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WASTE RESOURCE MANAGEMENT

ALTILIUM METALS LTD

TECHNOLOGY CENTRE, TAVISTOCK

OPERATING TECHNIQUES

APRIL 2024

wardell armstrong

Wardell Armstrong
Sir Henry Doulton House, Forge Lane, Etruria, Stoke-on-Trent, ST1 5BD, United Kingdom
Telephone: +44 (0)1782 276 700 www.wardell-armstrong.com

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ALTILIUM METALS LTD

APRIL 2024

4

PREPARED BY:

Arabella Sharrock	Principal Waste Permitting Consultant	

REVIEWED BY:

Alison Cook	Technical Director	

APPROVED BY:

Alison Cook	Technical Director	

CONTENTS

APPENDICES

DRAWINGS	TITLE	SCALE
BM12752-001-P0	Permit Boundary Plan	1:1000

1 INTRODUCTION

1.1.1 Altilium Metals Ltd have commissioned Wardell Armstrong LLP to prepare a permit application for their Technology Centre Facility, Unit 20, Plymouth Road Industrial Estate, Tavistock, Devon, PL19 9QN.

1.1.2 The Technology Centre is a research facility that uses state-of-the-art equipment and techniques to treat waste black mass from end-of-life lithium-ion Electric Vehicle (EV) batteries to recover the constituent materials via sequential hydrometallurgical processes, and subsequently use the recovered materials for trial-scale supply to manufacturers of new EV batteries.

1.1.3 The process was trialled under a Regulatory Position Statement granted by the Environment Agency for a site in Devon. The Site is currently operational under a Local Enforcement Position.

1.1.4 As older Electric Vehicles reach end-of-life, millions of batteries will need to be recycled over the coming decade (over one million tonnes a year by 2030, growing to nearly 20 million by 2040). The ability to recycle these batteries and 'close the loop' on their life cycle reduces the need for virgin mined materials and leads to significant reductions in the carbon footprint of new lithium-ion EV batteries. By building a circular domestic supply chain, we will reduce our reliance on global supply chains and imported materials[1].

1.1.5 The recovery of critical minerals such as lithium fall within the scope of the Government's Critical Minerals Strategy, and the scheme will support a circular economy of critical minerals. Lithium, cobalt and graphite have been identified as high criticality for the UK. Additionally, the processes also include minerals on the UK watch list, including manganese and nickel.

1.1.6 The site will also treat other waste streams including copper tailings and other metal rich wastes detailed in the proposed list of EWC codes in Table 2.2 to recover metals from the waste.

1.1.7 The National Grid Reference (NGR) for the site is SX 48156 73206. The site location and permit boundary are shown on drawing BM12752-001-P01

1.1.8 The process comprises activities which are listed within the Environmental Permitting Regulations (England and Wales) 2016. Therefore, a permit application has been

[1] Purpose - Altilium

prepared to apply for the relevant activities, as described in Sections 2 and 3 of this Operating Techniques Report.

1.1.9 The facility and equipment have been designed in accordance with the Best Available Techniques, using state-of-the-art equipment and material processing carried out under laboratory conditions. The following reference documents and guidance notes have been followed in the design of the facility, ensuring that the appropriate measures are followed:

- Guidance for the Recovery and Disposal of Hazardous and Non Hazardous waste (S5.06)[2];
- European Commission BREF Note on Speciality Inorganic Chemicals[3];
- How to Comply with your environmental permit: Additional Guidance for the inorganic chemicals sector (EPR4.03)[4].

1.1.10 The site will be operated in accordance with Altilium Metal Ltd's Environmental Management System (EMS), a summary of which has been provided as part of the permit application. The intention is to gain ISO14001 accreditation in due course.

1.1.11 Waste operations will be managed by a Technically Competent Manager (TCM) who will hold the relevant qualifications.

[2] waste_BAT_guidance.book (publishing.service.gov.uk)
[3] sic_bref_0907 (1).pdf
[4] How to comply (publishing.service.gov.uk)

2 PERMITTED ACTIVITIES

2.1.1 The facility will accept hazardous black mass waste, copper tailings and other metal rich wastes detailed in the proposed list of EWC codes (Table 2.2) for chemical treatment, with a capacity not exceeding 10 tonnes per day. The activities therefore fall below the threshold set out in Section 5.3, Part A(1)(a)(ii) of Schedule 1 of the Environmental Permitting Regulations (England and Wales) 2016. The treatment of these hazardous waste streams is therefore considered a waste activity.

2.1.2 The site will accept no more than 4 tonnes of waste from various streams at any one time.

2.1.3 The permitted activities will be limited to those specified in Table 2.1 below. Additionally, it is envisaged that there will be Directly Associated Activities (DAAs) which have potential to cause pollution if not appropriately managed and have a direct technical connection with the installation. These have also been included in the Table.

Table 2.1: Permitted Activities and Directly Associated Activities

Activity	EPR 2016	Waste Framework Directive Annex I and II R&D codes
Waste Activities		
Processing of black mass, copper tailings and other wastes detailed in Table 2.2	Chemical treatment of hazardous waste below the capacity threshold set in Section 5.3 Part A(1)(a)(ii)	**R4** Recycling/reclamation of metals and metal compounds **R5** Recycling/reclamation of other inorganic materials **R13** Storage of waste pending any of the operations numbered R1 to R12 (excluding temporary storage, pending collection, on the site where the waste is produced)
Directly Associated Activities		
Storage and handling of raw materials		
Control and abatement systems for point source emissions to air		
Waste storage and treatment		

2.1.4 The facility will accept waste black mass, copper tailings and other wastes containing metals as set out according to the appropriate EWC code, in Table 2.2 below. Further detail on the waste acceptance and handling procedures is provided in Sections 4 and 5 of this report.

Table 2.2:: Waste to be Accepted for Processing and Treatment	
01	**WASTES RESULTING FROM EXPLORATION, MINING, QUARRYING, AND PHYSICAL AND CHEMICAL TREATMENT OF MINERALS**
01 01	**Wastes from Mineral Extraction**
01 01 01	wastes from mineral metalliferous excavation
01 03	**Wastes from physical and chemical processing of metalliferous minerals**
01 03 04*	acid-generating tailings from processing of sulphide ore
01 03 05*	other tailings containing hazardous substances
01 03 06	tailings other than those mentioned in 01 03 04 and 01 03 05
06	**WASTES FROM INORGANIC CHEMICAL PROCESSES**
06 03	**wastes from MFSU of salts and their solutions and metallic oxides**
06 03 13*	solid salts and solutions containing heavy metals
06 03 14	solid salts and solutions other than those mentioned in 06 03 11 and 06 03 13
06 03 15*	metallic oxides containing heavy metals
06 03 16	metallic oxides other than those mentioned in 06 03 15
06 04	**metal containing wastes other than those mentioned in 06 03**
06 04 03*	wastes containing arsenic
06 04 05*	wastes containing other heavy metals
06 04 99	wastes not otherwise specified
10	**WASTES FROM THERMAL PROCESSES**
10 01	**Wastes from power stations and other combustion plants**
10 01 02	Coal fly ash
10 01 03	fly ash from peat and untreated wood
10 01 13*	fly ash from emulsified hydrocarbons used as fuel
11	**WASTES FROM CHEMICAL SURFACE TREATMENT AND COATING OF METALS AND OTHER MATERIALS, NON-FERROUS HYDROMETALLURGY**
11 02	**Wastes from non-ferrous hydrometallurgy**
11 02 05*	wastes from copper hydrometallurgical processes containing hazardous substances
11 02 06	wastes from copper hydrometallurgical processes other than those mentioned in 11 02 05
11 02 07*	other wastes containing hazardous substances
11 02 99	wastes not otherwise specified
12	**WASTES FROM SHAPING AND PHYSICAL AND MECHANICAL SURFACE TREATMENT OF METALS AND PLASTICS**
12 01	**wastes from shaping and physical and mechanical surface treatment of metals and plastics**
12 01 01	ferrous metal filings and turnings
12 01 03	non-ferrous metal filings and turnings
16	**WASTES NOT OTHERWISE SPECIFIED IN THE LIST**
16 01	**end of life vehicles from different means of transport (including off-road machinery) and wastes from dismantling of end-of-life vehicles and vehicle maintenance (except 13, 14, 16 06 and 16 08)**
16 01 12	brake pads other than those mentioned in 16 01 11
16 01 17	ferrous metal
16 01 18	non-ferrous metal
16 01 22	components not otherwise specified
16 01 99	wastes not otherwise specified
16 03	**Off-Specification Batches and unused products**
16 03 03*	inorganic wastes containing hazardous substances
16 03 04	inorganic wastes other than those mentioned in 16 03 03
16 06	**Batteries and Accumulators**
16 06 02*	Ni-Cd batteries
16 06 04	Alkaline Batteries (except 16 06 03)
16 06 05	other batteries and accumulators
16 06 06*	separately collected electrolyte from batteries and accumulators
16 11	**Waste linings and refractories**

Table 2.2:: Waste to be Accepted for Processing and Treatment	
16 11 01	carbon-based linings and refractories from metallurgical processes containing hazardous substances
16 11 02	carbon-based linings and refractories from metallurgical processes other than those mentioned in 16 11 01
16 11 03	other linings and refractories from metallurgical processes containing hazardous substances
16 11 04	other linings and refractories from metallurgical processes other than those mentioned in 16 11 03
16 11 05	linings and refractories from non-metallurgical processing containing hazardous substances
16 11 06	linings and refractories from non-metallurgical processing other than those mentioned in 16 11 05
19	**WASTES FROM WASTE MANAGEMENT FACILITIES, OFF-SITE WASTEWATER TREATMENT PLANTS AND THE PREPARATION OF WATER INTENDED FOR HUMAN CONSUMPTION AND WATER FOR INDUSTRIAL USE**
19 01	**Wastes from Incineration of pyrolysis of waste**
19 01 02	ferrous metals removed from bottom ash
19 01 11*	bottom ash and slag containing hazardous substances
19 01 12	bottom ash and slag other than those mentioned in 19 01 11
19 01 13	fly ash containing hazardous substances
19 01 14	fly ash other than those mentioned in 19 01 14
19 01 17*	pyrolysis wastes containing hazardous substances
19 01 18	pyrolysis wastes other than those mentioned in 19 01 17
19 02	**Wastes from Physio/chemical treatments of waste (including dechromation, decyanidation, neutralisation)**
19 02 03	pre-mixed wastes composed only of non-hazardous wastes
19 02 04*	pre-mixed wastes composed of at least one hazardous waste
19 02 05*	sludges from physio/chemical treatment containing hazardous substances
19 02 06	sludges from physio/chemical treatment other than those mentioned in 19 02 05
19 10	**Wastes from shredding of metal-containing wastes**
19 10 02	non-ferrous waste
19 10 03*	fluff-light fraction and dust containing hazardous substances
19 10 04	fluff-light fraction and dust other than those mentioned in 19 10 03
19 10 05*	other fractions containing hazardous substances
19 10 06	other fractions other than those mentioned in 19 10 05
19 12	**wastes from the mechanical treatment of waste (for example sorting, crushing, compacting, pelletising) not otherwise specified**
19 12 02	ferrous metals
19 12 03	non-ferrous metals
19 12 09	minerals (for example sand, stones)
19 12 11*	other wastes (including mixtures of materials) from mechanical treatment

3 PROPOSED ACTIVITIES

3.1.1 The proposed activities fall within one permittable waste activity; hazardous waste treatment to recover constituent components.

3.1.2 The hydrometallurgical extraction apparatus and processes devised by Altilium Metals Ltd is able to be applied to a number of different wastes containing metals.

3.1.3 Working at full volumetric capacity, this means the system would accept up to 5kg of black mass or equivalent feedstock per reaction cycle. A maximum of one cycle can be completed per 24 hours, with five cycles per week meaning that 25kg can be processed weekly. This is approximately 1.3 tonnes of black mass or equivalent feedstock that can be processed annually.

4 WASTE ACCEPTANCE PROCEDURES

4.1 Waste Acceptance

4.1.1 The site will accept the EWC codes as detailed in Table 2.2, all of these waste streams shall be accepted at the site in accordance with the below procedure.

4.1.2 While "Black Mass" is a term of art, used in this case to describe the shredded, sorted output of end-of-life Li-ion battery processing, the waste activities at the site are sufficiently versatile to process a number of waste streams from failed manufacture of Li-ion batteries, termed "Gigafactory scrap". The facility will accept both material streams for treatment.

4.1.3 Black mass will be delivered in a minimum containment specification of double-lined Flexible Intermediate Bulk Containers (FIBCs). These FIBCs will be transported and delivered to the site on pallets. Smaller fractions may be delivered in UN certified and safety marked drums or barrels.

4.1.4 Delivery and containment of copper tailings and other waste will follow the same acceptance procedures and only be accepted in suitable containers that are sealed and considered fit for purpose.

4.1.5 The facility expects to receive up to 4 tonnes of waste as detailed in Table 2.2 per year for the purposes of treatment for the recovery of the constituent materials. No more than 1.5 tonnes of black mass, 1.5 tonnes of copper tailings and no more than 1 tonne of any other waste stream will be stored at the facility at any one time.

4.2 Pre-Acceptance Procedures

4.2.1 The waste pre-acceptance procedure enables the determination of the suitability of the waste for processing before arrangements are made to accept the waste.

4.2.2 The following information will be obtained from the waste producer.

- The necessary permitting information declaring their legitimacy in producing such wastes.
- The nature of the process producing the waste, including variability of this process.
- The composition of the waste (chemicals and/or battery types present and individual concentrations).
- The relevant Materials Safety Data Sheet.

4.2.3 Representative sample of the waste will be taken and analysed. Sampling practices are to be determined by Altilium.

4.2.4 The Information will be recorded and referenced to the waste stream so that it is available at all times. Any updates to the information will be made where required to ensure that records accurately reflect the waste stream.

4.2.5 The waste producer has obligations under the Duty of Care requirements to provide the following information about the waste:

- composition of the waste;
- handling requirements;
- hazardous properties/Hazard Codes;
- the EWC code.

4.2.6 The following information will be obtained in writing.

- The type of process producing the waste.
- The specific process from which the waste derives.
- The quantity of waste.
- Chemical analysis of the waste (individual constituents and as a minimum their percentage compositions – analytical techniques may vary, however Altilium may use discretion to ensure that selected technique(s) are sufficiently sensitive to detect all necessary elements/chemicals and therefore hazards presented).
- The state of the waste (e.g. solid, liquid or gas).
- Hazards associated with the waste.
- Sample storage and preservation techniques, as well as date of processing.

4.2.7 All records relating to pre-acceptance should be maintained at the installation for cross-reference and verification at the waste acceptance stage. These records should be kept for a minimum of 3 years.

4.3 Acceptance Procedure

4.3.1 Waste acceptance procedures are in place to ensure that when the waste arrives to site, its characteristics are confirmed to be compliant.

4.3.2 Waste will be delivered to the site by a Registered Waste Carrier. Deliveries will be accompanied by a 'Waste Transfer Note' in accordance with the legal requirements of the Duty of Care for waste. A "Hazardous Waste Consignment Note" will also accompany the waste where it is hazardous waste.

4.3.3 Where the waste is not non-compliant, the load will be rejected and will be returned to the producer where possible. Where this is not possible, the waste will remain in the storage area inside the packaging in which the waste was delivered. Arrangements will be made to remove the waste to a suitably permitted facility as soon as possible.

4.3.4 Records will be kept for each load arriving on site including details of:

- date of delivery;
- waste producer details;
- a unique reference number;
- pre-acceptance and acceptance analysis results.
- package type and size and the quantity of waste.

4.3.5 All records relating to pre-acceptance should be maintained and kept available for cross-reference verification at the waste acceptance stage. Records should be held for a minimum of two years after the waste has been treated.

5 RESPONSIBLE PERSONS

5.1.1 The site currently operates under the control of Benjamin Wickham (Chief Technical Officer) who is the responsible person for the processes undertaken at the site. Members of the SHEQ department will support Benjamin with the safe operation and management of the site.

5.1.2 All other staff working at the site have been provided with training appropriate to their role and have a responsibility for their part in health and safety and environmental awareness and pollution control.

6 WASTE PROCESSESSING AND TREATMENT

6.1 Storage of Waste

6.1.1 The storage of black mass includes secondary containment to contain any spills that occur. FIBCs will be double-lined and palletised to minimise the risk of spillages. Smaller containers will be inspected on arrival for any damage and if compromised, the immediately transferred to a new container. Disbursement from larger containers will be done manually with appropriate precautions taken, such as full-length PPE, dust masks, eye protection and chemical resistant gloves and footwear using appropriate tools.

6.1.2 Disbursement between smaller containers will be done in the laboratory. Hard shelled plastic containers will be utilised for this process and pre-assessed to be compatible with the feedstock materials in question. Polypropylene and polyethylene containers are broadly inert and will typically be utilised in this process unless the Safety Data Sheets and COSHH assessment of the material to be moved stipulates otherwise.

6.1.3 Nickel, Manganese Cobalt precipitates will be stored in sealed HDPE containers, with a maximum of 10kg per container. Any secondary offtakes, such as graphite or gypsum filter cake will be stored similarly until an appropriate collection service can be arranged. Any liquid process streams (work in progress) will be stored in 5 or 10 litre vented HDPE jerry cans depending on requirements.

6.1.4 Tailings from the mining of copper are classified as a hazardous waste with European Waste Catalogue. This waste stream will be received at site as a dry, granular powder in sealed bags (FIBCs) with a capacity of 1 tonne each, or smaller sealed contained with a capacity of up to 20L.

6.1.5 A maximum of 1.5 tonnes of Copper Tailings will be stored on-site at any one time, although this may be distributed between a number of batches of differing origins. The storage of copper tailings will include secondary containment to contain any spills that occur.

6.1.6 FIBCs will be double-lined to minimise the risk of spillages. Smaller containers will be inspected on arrival for any damage and if compromised, the immediately transferred to a new container. Disbursement from larger containers will be done manually with appropriate precautions taken, such as full-length PPE, dust masks, eye protection and chemical resistant gloves and footwear, using appropriate tools. Disbursement between smaller containers will be done in the laboratory.

6.1.7 All powders are handled within a recirculating powder management hood the specification is:

Purair®RX Ductless Fume Hood, 48" / 1200mm Nominal Width, Comprising of a P5-48-HEAD-A and a P5-48-XT(RX)-ENCL, EXCOLLAR-P5-24 Exhaust Collar 6" OD, 115V 60Hz, North American Cord set (unless specified). Includes Qty Two ASTS-030 HEPA Main Filters.

6.1.8 This recirculating/ductless fume hood uses air flow and filtration to contain aerosolised powders, so operators are protected and there is no environmental release. Filters are replaced and disposed of within scheduled maintenance as set out within the manufacturer's guidance for consumers.

6.2 General

6.2.1 The process steps are carried out in a sequential order and can be divided into three distinct phases:

[redacted]

6.2.2 The three processes are predominantly a [redacted] with a liquid volume cap of 50 litres per batch.

[redacted]

6.2.4 There are three laboratories in which segregated chemical reactions can be performed for the purposes of conversion or refinement of waste and/or the constituent chemicals (including wet chemical processing and furnaces).

6.2.5 Intermediate process streams are stored in jerry cans in appropriate locations and bund according to their COSHH requirements.

[redacted]

6.2.7 Separate extractors and scrubbers, providing integrated ventilation, typically shared between laboratories of common risk profile, which remove and make safe gaseous

process products and vapours, either through chemical scrubbing (e.g. acid vapour) or dilution (e.g. hydrogen).

Figure 1 – Example Process Flow for Li-Battery Waste Treatment

REDACTED

6.2.8 It is noted that the general processes and waste treatment will remain the same as previously regulated under regulatory Position Statement (RPS)182 and the Local Enforcement Position. Therefore, there is no additional risk posed by the site for this Permit Application, only small volume of waste will be processed using the above methodology for research purposes.

6.2.9 However, as the site is a research and development facility there will be slight tweaks and changes to the process over time to ensure the most efficient metal extraction is obtained.

6.2.10 Different waste streams may require different processing methodologies. Materials brought into the research facility will be subject to pre-arranged trials. For each trial a written procedure will be prepared setting out the waste to be treated, the treatment process, any environmental considerations and the expected outputs. The operating techniques will be updated if a significant change to the process is required to facilitate the research.

7 STORAGE OF CHEMICALS

7.1.1 There are a range of reagents used in the treatment process. These will be stored in appropriate containment along with a record of the major hazard class and projected storage capacity for each item.

[redacted]Only reasonable quantities of each chemical required for the extraction processes will be stored on site at any one time in accordance with the relevant Material Safety Data Sheets (MSDS), risk profile and shelf life will contribute to these quantities. Storage locations of incompatible materials will be maximally distant within the confines of the unit and adhere to COSHH regulations. All opened containers of chemicals will be marked with opening dates and used as a priority. [redacted]

[redacted]

- Other chemicals will be used and stored on site in varying smaller quantities (up to 5kg / litres) to service R&D and analytical requirements. All such chemicals will be stored in appropriate locations according to their COSHH requirements.

7.1.3 All large chemical storage locations are fitted with polyethylene spill-trays to provide secondary containment/bunding. All chemicals to be used in the process are well understood by Altilium, and only specific volumes and chemicals are to be used in the processes as designed. COSHH cabinets are used to store smaller quantities of chemicals.

7.1.4 All chemicals will be stored in sealed containers appropriate for transport, such as polyethylene drums and/or sacks. Chemicals will be stored separately within these containers according to their properties and mutual compatibilities. Chemicals will be stored and handled in accordance with the appropriate Chemical Safety Data Sheet which will detail the physical and chemical properties, physical and health hazards, routes of exposure, precautions for safe handling and use, emergency and first aid procedures and control measures.

7.1.5 Bunding will be necessary for all hazardous chemicals, but principally for liquids. Bunding may take the form of local construction or tooling within the facility, or a facility built into the storage medium, such as a double-skinned IBC. Solid chemicals will be stored above ground level (palletised) to maintain safe distance from the floor in the event of a nearby leak. Further, the entire operations floor will be treated with a chemical-resistant (including concentrated acid) paint/resin to minimise the risk of damage to the impermeable surface as a result of leaks.

[redacted]

7.1.8 A strict inventory system of all materials on site will be kept, comprising dates substances received along with their shelf life/expiration dates, to ensure that stocks are appropriately managed.

8 PROCESS OUTPUT

8.1.1 The raw materials generated will be the required specification and quality that would be suitable for release to the open market. The materials will be quality controlled internally, however it expected that these will be of sufficient quality to be of external commercial interest in their output states.

9 ENVIRONMENTAL PROTECTION MEASURES

9.1 General

9.1.1 The purpose of the permit application is to allow Altilium Metals Ltd to carry out activities which will enable the processing of black mass, copper tailings and other metal rich wastes and the production of a material which can be recirculated back into the automotive sector, feeding into a circular economy. There will be an overall environmental benefit in reduced use of raw materials, some of which have been assigned a critical status by the UK Government, and reduced carbon emissions (by recycling and processing waste black mass).

9.1.2 Nevertheless, it is important that the activities are carried out without harm to the local environment. In order to minimise emissions, the activities will be carried out inside a fully enclosed building, and strict control measures have been put into place.

9.1.3 The site will operate in laboratory-like conditions meaning it is essential that the site be kept clean, uncontaminated and safe.

9.1.4 All equipment will be properly maintained so that it is fit for purpose and operates at noise levels consistent within the context of the location of ACT1 (industrial estate).

9.1.5 The site will be managed by a Technically Competent Manager who will hold the relevant certification and attend site at a minimum frequency and duration as specified in the Environment Agency's guidance on TCM attendance. As Technical Competence is critical to the administration of the permitted site and activities, more than one Altilium employee will be qualified and provide supervision as required.

10 POINT SOURCE EMISSIONS TO AIR

10.1 General

10.1.1 All waste treatment at elevated temperatures is undertaken within fume cupboards, which each connect to a point source emission to air. The hydrometallurgy fume cupboard extracts into ducting which feeds directly into a chemical scrubber for removing chemical traces (acid vapour etc) before being emitted through a flue at 2m above roof height.

10.1.2 The chemical scrubber comprises diluted sodium hydroxide solution in a washdown format that rains down on the acid vapour within a fume cupboard. This sodium hydroxide can be reused for the scrubbing process. Manufacturers specify a minimum efficiency of 95% for removing acid vapour from extracted emissions, see Appendix 1.

10.1.3 The following section sets out the emissions to air with regard to gasses generated from the process.

[redacted]

[redacted]

10.3.3 Gaseous emissions vary locally across this phase, largely due to the [redacted] concentration in different stages. The organic solvent selected is [redacted] such that ATEX zonal regulation is not necessary for equipment and supporting services. [redacted]. The low volatility means that emissions due to evaporation are minimal.

10.4 Analytical Laboratory

10.4.1 Sample Analysis takes place in this laboratory using:

[redacted]

10.4.2 The emissions from this laboratory are derived from the [redacted]. The system comprises a high power Radio Frequency generator, [redacted]

10.4.3 A [redacted] and individual elemental concentrations can be determined. 95% of the sample is not emitted to air but will drop out and becomes an aqueous waste.

10.4.4 Argon is a non-toxic asphyxiant gas, the exhaust is contained and extracted to atmosphere. Under typical operations, argon flows at ~20l/min (input and exhaust) approximate heavy metal concentrations in the emission point are detailed in the Table 11.5.

10.4.5 Electricity is used to excite the plasma and therefore no combustion products are present in the exhaust. The maximum expected emitting operation time will be approximately 7-10 hours per week, during permitted working hours only. Air speed monitoring has been installed in the extract ducting to assess extraction capability.

10.4.6 Table 11.5 below provides the associated emissions from the Laboratory as a whole and the relevant emission limit values.

[5] https://www.exxonmobilchemical.com/en/chemicals/webapi/dps/v1/datasheets/130000000209/1/en

Table 11.5: Emission Identity and Emission Control Limits				
Emission	**Maximum Emission / Emission Limit Value**	**Regulation**	**Abatement Method**	**Maximum Expected Emission**
H_2SO_4 (Sulphuric Acid)	10 ppb (v/v) annual 300ppb (v/v) hourly	HSE: EH40/2005 Workplace Occupational Exposure Limits	Capped vessels, low temperatures and a defined room replacement rate through LEV. Chemical Scrubber in the Hydro lab	0.03mg/m^3
NH_3 (Ammonia)	180 ppb (v/v) annual 2,500 ppb (v/v) hourly	HSE: EH40/2005 Workplace Occupational Exposure Limits BREF: Waste Gas Management and Treatment Systems in the Chemical Sector BAT-associated emission levels (BAT AELs for channelled emissions to air of inorganic compounds: BAT AEL 1-10 (mg/Nm^3)	Capped vessels, low temperatures and a defined room replacement rate through LEV. Chemical Scrubber in the Hydro lab	7.18mg/m^3
VOCs [redacted] (Worst Case Benzene used in H1)	165ppm	-	Emissions expected to be minimal* Capped vessels, low temperatures and a defined room replacement rate through LEV.	0.033mg/m^3
Metals: Nickel Manganese Copper Lead Chromium Arsenic Zinc Oxide Cadmium	Nickel 0.02ppb (w/w) 15 min mean	Air Q-S Regulations 2010	Nebuliser in Analytical Lab means that 95% of the particles are damped down and enter an aqueous solution. Only 5% emissions to air	 0.0031 mg/m^3 0.0029 mg/m^3 0.0034 mg/m^3 0.0109 mg/m^3 0.0028 mg/m^3 0.0039 mg/m^3 0.0035 mg/m^3 0.0059 mg/m^3
Particulates (PM2.5 & PM10)	<5 mg/Nm^3	BAT AEL 5 mg/Nm^3		5mg/m^3
[redacted] has been chosen because it is de-aromatised and known to contain <0.1% aromatic contents. It has low volatility so that losses via evaporation should be minimal. This part of the process also takes place at near ambient temperatures, reducing the risk of solvent evaporating.				

10.5 Safety Factors

10.5.1 Safety factors have already been built into the annual average versus 1 hour event in EH40/2001 Occupational Exposure Limits[6]. However, in addition to these limits, Altilium have specified bespoke safety factors to allow for comfortable margins of compliance.

10.6 Emissions to Water

10.6.1 There are no point source emissions to water. No waste liquids will be tipped down any drains.

10.6.2 Liquids generated from the chemical processing which are not recirculated back into the system are collected and stored in the combined aqueous waste overflow. Wastewater will be held in a bunded tank pending removal to a permitted treatment site.

10.7 Litter

10.7.1 The site will only be permitted to accept metal containing waste, which will arrive in suitable containment. Due to the very specific nature of the facility, there will be little to no risk of litter generation from incoming waste.

10.7.2 Any used containers, cardboard, paper and plastic packaging for which feedstock and reagent materials arrive to the site in will be stored securely in a manner which will not present a risk to wastes becoming swept beyond the boundary of the site.

10.7.3 Any waste generated by Altilium staff will be placed in an appropriate receptacle, awaiting suitable disposal, and the site will be kept clean and tidy at all times.

10.8 Odour

10.8.1 Incoming wastes such as black mass, gigafactory waste and copper tailings will arrive in secure bags/containers. Due to the specific nature of the operations and the highly selective waste being bought to site, the risk of malodourous wastes is negligible.

10.8.2 Some chemicals and gases may have odours, however these will be fully contained within the various reaction vessels and extraction / scrubbing services. Extractors and scrubbers are fitted to the equipment, which will provide integrated ventilation.

[6] EH40/2005 Workplace exposure limits Containing the list of workplace exposure limits for use with the Control of Substances Hazardous to Health Regulations 2002 (as amended)

10.9 Noise

10.9.1 All operations are carried out inside an enclosed building, which will provide a degree of attenuation.

10.9.2 ACT 1 will operate within the bounds set under planning permission 0155/21/FUL.

10.10 Pests and Vermin

10.10.1 Due to the strict waste acceptance procedures, no putrescible wastes will be accepted onto site which may attract pests or vermin. Nor is it likely that the process feedstocks, such as chemicals, would attract pests or vermin due to their nature.

10.10.2 Any waste generated by Altilium staff will be placed in an appropriate receptacle, awaiting suitable disposal, and the site will be kept clean and tidy at all times.

10.10.3 Should there be an indication of pests or vermin present at the site, a pest controller will be contacted as soon as possible to investigate, and where required, remedy the issue.

11 ENVIRONMENTAL MONITORING

11.1.1 Visual/olfactory assessments will be made around the site at least once a day to ensure that there are no unusual emissions, such as noticeable odour or visible dust.

11.1.2 Emissions from all stacks will be sampled and tested once a year to ensure compliance with the permit conditions, that is emissions are below the BAT AELs as set out below.

Table 12.1: Monitoring of Emissions to Air

Process Phase	Substance	BAT AEL
[redacted]	Sulphuric acid	10 – 35 mg/Nm³
	Ammonia	2-10 mg/Nm³
[redacted]	Sulphuric acid	10 – 35 mg/Nm³
	Benzene	<0.5-1 mg/Nm³
	Total VOCs	0.2-4.2 mg/Nm³

12 RECORD KEEPING AND COMPLAINTS PROCEDURE

12.1.1 The records described below will be maintained at the site office and will be made available to warranted officers of the Environment Agency upon request.

- The pre-acceptance record for each waste stream and copies of related transfer notes.
- Details of all waste taken off site, where applicable, with a copy of the appropriate transfer note.
- Records that the end product specification has been met.
- Records of all by-products sent off site for use by third parties.

12.1.2 A copy of the preventative maintenance programme will be kept on site, showing plant has been properly inspected and maintained and when this was carried out.

12.1.3 A log will be maintained detailing any complaints received and the actions taken to resolve them.

12.1.4 A log will be maintained detailing any complaints received and the actions taken to resolve them.

12.1.5 Records will be kept regarding staff training, including any refresher training or toolbox talks delivered.

12.1.6 Records will be kept for a minimum of two years and in line with any statutory requirements. Records of any pollution incidents should one occur will be maintained indefinitely in order to inform any eventual permit surrender application.

APPENDICES

APPENDIX 1

Hydromet Laboratory Calculations for Sodium Hydroxide Scrubber

Extraction Capability and Scrubber Performance - Test case against Black Mass leaching Process

	H2SO4	H2O2	Ammonia
Vessel Volume / L	5	5	5
TOTAL Vessels	2	2	2
Process MAX Temp / oC	85	85	50
Process MAX Temp / K	358	358	323
Reagent Concentration / M	4		
Reagent Concentration / %	22%	8%	10%
Vapour Pressure Ref Temp STD / oC	25	40	20
Vapour Pressure Ref Temp HOT / oC	145	100	50
Vapour Pressure Ref 100% STD / atm	1.31E-06	2.50E-04	1.00E-01
Vapour Pressure Ref 100% HOT / atm	0.0013	0.0039	0.375
LINEST Vapour Pressure m	8.71E-06	3.45E-05	7.16E-03
LINEST Process Vapour Pressure	7.40E-04	2.93E-03	3.58E-01
Process Partial Vapour Pressure	1.63E-04	2.20E-04	3.58E-02
[Safety Factor]	**10**	**10**	**10**
PVP*[Safety Factor]	**0.00163**	**0.00220**	**0.35776**
Mass of air at 20oC / kg.m-3	1.204	1.204	1.204
Partial Mass of reagent / kg.m-3	1.96E-03	2.65E-03	4.31E-01
TOTAL Vessel Volume / m3	0.01	0.01	0.01
MAX Mass of vaporised reagent / kg	1.96E-05	2.65E-05	4.31E-03
MAX Mass of vaporised reagent in vessel volume / g	1.96E-02	2.65E-02	4.31E+00
IF all vessel atmosphere continuously extracted at 1m3/min & Partial Pressures maintained			
MAX concentration in extracted air / g.m-3	1.96E-02	2.65E-02	4.31E+00
Full Fume cupboard air flow / m3.min-1	30	30	30
Diluted concentration / g.m-3	6.54E-04	8.82E-04	1.44E-01
Diluted concentration / mg.m-3	6.54E-01	8.82E-01	1.44E+02
Scrubber Performance / %	95%	50%	95%
Final Release Concentration	3.27E-02	4.41E-01	7.18E+00
Long Term Exposure Limit / mg.m-3	**0.05**	**5**	**18**
RESULT	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE

H2SO4 [redacted]

22% is reasonable maximum concentration. 85oC is reasonable maximum temperature.
Safety factor of x10 applied to partial pressure calculation and condensor will reduce passive vapour release.
Active vapour removal from vessel is not designed into process, but can be and all calculations based on 1m3/min "sparging" or active vapour removal.
Scrubber designed to neutralise acid vapour.

H2O2 [redacted]

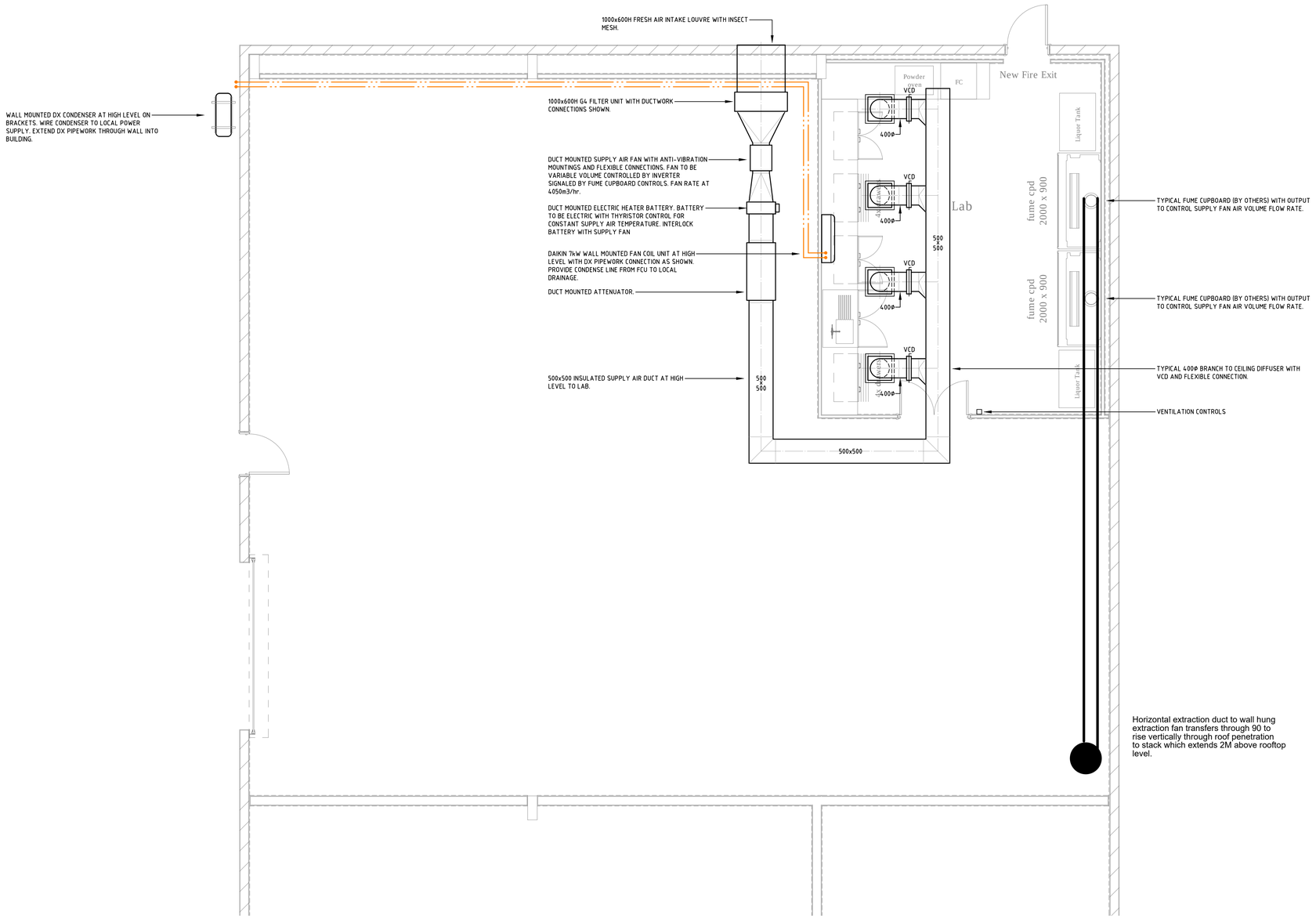
8% is reasonable maximum concentration. 85oC is reasonable maximum temperature.
Safety factor of x10 applied to partial pressure calculation and condensor will reduce passive vapour release.
Active vapour removal from vessel is not designed into process, but can be and all calculations based on 1m3/min "sparging" or active vapour removal.
Scrubber effectiveness will be reduced as not designed to neutralise. But, dissolution in basic scrubber fluid will actively decompose H2O2 vapour to O2/H2O

Ammonia [redacted]

10% is reasonable maximum concentration. 50oC is reasonable maximum temperature (allowing for exothermic effects).
Safety factor of x10 applied to partial pressure calculation and condensor will reduce passive vapour release.
Active vapour removal from vessel is not designed into process, but can be and all calculations based on 1m3/min "sparging" or active vapour removal.
Scrubber designed to neutralise ammonia vapour.

APPENDIX 2

Stack Emission Layout and Design



LEGEND OF SYMBOLS:

- PIPEWORK RUN IN CEILING VOID
- PIPEWORK RUN AT HIGH LEVEL
- PIPEWORK RUN AT LOW LEVEL
- PIPEWORK RUN IN FLOOR VOID
- PIPEWORK BURIED IN GROUND

DX	DIRECT EXPANSION
VRV	VARIABLE REFRIGERANT VOLUME
FCU	FAN COIL UNIT
BSB	BRANCH SELECTOR BOX
FD	FIRE DAMPER
FSD	FIRE AND SMOKE DAMPER
S.A	SUPPLY AIR
E.A	EXTRACT AIR
FSD	FIRE AND SMOKE DAMPER
FSD	FIRE AND SMOKE DAMPER
BW	BUILDERSWORK
C/V	CEILING VOID
F/D	FLOOR DUCT
F/V	FLOOR VOID
F.A.	FROM ABOVE
F.B.	FROM BELOW
T.A.	TO ABOVE
T.B.	TO BELOW
H/L	HIGH LEVEL
L/L	LOW LEVEL
DTB	DROP TO BELOW
DFA	DROP FROM ABOVE
RTA	RISE TO ABOVE
RTHL	RISE TO HIGH LEVEL
RTCV	RISE TO CEILING VOID
DTLL	DROP TO LOW LEVEL

REV	DATE	DESCRIPTION
P03	09.11.2022	UPDATED AND RE-ISSUED
P02	07.11.2022	UPDATED AND RE-ISSUED
P01	02.11.2022	FIRST ISSUE FOR COMMENT

Status
FOR COMMENT

Client
McFEGGAN BROWN

Project
ALTILITECH
TAVISTOCK

Title
MECHANICAL SERVICES
GROUND FLOOR

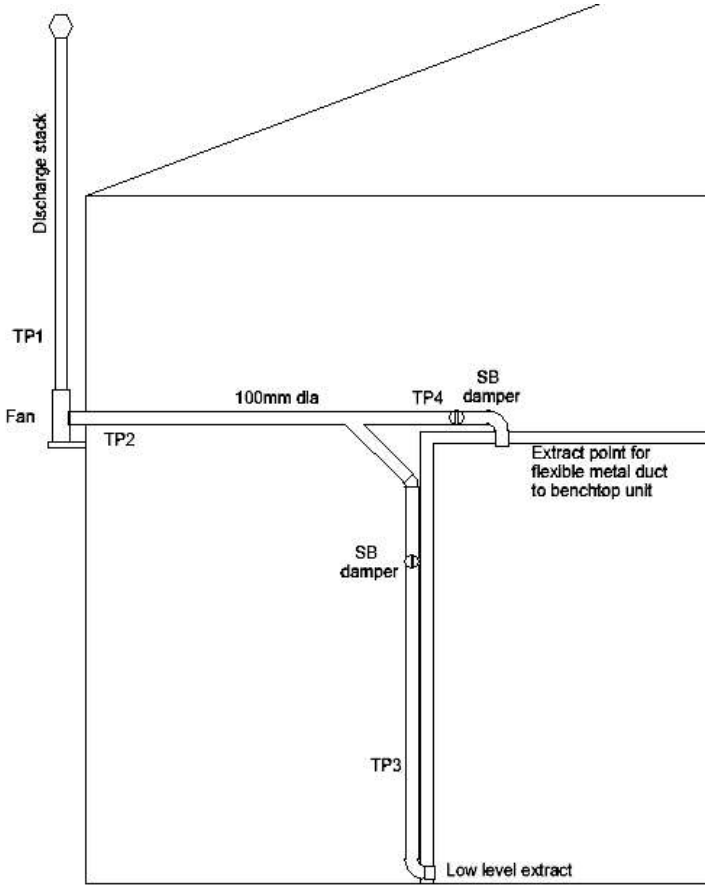
Coolstream Refrigeration & Air Conditioning
Unit 3 Kenn Court South Bristol Business Park BS4 1UL
Tel 0117 963 3360
www.coolstreamac.co.uk
e-mail - sales@coolstreamac.co.uk

Date NOV 2022	Drawn by MEP
Scale 1:50 @ A1	Checked by MC
Drawing No. M101	Rev. P03

LEV Commissioning & Test Report

Section 9	Schematic

Line schematic/Drawing to show key components of the system:



LEV Commissioning & Test Report

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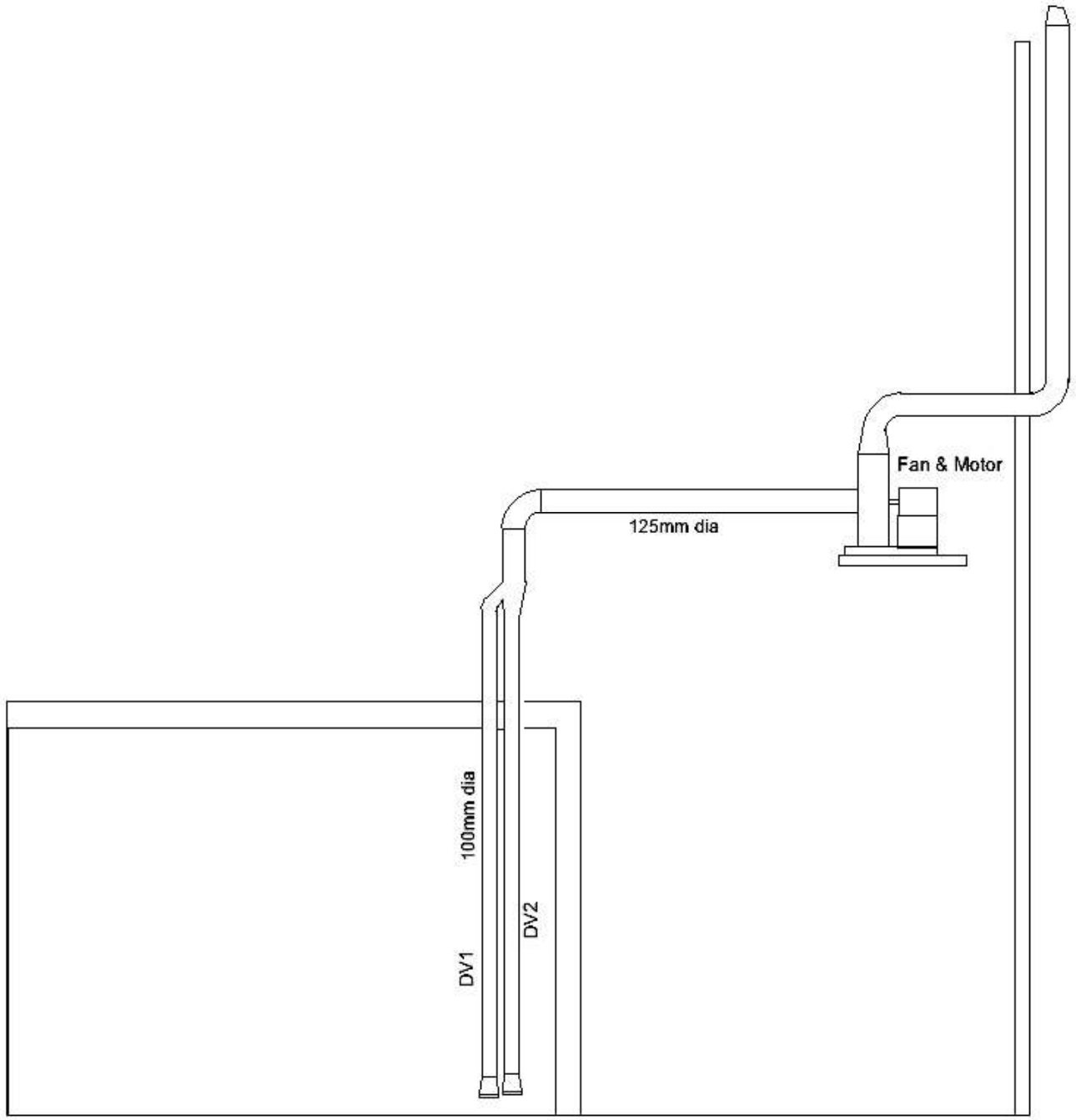
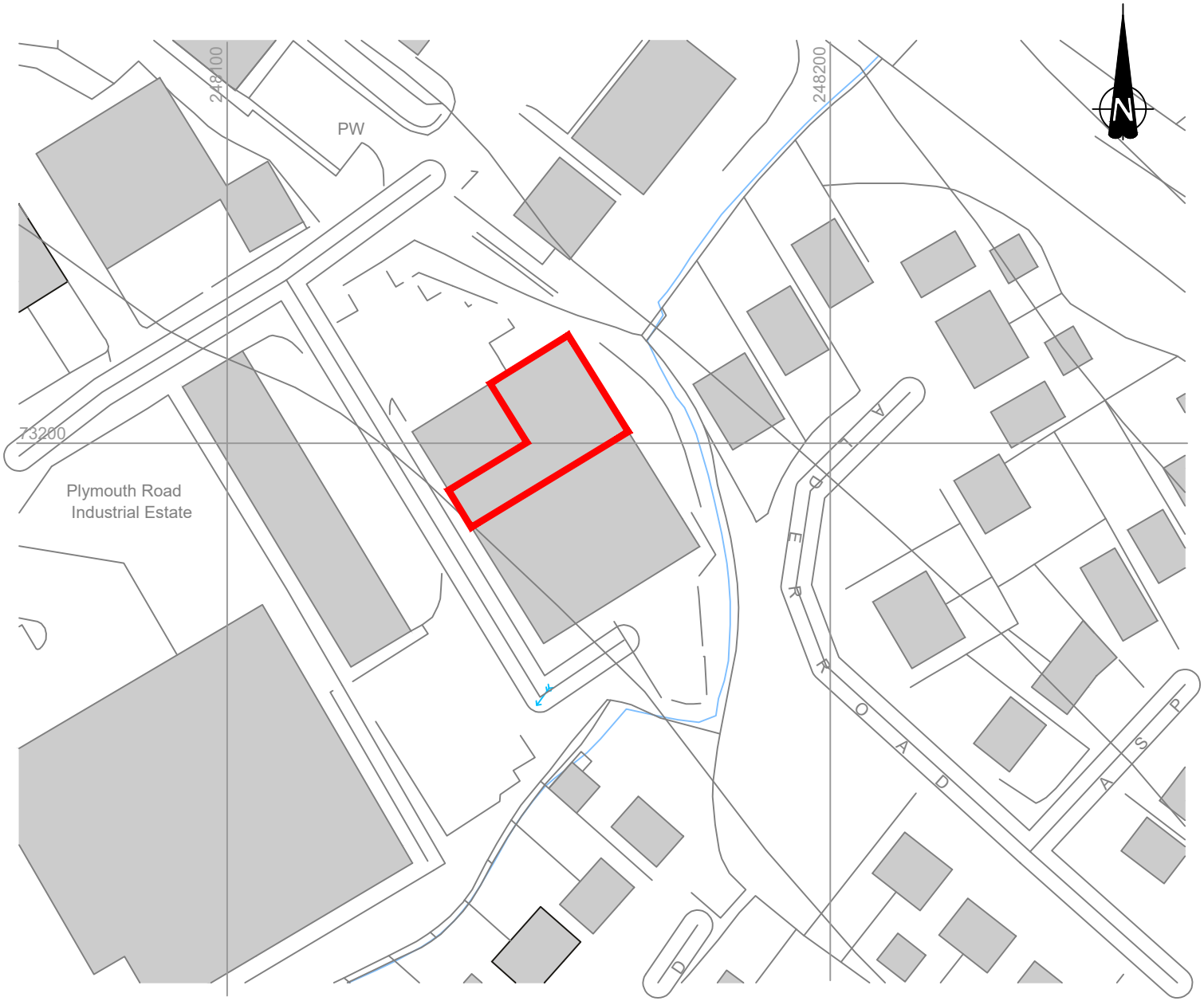
Line schematic/Drawing to show key components of the system:



DRAWINGS



DO NOT SCALE FROM THIS DRAWING

KEY

SITE BOUNDARY

REVISION	DETAILS	DATE	DRAWN	CHK'D	APP'D

CLIENT

ALTILIUM METALS LIMITED

PROJECT

TECHNOLOGY CENTRE FACILITY,
UNIT 2, PLYMOUTH ROAD INDUSTRIAL ESTATE,
TAVISTOCK, DEVON

PRELIMINARY

DRAWING TITLE

PERMIT BOUNDARY PLAN

DRG No	REV	SUIT.
BM12752-001	P0	

SIZE	SCALE	DATE
A4	1:1000	15-04-24

DRAWN BY	CHECKED BY	APPROVED BY
DR		

wardell armstrong

N:\BM\BM12752 - ALTILIUM TAVISTOCK ENVIRONMENT\03 - DESIGN\AUTOCAD\BM12752-001-P0 PERMIT BOUNDARY PLAN.DWG

wardell-armstrong.com

STOKE-ON-TRENT
Sir Henry Doulton House
Forge Lane
Etruria
Stoke-on-Trent
ST1 5BD
Tel: +44 (0)1782 276 700

BIRMINGHAM
Two Devon Way
Longbridge Technology Park
Longbridge
Birmingham
B31 2TS
Tel: +44 (0)121 580 0909

BOLTON
41-50 Futura Park
Aspinall Way
Middlebrook
Bolton
BL6 6SU
Tel: +44 (0)1204 227 227

BRISTOL
Temple Studios
Temple Gate
Redcliffe
Bristol
BS1 6QA
Tel: +44 (0)117 203 4477

BURY ST EDMUNDS
Armstrong House
Lamdin Road
Bury St Edmunds
Suffolk
IP32 6NU
Tel: +44 (0)1284 765 210

CARDIFF
Tudor House
16 Cathedral Road
Cardiff
CF11 9LJ
Tel: +44 (0)292 072 9191

CARLISLE
Marconi Road
Burgh Road Industrial Estate
Carlisle
Cumbria
CA2 7NA
Tel: +44 (0)1228 550 575

EDINBURGH
Great Michael House
14 Links Place
Edinburgh
EH6 7EZ
Tel: +44 (0)131 555 3311

GLASGOW
24 St Vincent Place
Glasgow
G1 2EU
Tel: +44 (0)141 428 4499

LEEDS
36 Park Row
Leeds
LS1 5JL
Tel: +44 (0)113 831 5533

LONDON
Third Floor
46 Chancery Lane
London
WC2A 1JE
Tel: +44 (0)207 242 3243

NEWCASTLE UPON TYNE
City Quadrant
11 Waterloo Square
Newcastle upon Tyne
NE1 4DP
Tel: +44 (0)191 232 0943

TRURO
Baldhu House
Wheal Jane Earth Science Park
Baldhu
Truro
TR3 6EH
Tel: +44 (0)187 256 0738

International office:

ALMATY
29/6 Satpaev Avenue
Hyatt Regency Hotel
Office Tower
Almaty
Kazakhstan
050040
Tel: +7(727) 334 1310

wardell armstrong