduce the mass flow of organic compounds sent to the final waste gas treatment, BAT is to recover organic compounds from process off-gases by using one or a combination of the techniques given below and to reuse them.

<table><tr><th colspan="2">Techniques</th><th>Description</th></tr><tr><td>a.</td><td>Absorption (regenerative)</td><td>See Section 4.4.1.</td></tr><tr><td>b.</td><td>Adsorption (regenerative)</td><td>See Section 4.4.1.</td></tr><tr><td>c.</td><td>Condensation</td><td>See Section 4.4.1.</td></tr></table></td><td>Abatement techniques for channelled emission points to air will include:

• Thermal oxidiser
•</td></tr>
<tr><td>BAT 10. In order to increase energy efficiency and to reduce the mass flow of organic compounds sent to the final waste gas treatment, BAT is to send process off-gases with a sufficient calorific value to a combustion unit that is, if technically possible, combined with heat recovery. BAT 9 has priority over sending process off-gases to a combustion unit</td><td>Off-gas streams will be sent to the RTO rather than using them as fuel, as insufficient calorific value, therefore not applicable.</td></tr>
<tr><td>BAT 11. In order to reduce channelled emissions to air of organic compounds, BAT is to use one or a combination of the techniques given below.

<table><tr><th colspan="2">Technique</th><th>Description</th><th>Applicability</th></tr><tr><td>a.</td><td>Adsorption</td><td>See Section 4.4.1.</td><td>Generally applicable.</td></tr><tr><td>b.</td><td>Absorption</td><td>See Section 4.4.1.</td><td>Generally applicable.</td></tr><tr><td>c.</td><td>Catalytic oxidation</td><td>See Section 4.4.1.</td><td>Applicability may be restricted by the presence of catalyst poisons in the waste gases.</td></tr><tr><td>d.</td><td>Condensation</td><td>See Section 4.1.1.</td><td>Generally applicable.</td></tr><tr><td>e.</td><td>Thermal oxidation</td><td>See Section 4.1.1.</td><td>Applicability of recuperative and regenerative thermal</td></tr></table></td><td>Abatement techniques for organic compounds for channelled emission points to air will include the regenerative thermal oxidiser only as there are no recoverable compounds for a scrubber or condenser.

The chemicals released to air from the RTO (channelled emission point), will be:

• Ethanol & propanol (assessed as Total VOCs).
• Aldehydes.
• CO.
• NOx.</td></tr>
</table>

BAT Requirement				Specific Measure
			oxidation to existing plants may be restricted by design and/or operational constraints. Applicability may be restricted where the energy demand is excessive due to the low concentration of the compound(s) concerned in the process off-gases.	• JM will undertake monitoring for the chemicals outlined above in accordance with the directions provided in BAT 8 and ensure that the results meet the BAT AEL's provided in BAT 11. Regarding VOC emissions to air; the Draft Common Waste Gas Management and Treatment Systems BREF note now considers some VOCs BAT AELs according to their CMR (carcinogenic, mutagenic and toxic for reproduction). VOCs must be classified as either according to the CMR1A and CMR 1B substance lists provided in Table 3.1 of the Annex VI of EU Regulation 1272 / 2008[2]: • CAT 1A: CMR substance of category 1A as defined in Regulation (EC) No 1272/2008 as amended, i.e., carrying the hazard statements H340, H350, H360 • CAT 1B: CMR substance of category 1B as defined in Regulation (EC) No 1272/2008 as amended, i.e., carrying the hazard statements H340, H350, H360 • CAT 2: CMR substance of category 2 as defined in Regulation (EC) No 1272/2008
f.	Bioprocesses	See Section 4.4.1	Only applicable to the treatment of biodegradable compounds	

[2] Annex VI 'Harmonised classification and labelling for certain hazardous substances' in EU Regulation No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures.

<table>
<tr><th>BAT Requirement</th><th>Specific Measure</th></tr>
<tr><td></td><td>as amended, i.e., carrying the hazard statements H341, H351, H361.

Propanol ethanol and aldehydes are not classified as CMR chemicals and as such, the BAT AELs relating to CMR VOCs do not apply.</td></tr>
<tr><td>BAT 12. In order to reduce channelled emissions to air of PCDD/F from thermal treatment of waste gases containing chlorine and/or chlorinated compounds, BAT is to use techniques a. and b., and one or a combination of techniques c. to e., given below.

<table>
<tr><th colspan="2">Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td colspan="4">Specific techniques to reduce PCDD/F emissions</td></tr>
<tr><td>a.</td><td>Optimised catalytic or thermal oxidation</td><td>See Section 4.4.1.</td><td>Generally applicable.</td></tr>
<tr><td>b.</td><td>Rapid waste-gas cooling</td><td>Rapid cooling of waste gases from temperatures above 400 ^{O}C to below 250 ^{O}C to prevent the de novo synthesis of PCDD/F.</td><td>Generally applicable.</td></tr>
<tr><td>c.</td><td>Adsorption using activated carbon.</td><td>See Section 4.4.1.</td><td>Generally applicable.</td></tr>
<tr><td>d.</td><td>Absorption</td><td>See Section 4.4.1.</td><td>Generally applicable.</td></tr>
<tr><td colspan="4">Other techniques not primarily used to reduce PCDD/F emissions</td></tr>
<tr><td>e.</td><td>Selective catalytic reduction (SCR)</td><td>See Section 4.4.1.
When SCR is used for NOX abatement, an adequate catalyst surface of the SCR system</td><td>Applicability to existing plants may be restricted by space availability and/or by the presence of catalyst poisons in the waste gases.</td></tr>
</table>
</td><td>Not applicable, waste gases to be treated will comprise ethanol and propanol.</td></tr>
</table>

BAT Requirement	Specific Measure
<table><tr><td></td><td></td><td>also provides for the partial reduction of the emissions of PCDD/F.</td><td></td></tr></table> BAT-associated emission level (BAT-AEL) for channelled emissions to air of PCDD/F from thermal treatment of waste gases containing chlorine and/or chlorinated compounds <table><tr><th>Substance/Parameter</th><th>BAT-AEL (ngI-TEQ/Nm^3) Average over the sampling period)</th></tr><tr><td>PCDD/F</td><td><0.01-0.05</td></tr></table>	
BAT 13. In order to increase resource efficiency and to reduce the mass flow of dust and particulate-bound metals sent to the final waste gas treatment, BAT is to recover materials from process off-gases by using one or a combination of the techniques given below and to reuse them. <table><tr><th colspan="2">Techniques</th><th>Description</th></tr><tr><td>a.</td><td>Cyclone</td><td>See Section 4.4.1.</td></tr><tr><td>b.</td><td>Fabric filter</td><td>See Section 4.4.1.</td></tr><tr><td>c.</td><td>Absorption</td><td>See Section 4.4.1.</td></tr></table>	Due to the nature of the processes on site powders will be tightly controlled due to explosion risk. The process is wet and does not emit dust / powder to air. The oven will have a filter on it to capture dust, dust-free gases will enter the RTO.
14. In order to reduce channelled emissions to air of dust and particulate-bound metals, BAT is to use one or a combination of the techniques given below. <table><tr><th colspan="2">Techniques</th><th>Description</th><th>Applicability</th></tr><tr><td>a.</td><td>Absolute filter</td><td>See Section 4.4.1.</td><td>Applicability may be limited in the case of sticky dust or when the temperature of the waste gases is below the dew point.</td></tr><tr><td>b.</td><td>Absorption</td><td>See Section 4.4.1.</td><td>General applicable.</td></tr><tr><td>c.</td><td>Fabric filter</td><td>See Section 4.4.1.</td><td>Applicability may be limited in the case of sticky dust or when the temperature of the waste gases is below the dew point.</td></tr><tr><td>d.</td><td>High-efficiency air filter</td><td>See Section 4.4.1.</td><td>General applicable.</td></tr></table>	Dust and metal bound particulates will not be emitted through channelled emission points.

BAT Requirement	Specific Measure

e.	Cyclone	See Section 4.4.1.	General applicable.
f.	Electrostatic precipitator	See Section 4.4.1.	General applicable.

BAT-associated emission levels (BAT-EALs) for channelled emissions to air of dust, lead and nickel.

Substance/Parameter	BAT-AEL (mg/Nm^3) Daily average or average over the sampling period)
Dust	< 1-5 ([1])([2])([3])([4])
Lead and its compounds, expressed as Pb	< 0.01-0.1 ([5])
Nickel and its compounds, expressed as Ni	<0.02-0.1 ([6])

(1) The upper end of the range is 20 mg/Nm^3 when either an absolute or a fabric filter is not applicable.
(2) The BAT-AEL does not apply to minor emissions (i.e., when the dust mass flow is below e.g., 50 g/h) if no CMR substances are identified as relevant in the dust based on the inventory given in BAT 2.
(3) In the case of the production of complex inorganic pigments using direct heating, and in the case of the drying step in the production of E-PVC, the upper end of the BAT-AEL range may be higher and up to 10 mg/Nm^3.
(4) Dust emissions are expected to be towards the lower end of the BAT-AEL range (e.g., below 2.5 mg/Nm^3) when the presence of substances classified as CMR 1A or 1B, or CMR 2 in the dust is identified as relevant (see BAT 2).
(5) The BAT-AEL does not apply to minor emissions (i.e., when the lead mass flow is below e.g., 0.1 g/h).
(6) The BAT-AEL does not apply to minor emissions (i.e., when the Ni mass flow is below e.g., 0.15 g/h).

Inorganic compounds	
BAT 15. In order to increase resource efficiency and to reduce the mass flow of inorganic compounds sent to the final waste gas treatment, BAT is to recover inorganic compounds from process off-gases by using absorption and to reuse them.	There is no recovery as part of the project scope.

BAT Requirement	Specific Measure

BAT 16. In order to reduce channelled emissions to air of CO, NOx and SOx from thermal treatment, BAT is to use technique c. and one or a combination of the other techniques given below.

	Technique	Description	Main inorganic compounds targeted	Applicability
a.	Choice of fuel	See Section 4.4.1.	NOx, SOx	Generally applicable.
b.	Low-NOx burner	See Section 4.4.1.	NOx	Applicability to existing plants may be restricted by design and/or operational constraints.
c.	Optimisation of catalytic or thermal oxidation	See Section 4.4.1.	CO, NOx	Generally applicable.
d.	Removal of high levels of NOx precursors	Remove (if possible, for reuse) high levels of NOx precursors prior to thermal or catalytic oxidation, e.g., by absorption, adsorption or condensation.	NOx	Generally applicable.
e.	Absorption	See Section 4.4.1.	SOx	Generally applicable.
f.	Selective catalytic reduction (SCR)	See Section 4.4.1.	NOx	Applicability to existing plants may be restricted by space availability.
g.	Selective non catalytic reduction (SNCR)	See Section 4.4.1.	NOx	Applicability to existing plants may be restricted by the residence time

Thermal treatment (oxidisation) of waste gases occurs through the RTO. The RTO is powered by natural gas, this choice of fuel reduces the amount of NOx generated and releases no SOx compared to gas oil.

The RTO will comprise and low NOx burners.

BAT Requirement	Specific Measure
<table><tr><td></td><td></td><td></td><td></td><td>needed for the reaction.</td></tr></table> BAT-associated emission levels (BAT-AELs) for channelled emissions to air of NOx and indicative level for channelled emissions to air of CO from thermal treatment <table><tr><th>Substance/Parameter</th><th>BAT-AEL (mg/Nm³) (Daily average or average over the sampling period)</th></tr><tr><td>Nitrogen oxides (NOx) from catalytic oxidation</td><td>5-30 (1)</td></tr><tr><td>Nitrogen oxides (NOx) from thermal oxidation</td><td>5-130(2)</td></tr><tr><td>Carbon monoxide (CO)</td><td>No BAT-AEL (3)</td></tr><tr><td colspan="2">(1) The upper end of the BAT-AEL range may be higher and up to 80 mg/Nm³ if the process off-gas(es) contain(s) high levels of NOx precursors. (2) The upper end of the BAT-AEL range may be higher and up to 200 mg/Nm³ if the process off-gas(es) contain(s) high levels of NOx precursors. (3) As an indication, the emission levels for carbon monoxide are 4-50 mg/Nm³ , as a daily average or average over the sampling period.</td></tr></table>	
BAT 17. In order to reduce channelled emissions to air of ammonia from the use of selective catalytic reduction (SCR) or selective non-catalytic reduction (SNCR) for the abatement of NOX emissions (ammonia slip), BAT is to optimise the design and/or operation of SCR or SNCR (e.g., optimised reagent to NOX ratio, homogeneous reagent distribution and optimum size of the reagent drops). BAT-associated emission level (BAT-AEL) for channelled emissions to air of ammonia from the use of SCR or SNCR (ammonia slip) <table><tr><th>Substance/Parameter</th><th>BAT-AEL (mg/Nm³) (Average over the sampling period)</th></tr><tr><td>Ammonia (NH_3) from SCR/SNCR</td><td>< 0.5-8 (1)</td></tr><tr><td colspan="2">(1) The upper end of the BAT-AEL range may be higher and up to 40 mg/Nm³ in the case of process off-gases containing very high levels of NOX (e.g., above 5 000 mg/Nm³) prior to treatment with SCR or SNCR.</td></tr></table>	Not applicable as either SCR or SNCR will be used on Project Apollo as a means of NOx abatement.

<table>
<tr><th>BAT Requirement</th><th>Specific Measure</th></tr>
<tr><td>BAT 18. In order to reduce channelled emissions to air of inorganic compounds other than channelled emissions to air of ammonia from the use of selective catalytic reduction (SCR) or selective non-catalytic reduction (SNCR) for the abatement of NOx emissions), channelled emissions to air of CO, NOx and Sox from the use of thermal treatment, and channelled emissions to air of NOx from process furnaces/heaters, BAT is to use one or a combination of the techniques given below.
a.absorption.
b.adsorption.
c. selective catalytic reduction.
d. selective non catalytic reduction.
e. catalytic oxidation.
f. thermal oxidation.</td><td>Thermal oxidation is utilised to treat emissions to air.

The following gases are fed into the RTO:

- propanol.

- ethanol.

- Solvents including aldehydes (less 1% of solvent passed to the RTO).

BAT AELs:

Monitoring data for inorganic compounds from the RTO will compared to the BAT AEL listed in BAT 18 on a frequency determined by BAT 8.

<table><tr><th>Substance/Parameter</th><th>BAT-AEL (mg-Nm^3) (Daily average or average over the sampling period)</th></tr><tr><td>Nitrogen oxides (NOx)</td><td>10-150</td></tr></table></td></tr>
<tr><td colspan="2">Diffuse VOC emissions to air</td></tr>
<tr><td>BAT 19.i. In order to prevent or, where that is not practicable, to reduce diffuse VOC emissions to air, BAT is to elaborate and implement a management system for diffuse VOC emissions, as part of the environmental management system (see BAT 1), that includes all of the following features:
b. Estimating the annual quantity of diffuse VOC emissions (see BAT 20).
ii. Monitoring diffuse VOC emissions from the use of solvents by compiling a solvent mass balance, if applicable (see BAT 21).
iii. Establishing and implementing a leak detection and repair (LDAR) programme for fugitive VOC emissions. The LDAR programme typically lasts from 1 to 5 years depending on the nature, scale and complexity of the plant (5 years may correspond to large plants with a high number of emission sources). The LDAR programme includes all of the following features:</td><td>Refer to Appendix 03 for definitions of diffuse, fugitive and non-fugitive emissions.

JM will implement a management system for diffuse emissions to air for the whole site and include the contribution from the Apollo Project, including the following:
• i. Monthly estimate of diffuse VOC emissions (refer BAT 20).</td></tr>
</table>

BAT Requirement	Specific Measure
a. Listing of equipment identified as relevant fugitive VOC emission sources in the inventory of diffuse VOC emissions (see BAT 2). b. Definition of criteria associated with the following: o Leaky equipment. Typical criteria could be a leak threshold, above which equipment is considered leaky, and/or the visualisation of a leak with OGI cameras. This depends on the characteristics of the emission source (e.g., accessibility) and the hazardous properties of the emitted substance(s). o Maintenance and/or repair actions to be carried out. A typical criterion could be a VOC concentration threshold triggering the maintenance or repair action (maintenance/repair threshold). The maintenance/repair threshold is generally equal to or higher than the leak threshold. This depends on the characteristics of the emission source (e.g., accessibility) and the hazardous properties of the emitted substance(s). For the first LDAR programme, it is generally not higher than 5 000 ppmv for VOCs other than VOCs classified as CMR 1A or 1B, and 1 000 ppmv for VOCs classified as CMR 1A or 1B. For subsequent LDAR programmes, the maintenance/repair threshold is lowered (see point vi. A.) and not higher than 1 000 ppmv for VOCs other than VOCs classified as CMR 1A or 1B, and 500 ppmv for VOCs classified as CMR 1A or 1B, targeting 100 ppmv. c. Measuring fugitive VOC emissions from equipment listed under point iii. A. (see BAT 22). D. Carrying out maintenance and/or repair actions (see BAT 23, techniques e. and f.), as soon as possible and where necessary according to the criteria defined in point iii. B. Maintenance and repair actions are prioritised according to the hazardous properties of the emitted substance(s), the significance of the emissions and/or operational constraints. The effectiveness of the maintenance and/or repair actions is verified according to point iii. C., leaving enough time after the intervention (e.g., 2 months). e. Filling in the database mentioned in point v. iv. Establishing and implementing a detection and reduction programme for non-fugitive VOC emissions that includes all of the following features: a. Listing of equipment identified as relevant non-fugitive VOC emission sources in the inventory of diffuse VOC emissions (see BAT 2). b. Monitoring non-fugitive VOC emissions from equipment listed under point iv. A. (see BAT 22). c. Planning and implementing techniques to reduce non-fugitive VOC emissions (see BAT 23, techniques a., c. and g. to j.). The planning and implementation of the techniques are	• ii. Undertaking an annual mass balance of solvent emissions. • iii. JM will put a LDAR programme in place that is line with BAT 19, which will include: • Set the timeframe for the programme depending on the complexity of the plant. • Incorporation of the VOC emission point inventory of diffuse emissions. • include PPM to formalise the checking of equipment for leaks, undertaking maintenance and repair. • Setting thresholds for VOC concentrations emitted that trigger maintenance or repair. iv. Introduce a detection and reduction programme for non-fugitive VOC emissions, including an inventory of all the sources, monitoring requirements, implementing techniques to reduce non fugitive emissions. v. Implement establish a database that records non • fugitive emissions that includes listing the design specification of all equipment, tracking the maintenance undertaken on the equipment, if

BAT Requirement	Specific Measure
prioritised according to the hazardous properties of the emitted substance(s), the significance of the emissions and/or operational constraints. d. Filling in the database mentioned in point v. v. Establishing and maintaining a database, for diffuse VOC emissions sources that are identified in the inventory mentioned in BAT 2, for keeping record of: a. equipment design specifications (including the date and description of any design changes); b. the equipment maintenance, repair, upgrade, or replacement actions, performed or planned, and their date of implementation; c. the equipment that could not be maintained, repaired, upgraded or replaced due to operational constraints; d. the results of the measurements or monitoring, including the concentration(s) of the emitted substance(s), the calculated leak rate (as kg/year), the recording from OGI cameras (e.g., from the last LDAR programme) and the date of the measurements or monitoring; e. the annual quantity of diffuse VOC emissions (as fugitive and non-fugitive emissions), including information on non-accessible sources and accessible sources not monitored during the year. vi. Reviewing and updating the LDAR programme periodically. This may include the following: a. lowering the leak and/or maintenance/repair thresholds (see point iii. B.); b. reviewing the prioritisation of equipment to be monitored, giving higher priority to (the type of) equipment identified as leaky during the previous LDAR programme; c. planning the maintenance, repair, upgrade or replacement of equipment that could not be performed during the previous LDAR programme due to operational constraints. vii. Reviewing and updating the detection and reduction programme for non-fugitive VOC emissions. This may include the following: a. monitoring non-fugitive VOC emissions from equipment where maintenance, repair, upgrade or replacement actions were implemented, in order to determine if those actions were successful; b. planning the maintenance, repair, upgrade or replacement actions that could not be performed due to operational constraints.	equipment cannot be replaced / repaired due to operational constraints, results of monitoring data, leak data. • vi. The LDAR programme will be reviewed periodically. • vii. The detection and reduction programme will be reviewed periodically.
BAT 20. BAT is to estimate fugitive and non-fugitive VOC emissions to air separately at least once every year by using one or a combination of the techniques given below, as well as to determine the uncertainty of this estimation. The estimation distinguishes between VOCs classified as CMR 1A or 1B and VOCs that are not classified as CMR 1A or 1B.	JM intend to use a mass balance to estimate fugitive and non-fugitive emissions of VOC to air. JM will undertake a mass balance assessment at least annually.

<table>
<tr><th>BAT Requirement</th><th>Specific Measure</th></tr>
<tr><td>
<table>
<tr><th colspan="2">Technique</th><th>Description</th><th>Type of emissions</th></tr>
<tr><td>a.</td><td>Use of emission factors</td><td>See Section 4.4.2.</td><td rowspan="3">Fugitive and/or non-fugitive</td></tr>
<tr><td>b.</td><td>Use of a mass balance</td><td>Estimation based on the difference in the mass of the substance inputs to and outputs from the plant/production unit, taking into account the generation and destruction of the substance in the plant/production unit. A mass balance may also consist of measuring the concentration of VOCs in the product (e.g., raw material or solvent).</td></tr>
<tr><td>c.</td><td>Use of thermodynamic models</td><td>Estimation using the laws of thermodynamics applied to equipment (e.g., tanks) or particular steps of a production process. The following data are generally used as input for the model:
• chemical properties of the substance (e.g., vapour pressure, molecular mass);
• process operating data (e.g., operating time, product quantity, ventilation);
• characteristics of the emission source (e.g., tank diameter, colour, shape).</td></tr>
</table>
</td><td></td></tr>
<tr><td>BAT 21. BAT is to monitor diffuse VOC emissions from the use of solvents by compiling, at least once every year, a solvent mass balance of the solvent inputs and outputs of the plant, as defined in Part</td><td>JM will undertake the following in their annual mass balance modelling in accordance with BAT 21:</td></tr>
</table>

BAT Requirement	Specific Measure
7 of Annex VII to Directive 2010/75/EU and to minimise the uncertainty of the solvent mass balance data by using all of the techniques given below.	a. Full quantification and identification of inputs and outputs. b. Implementation of a solvent tracking system. JM will implement a VOC tracking system for VOCs received and utilised on site with the tank levels being read and recorded at the end of the stock period. c. Monitoring of shutdowns / malfunctions / changes in flow rates that may need to be reflected in the mass balance data.

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

BAT Requirement	Specific Measure

BAT 22. BAT is to monitor diffuse VOC emissions to air with at least the frequency given below and in accordance with EN standards. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.

Type of sources of diffuse VOC emissions ([1])([2])	Type of VOCs	Standard(s)	Minimum monitoring frequency
Sources of fugitive emissions	VOCs classified as CMR 1A or 1B	EN 15446	Once every year ([3])([4])([5])
	VOCs not classified as CMR 1A or 1B		Once during the period covered by each LDAR programme (see BAT 19 point iii.) ([6])
Sources of non-fugitive emissions	VOCs classified as CMR 1A or 1B	No EN standard available	Once every year
	VOCs not classified as CMR 1A or 1B		Once every year ([7])

(1) The monitoring only applies to emission sources that are identified as relevant in the inventory given in BAT 2.
(2) The monitoring does not apply to equipment operated under sub atmospheric pressure.
(3) In the case of inaccessible sources of fugitive VOC emissions (e.g., if the monitoring requires the removal of insulation or the use of scaffolding), the monitoring frequency may be reduced to once during the period covered by each LDAR programme (see BAT 19 point iii.).
(4) For the production of PVC, the minimum monitoring frequency may be reduced to once every 5 years if the plant uses VCM gas detectors to continuously monitor VCM emissions in a way that allows an equivalent level of detection of VCM leaks.
(5) In the case of high-integrity equipment (see BAT 23 b.) in contact with VOCs classified as CMR 1A or 1B, a lower minimum monitoring frequency may be adopted, but in any case, at least once every 5 years.
(6) In the case of high-integrity equipment (see BAT 23 b.) in contact with VOCs other than VOCs classified as CMR 1A or 1B, a lower minimum monitoring frequency may be adopted, but in any case, at least once every 8 years.

JM currently do not monitor diffuse emissions to air on an annual basis. JM will select one of the following methods to monitor diffuse emissions at the site once Project Apollo is operational:

- Portable VOC Analyser. This is a hand-held device used to measure the concentration of organic compounds at the leak interface of a piece of equipment. A pump within the instrument draws a continuous sample of gas from the leak interface area to the instrument detector.
- Optical gas imaging. Optical gas imaging uses hand-held infrared (IR) cameras which enable the visualisation of gas leaks in real time, as they appear as ‘smoke’ on a video recorder together with the image of the component concerned.
- Differential absorption Lidar. The DIAL method operates in the infrared and ultraviolet spectral region using laser sources for the detection and quantification of emissions of specified VOCs.
- Solar occultation flux (SOF) method. The solar occultation flux (SOF) method is used to map and quantify gas emissions from the scale of a site down to

BAT Requirement	Specific Measure
(7) The minimum monitoring frequency may be reduced to once every 5 years if non-fugitive emissions are quantified by using measurements.	individual pieces of the main equipment. It is able to screen large sections of the site and identify significant sources. • Tracer correlation. This is used for two-dimensional mapping of concentrations and emissions detection on an industrial site and quantification of gas emissions from individual components, main equipment (e.g., tanks). BAT 22 only applies when the annual quantity of diffuse VOC emissions from the plant estimated according to BAT 20 is greater than the following: For fugitive emissions: • 1 tonne of VOCs per year in the case of VOCs classified as CMR 1A or 1B; or • 5 tonnes of VOCs per year in the case of other VOCs. • For non-fugitive emissions: • 1 tonne of VOCs per year in the case of VOCs classified as CMR 1A or 1B; or • 5 tonnes of VOCs per year in the case of other VOCs JM will assess the need for monitoring based on balance model estimates for emissions to air.

BAT Requirement	Specific Measure

BAT 23. In order to prevent or, where that is not practicable, to reduce diffuse VOC emissions to air, BAT is to use a combination of the techniques given below with the following order of priority.

Technique		Description	Type of emissions	Applicability
1. Prevention techniques				
a.	Limiting the number of emission sources	This includes: • minimising pipe lengths; • reducing the number of pipe connectors (e.g., flanges) and valves; • using welded fittings and connections; • using compressed air or gravity for material transfer.	Fugitive and non-fugitive emissions	Applicability may be restricted by operational constraints in the case of existing plants.
b.	Use of high integrity equipment	High-integrity equipment includes, but is not limited to: • valves with bellow or double packing seals or equally effective equipment; • magnetically driven or canned pumps/compressors/agitators, or pumps/compressors/agitators using double seals and a liquid barrier; • certified high-quality gaskets (e.g., according to EN 13555) that are tightened according to technique e.; • closed sampling system. The use of high-integrity equipment is especially relevant to prevent or minimise:	Fugitive emissions	Applicability may be restricted by operational constraints in the case of existing plants. Generally applicable to new plants and major plant upgrades.

a. The Apollo Project will be situated in the existing CSF2 building, operational and financial constraints mean that limiting pipe lengths etc may be difficult. However, the type of fittings used will be considered to reduce the likelihood of leaks.
b. JM are installing high quality new equipment. c. Diffused emissions will be emitted through the heating, ventilation and air conditioning (HVAC) system with has high efficiency particulate air filters (HEPA) and carbon filters.

d. Access to pipework will be considered in the installation of Project Apollo, however there may be restrictions due to the fact the project is being installed in an existing building.
e. JM are installing high quality new equipment.

f. Project Apollo will operate under the LDAR programme – see BAT 19 which will identify any leaky parts which will subsequently be replaced.
g. Project Apollo has been designed to operate efficiently, the process will be monitored, and adjustments made to inputs etc to lower the temperature and / or solvents used where possible.
h. As the process is monitored operating conditions will be constantly updated to allow the most efficient running possible.
i. closed systems will be used on the powder input and on the drainage system. Effluent comprising VOCs and PGM material are sent to a suitably permitted offsite waste management facility for refining.
j. waste gases comprising VOCs are sent for abatement to the RTO.

BAT Requirement					Specific Measure
		• emissions of CMR substances or substances with acute toxicity; and/or • emissions from equipment with high-leaking potential; and/or • leaks from processes operated at high pressures (e.g., between 300 bar and 2 000 bar). High-integrity equipment is selected, installed and maintained according to the type of process and the process operating conditions.			
c.	Collecting diffuse emissions and treating off-gases	Collecting diffuse VOC emissions (e.g., from compressor seals, vents and purge lines) and sending them to recovery (see BAT 9 and BAT 10) and/or abatement (see BAT 11).	Fugitive and non-fugitive emissions	Applicability may be restricted: • for existing plants; and/or • by safety concerns (e.g., avoiding concentrations close to the lower explosive limit).	
2. other techniques					
d.	Facilitating access and/or monitoring activities	To ease maintenance and/or monitoring the access to potentially leaky equipment is facilited, e.g., by activities, installing platforms, and/or drones are used for monitoring.	Fugitive emissions	Applicability may be restricted by operational constraints in the case of existing plants.	

BAT Requirement					Specific Measure
e.	Tightening	• Tightening of gaskets by personnel that is qualified according to EN 1591-4 and using the designed gasket stress (e.g., calculated according to EN 1591-1); • installing tight caps on open ends; • using flanges selected assembled according to EN 13555.	Fugitive emissions	Generally applicable.	
f.	Replacement of leaky equipment and/or parts	This includes the replacement of: • gaskets; • sealing elements (e.g., tank lid); • packing material (e.g., valve stem packing material).	Fugitive emissions	Generally applicable.	
g.	Reviewing and updating process design	This includes: • reducing the use of solvents and/or using solvents with lower volatility; • reducing the formation of side products containing VOCs; • lowering the operating temperature; • lowering the VOC content in the final product.	Non-fugitive emissions	Applicability may be restricted in the case of existing plants due to operational constraints.	
h.	Reviewing and updating operating conditions	This includes: • reducing the frequency and duration of reactor and vessel openings; • preventing corrosion by lining or coating of equipment, by painting pipes (for external corrosion) and by using corrosion inhibitors for	Non-fugitive emissions	Generally applicable.	

BAT Requirement					Specific Measure
		materials in contact with equipment.			
i.	Using closed systems	This includes: • vapour balancing (see Section 4.4.3); • closed systems for solid/liquid and liquid/liquid phase separations; • closed systems for cleaning operations; • closed sewers and/or wastewater treatment plants; • closed sampling systems; • closed storage areas. Off-gases from closed systems are sent to recovery (see BAT 9 and BAT 10) and/or abatement (see BAT 11)	Non-fugitive emissions	Applicability may be restricted by operational constraints in the case of existing plants and/or by safety concerns.	
j.	Using techniques to minimise emissions from surfaces	This includes: • installing oil creaming systems on open surfaces; • periodically skimming open surfaces (e.g., removing floating matter); • installing anti-evaporation floating elements on open surfaces; • treating wastewater streams to remove VOCs and send the VOCs to recovery (see BAT 9 and BAT 10) and/or abatement (see BAT 11); • installing floating roofs on tanks; • using fixed-roof tanks connected to a waste gas treatment.	Non-fugitive emissions	Applicability may be restricted by operational constraints in the case of existing plants.	

BAT Requirement	Specific Measure
Process furnace/heaters	
BAT 36. In order to prevent or, where that is not practicable, to reduce channelled emissions to air of CO, dust, NOx and SOx, BAT is to use technique c. and one or a combination of the other techniques given below.	Not applicable, process furnace or heaters not used on the CCM.

APPENDIX 05

BAT Assessment for Boilers

Table App05-1
Boilers – Compliance with indicative BAT for Energy Efficiency

Indicative BAT requirement	Compliance level
BAT 1. BAT is to implement an Energy Management System	Whilst JM does not have a formal energy management system, there are processes in place to ensure that energy efficiency is considered when procuring new plant and equipment. Energy KPIs are in place at the site and the monitoring of energy usage at the site is undertaken.
BAT 2. Continuously minimise the environmental impact of an installation by planning actions and investment on an integrated basis….. considering the cost benefits and cross media effects	The environmental impacts of the proposed change to the Installation were considered at the design stage of the project; the changes have been designed to minimise adverse environmental impacts. JM requires that equipment suppliers provide energy efficient equipment for all new projects.
BAT 3. Identify aspects of an installation that influence energy efficiency by carrying out an audit.	The facility has an EMS which addresses energy use and considers the aspects and impacts of all activities undertaken at the site. JM also operates to a formal Climate Change Agreement. Energy usage is monitored and reviewed regularly. This allows for the investigation of any notable changes in energy usage.
BAT 4. When carrying out an audit, ensure that the audit identifies the following aspects: • Energy use and type and its component systems and processes • Energy-using equipment and type and quantity of energy used in the installation • Possibilities to minimise energy use… • Possibilities to use alternative sources or use of energy that is more efficient … • Possibility to apply energy surplus to other processes …	The energy review process concentrates on reducing energy and resource input into the production process. The emphasis is on the day-to-day usage of energy and resources. Energy use is also considered as part of the selection process for new equipment/processes. Energy performance in association with the facility's CCA is based on an absolute percentage reduction whereby JM must achieve a required percentage reduction in energy use; all reasonable measures are considered to achieve this target.

Indicative BAT requirement	Compliance level
• Possibilities to upgrade heat quality	
BAT 5. Use tools or methodologies to assist with identifying and quantifying energy optimisation …	Various tools are used to identify and quantify energy optimisation including, estimates and calculations. Such tools were used when specifying the boilers.
BAT 6. Identify opportunities to optimise energy recovery …	Energy recovery was considered at the design stage of the project. The boilers are designed to be energy efficient: • waste heat will, be recovered from the engine exhaust gas; • the gas engine will have a cooling water loop which will recover heat from the engine and integrate it in a process heat sink. The heated water will then pass through an economiser picking up additional heat, raising the water temperature further; and • Heat generated by CHP (LTHW) will be used to preheat the feed water before it enters the Hot Well before use in the boilers
BAT 7. Optimise energy efficiency by taking a systems approach to energy management …	JM will adopt a systems approach when considering energy efficiency of proposed changes.
BAT 8. Establish energy efficiency indicators by: • identifying suitable energy efficiency indicators for the installation, and where necessary individual processes, systems, units and measure change over time • Identifying and recording appropriate boundaries associated with the indicators • Identifying and recording factors that can cause variance in energy efficiency of the process, system, units.	The energy efficiency of the boilers will be monitored by the facility's existing control systems and by the technology supplier remotely. The efficiency of the boilers will be maintained at the required optimal level as a minimum; this efficiency will be subject to regular review. JM has energy KPIs in place for the facility and in accordance with the CCA, JM must achieve a required percentage reduction in energy use. KPIs are regularly reviewed, where unexpected fluctuations occur, these are investigated to establish the reason and to implement actions to avoid such a future occurrence. Energy KPIs are in place at the facility against which the plant energy efficiency is monitored. Where peaks in energy use are identified investigation will be made into the causes of this variance.

Indicative BAT requirement	Compliance level
BAT9. BAT is to carry out … comparisons with sector, national or regional benchmarks, where validated data are available	JM has targets for energy reduction in accordance with the requirements of the CCA and the site's energy KPI.
BAT 10. Optimise energy efficiency when planning a new installation, unit or system or significant upgrade by considering: • Initiating EED at early design stage… • Development/selection of energy efficient technologies • EED should be carried out by an energy expert • Initial mapping of energy consumption should also be addressed which parties in the project organisations influence the future energy consumption and should optimise the energy efficiency design of the future plant.	Improvement in energy use/efficiency was a key driver in the decision to replace the boilers. Energy efficiency was considered at the design stage for the proposed changes by JM and the appointed technology providers.
BAT 11. Seek to optimise the use of energy between more than one process or system with the installation or with a third party	The boilers have been designed to optimise energy usage and recover heat. Heat is recovered from the flue gases to heat the feed water to the boiler by the means of an economiser. The boilers are to provide demand above the baseload provided by the CHP, so have been designed for efficiency even at low turn down.
BAT 12Maintain the impetus of the energy efficiency programme by using a variety of techniques such as: • Implementing specific energy efficiency measures • Accounting for energy usage based on real (metered) values… • Creation of financial profit centres for energy efficiency • Benchmarking • Fresh look at existing management systems • Using change management techniques	Site energy KPIs are established. The site records energy data, where energy usage is monitored, and energy efficiency improvements/minimisation are addressed. Specialist consultants are employed to undertake ESOS assessments on behalf of JM from which opportunities to improve energy efficiency are recommended. The energy requirements of any proposed changes are considered at the design stage, as previously discussed.

Indicative BAT requirement	Compliance level
BAT 13. Maintain expertise in energy efficiency and energy using systems by using: • Skilled staff • Training staff offline periodically… • Sharing in-house resources between sites • Use of appropriately skilled consultants • Outsourcing specialist systems and/or functions.	The business employs technical specialists to manage energy. JM will, where required, engage specialist consultants to provide support in maintaining and developing expertise in energy efficiency and processes and to ensure the energy and resource obligations placed on the organisation are fully met. JM employs specialist consultants to undertake ESOS assessments from which opportunities to improve energy efficiency are recommended.
BAT 14. Ensure that the effective control of processes is implemented by • a. having systems in place to ensure that procedures are known, understood and complied with (see Sections 2.1(d)(vi) and 2.5) • b. ensuring that the key performance parameters are identified, optimised for energy efficiency and monitored (see Sections 2.8 and 2.10) • c. documenting or recording these parameters (see Sections 2.1(d)(vi), 2.5, 2.10 and 2.15)	The technology supplier will be contracted to operate and maintain the boilers. Additionally, operating procedures will be developed, where required, for the proposed changes to the Installation and staff will be suitably trained to ensure optimal operation of the boilers. Key performance parameters will be identified and recorded.
BAT 15. Carry out maintenance to optimise energy efficiency by … • a. clearly allocating responsibility for the planning and execution of maintenance • b. establishing a structured programme for maintenance based on technical descriptions of the equipment, norms, etc. as well as any equipment failures and consequences. Some maintenance activities may be best scheduled for plant shutdown periods • c. supporting the maintenance programme by appropriate record keeping systems and diagnostic testing	The technology supplier will be contracted to operate and maintain the boilers. JM will also undertake occasional oil top up of the engines. In addition to preventative maintenance, the boilers will be included in the daily site walkover visual checks undertaken by JM. This will identify any malfunctioning parts quickly so that they can be repaired / replaced. The maintenance of equipment will be undertaken in accordance with manufacturer's requirements to ensure the efficiency, including energy efficiency, of equipment is maintained. Records of maintenance will be retained at the facility.

Indicative BAT requirement	Compliance level
• d. identifying from routine maintenance, breakdowns and/or abnormalities possible losses in energy efficiency, or where energy efficiency could be improved • e. identifying leaks, broken equipment, worn bearings, etc. that affect or control energy usage, and rectifying them at the earliest opportunity	
BAT 16. Establish and maintain documented procedures to monitor on a regular basis key characteristics of operations and activities that can have a significant impact on energy efficiency	Operational and maintenance procedures for the proposed new boilers will be developed, where required, to ensure that efficient operation of the boilers is maintained.
BAT 17. Optimise energy efficiency of combustion …	The combustion of natural gas in the boilers will be optimised during the commissioning phase to ensure efficient operation. This equipment will be subject to regular preventative maintenance to ensure efficient operation, additionally servicing of equipment is undertaken by the supplier at least annually.
BAT 18. Maintain efficiency of heat exchangers by monitoring the efficiency periodically and preventing/removing fouling.	See previous comments for preventive maintenance.
BAT 19. BAT is to maintain the efficiency of heat exchangers by both: a. monitoring the efficiency periodically, and b. preventing or removing fouling	The heat exchangers will be included in the PPM to manage fouling and the heat exchanger efficiency will be monitored regularly.
BAT 20. BAT is to seek possibilities for cogeneration, inside and/or outside the installation (with a third party).	This is not practical due to constraints on the existing site.
BAT 21. BAT is to increase the power factor according to the requirements of the local electricity distributor by using techniques such as those in Table 4.3, according to applicability (see Section 3.5.1) - Installing capacitors in the AC circuits to decrease the magnitude of reactive power. - Minimising the operation of idling or lightly loaded motors. - Avoiding the operation of equipment above its rated voltage.	Not applicable as the boiler will be fired by natural gas not electricity power supply.

Indicative BAT requirement	Compliance level
- When replacing motors, using energy efficient motors.	
Bat 22. BAT is to check the power supply for harmonics and apply filters if required (see Section 3.5.2)	Not applicable as the equipment is a gas fired boiler and not electrical equipment.
BAT 23. BAT is to optimise the power supply efficiency by using techniques such as those in Table 4.4, according to applicability:	Not applicable as the equipment is a gas fired boiler and not electrical equipment.
BAT 24 Optimise electric motors …	Energy efficient motors will be used in the boilers. These motors will be subject to regular PPM.
Compressed Air Systems	
BAT 25 Optimise compressed air systems by .	n/a
BAT 26. Optimise pumping systems	The proposed pumping systems have been designed/specified to the correct sizing; oversized pumps have not been specified. All new pumps have been correctly matched to the motor duty. The pumps and motors will be subject to regular PPM. All pipework has been designed to the correct diameter for the proposed activity and pipeline layouts designed to minimise the need for bends and valves.
BAT 27. HVAC Systems	The proposed changes do not include HVAC systems.
BAT 28. Lighting	The boilers are being installed in the existing boiler house with existing lighting systems.
BAT 29. Drying, Separation and Concentration Processes	Not applicable

EUROPEAN OFFICES

United Kingdom

AYLESBURY
T: +44 (0)1844 337380

BELFAST
belfast@slrconsulting.com

BRADFORD-ON-AVON
T: +44 (0)1225 309400

BRISTOL
T: +44 (0)117 906 4280

CARDIFF
T: +44 (0)29 2049 1010

CHELMSFORD
T: +44 (0)1245 392170

EDINBURGH
T: +44 (0)131 335 6830

EXETER
T: + 44 (0)1392 490152

GLASGOW
glasgow@slrconsulting.com

GUILDFORD
guildford@slrconsulting.com

KILKENNY
kilkenny@slrconsulting.com

LONDON
T: +44 (0)203 805 6418

MAIDSTONE
T: +44 (0)1622 609242

MANCHESTER
T: +44 (0)161 549 8410

NEWCASTLE UPON TYNE
T: +44 (0)191 261 1966

NOTTINGHAM
T: +44 (0)115 964 7280

SHEFFIELD
T: +44 (0)114 2455153

SHREWSBURY
T: +44 (0)1743 23 9250

STIRLING
T: +44 (0)1786 239900

WORCESTER
T: +44 (0)1905 751310

Ireland

DUBLIN
T: + 353 (0)1 296 4667

France

GRENOBLE
T: +33 (0)6 23 37 14 14