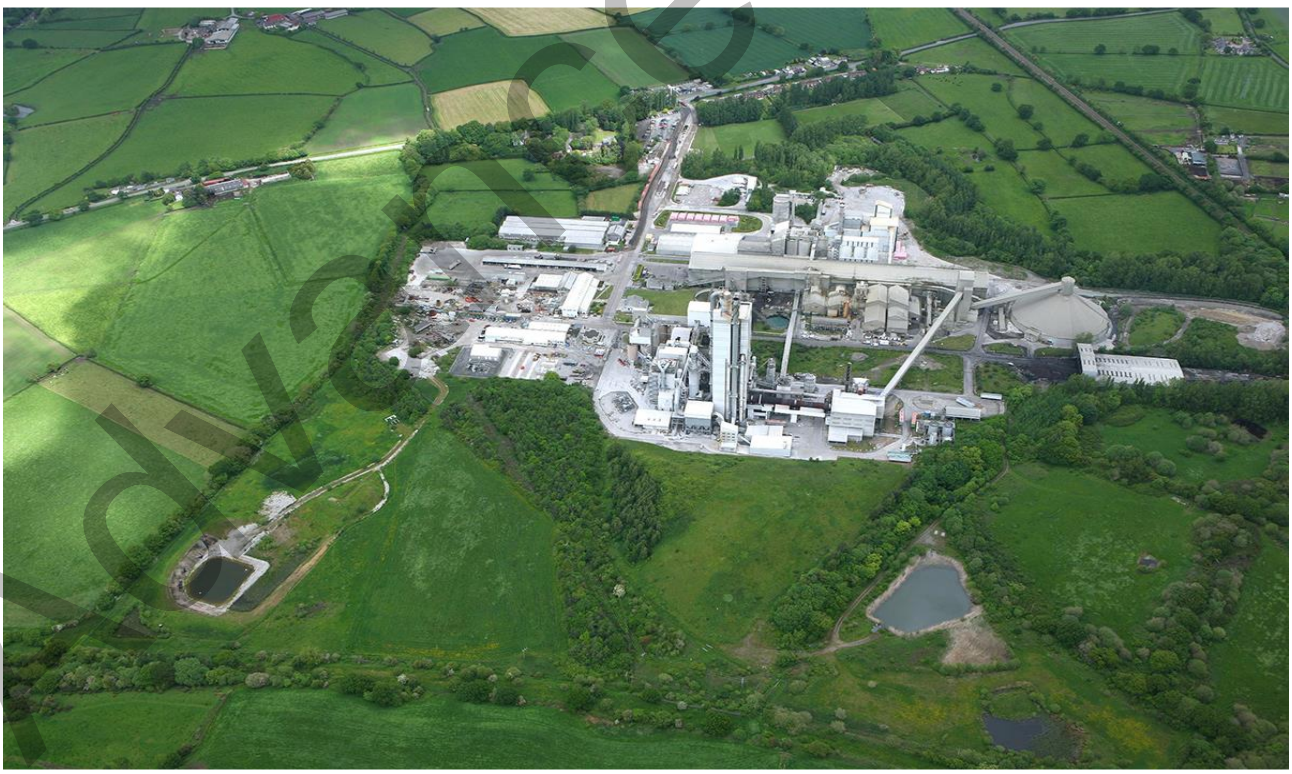
HEIDELBERG MATERIALS

Padeswood Carbon Capture Plant - FEED Phase

BAT Demonstration Report

Document no. Rev 0: 215000-00190-000-EN-REP-00005



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PROJECT 215000-00190-000 - 215000-00190-000-EN-REP-00005: Padeswood Carbon Capture Plant - FEED Phase - BAT Demonstration Report

Rev	Description	Originator	Reviewer	Worley Approver	Revision Date	Customer Approver	Approval Date
Rev A	Issued for Review	A Stephen	A Moghaddam	A George	23 February 2024		
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Revision History

Rev	Status	Section	Description of Change
A	IFR	All	Initial Issue
0	IFU	3.4.1	

Table of Contents

List of tables

1. Introduction

1.1 Project Background

Heidelberg Materials (HM) has become a partner in the HyNet Northwest consortium, which aims to create the world's first low-carbon industrial cluster in the region of Northwest England. The proposed hydrogen and carbon capture and storage (CCS) industrial cluster will play a critical role in the UK's transition to net zero greenhouse gas emissions and the fight against climate change. As part of 'Making Net Zero Possible', Asset Improvement programme options to decarbonise COMPANY cement plant are being considered. Carbon Capture (CC) is one of the key technologies being developed as a route to decarbonisation. COMPANY cement plant located at Padeswood which currently produces about 110 ton per hour (tph) of clinker, has been selected by DESNZ as a track 1 phase 2 carbon capture project. The PROJECT will enable carbon capture from the existing cement kiln 4 and from a new Combined Heat and Power (CHP) plant designed to provide the heat and electricity required to operate the Carbon Capture and Compression (CCC) plant. Captured CO_2 will be transported by pipeline to the HyNet CO_2 main pipeline at Northop Hall AGI for onward transportation to storage offshore in depleted gas fields operated by Eni UK. The PROJECT will enable the production of net zero cement for use in the UK construction industry.

Ahead of this CONTRACTOR has been engaged by COMPANY to undertake a pre-FEED study for the carbon capture development. The pre-FEED study was completed in March 2023. Based on the pre-FEED study, an amine-based post combustion CO_2 capture technology has been selected as a suitable technology for capturing 95% of the CO_2 emissions from cement plant.

A consortium between Mitsubishi Heavy Industries (MHI) and Worley as the selected FEED contractor for the Heidelberg Material (HM) Padeswood CCS Project shall deliver an overall FEED package utilizing MHI's Carbon capture technology.

The capture plant can be considered a green field development, but some elements of the integration with the cement plant will be considered brown field. Green field elements will be developed by MHI and Worley, while brownfield elements will be developed by both HM and MHI/Worley.

1.2 Purpose

The purpose of this report is two-fold; one- document the Best Available Techniques (BAT) which are relevant to the PROJECT and two- record/evidence the use of relevant BAT in PROJECT design based on engineering documentation at the early FEED phase.

1.3 Scope

The assessment will include existing BAT documents and, where relevant, emerging techniques and guidance highlighted by the United Kingdom Environment Agency (EA).

Unless specifically referenced by EA guidance, white papers on emerging techniques will not be included in this assessment.

Comparison of specific technology packages and alternatives is not in scope of this assessment.

2. Abbreviations, Definitions & References

2.1 Definitions

Term	Definition
COMPANY	Heidelberg Materials
CONTRACTOR	Consortium of Worley Europe Limited and Mitsubishi Heavy Industries Limited (MHI)
LICENSOR	MHI entering a Licensing Agreement with the CLIENT
PROJECT	Padeswood Carbon Capture Plant
DELIVERY PARTNER	Company other than the prime COMPANY and CONTRACTOR associated with the delivery of the PROJECT.
SUPPLIER/VENDOR	Company / organisation suppling equipment, materials or services.
SUB-SUPPLIER	The organisation selected by the SUPPLIER/VENDOR to supply the part of equipment and services.
WORK	Shall mean all and any of the WORKs and / or services and / or materials required to be provided under the Contract with CLIENT.

2.2 Abbreviation & Descriptions

Abbreviations	Definition
AGI	Above Ground Installation
ALARP	As Low as Reasonably Practical
BAT	Best Available Technique
BATC	Best Available Technique Conclusions
BFW	Boiler Feed Water
BOD	Biological Oxygen Demand
BREF	Best Available Technique Reference
$Ca(OH)_2$	Calcium Hydroxide
CCC	Carbon Capture and Compression
CCGT	Closed Cycle Gas Turbine
CCS	Carbon Capture and Storage
CH_4	Methane
CHP	Combined Heat and Power
Cl_2	Chlorine
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand
Cr	Chromium
Cu	Copper
dB	Decibel
EA	Environment Agency
EED	Energy-efficient Design
EIA	Environmental Impact Assessment
EU	European Union
$FeCl_3$	Iron Chloride
FEED	Front End Engineering Design
GW	Gigawatt
H_2	Hydrogen
HCL	Hydrochloride
HCN	Hydrogen cyanide
HDPE	High-density polyethylene
HF	Hydrogen Fluoride

Abbreviations	Definition
HFC	Hydrofluorocarbons
HM	Heidelberg Material
IPPC	Integrated Pollution Prevention and Control
km	Kilometre
LCPD	Large Combustion Plant Directive
LDAR	Leak Detection and Repair
LHV	Lower Heating Value
m/s	Metres per second
m^3	Cubic metre
m^3	Cubic metre
MHI	Mitsubishi Heavy Industries
MVR	Mechanical Vapor Recovery
MW	Megawatt
MWth	MegaWatt Thermal
NH_3	Ammonia
Ni	Nickel
NO_2	Nitrogen Dioxide
NOx	Nitrogen Oxides
NZHF	Net Zero Hydrogen Fund
NZT	Net Zero Teesside
O_2	Oxygen
OEM	Original Equipment Manufacturer
OTNOC	Other Than Normal Operating Conditions
PAH	Polyaromatic Hydrocarbons
Pb	Lead
PCB	Poly-chlorinated biphenyls
PCC	Post-combustion Carbon Capture
PM	Particulate Matter
SCC	Stress corrosion cracking
SCR	Selective Catalytic Reduction
SNCR	Selective Non-Catalytic Reduction
SO_2	Sulphur Dioxide
SOx	Sulphur Oxides
TN	Total Nitrogen
TOC	Total Organic Carbon
TP	Total Phosphorus
tph	Tonnes per hour
UK	United Kingdom
VOC	Volatile Organic Compounds
VSD	Variable Speed Drives
WWT	Wastewater Treatment
Zn	Zinc

2.3 References

Ref	Document/Title	Document Number
Ref 1	Environmental Basis of Design	215000-00190-000-MS-EP-TEM-0008
Ref 2	BAT Review for New-Build and Retrofit Post-Combustion Carbon Dioxide Capture (PCC) Using Amine-Based Technologies (2022)	Online Link
Ref 3	Review of emerging techniques for hydrogen production from methane and refinery fuel gas with carbon capture	Online Link
Ref 4	UK Gov. Guidance Post-combustion carbon dioxide capture: best available techniques	Online Link
Ref 5	Project Process Description	215000-00190-000-PR-REP-0006
Ref 6	RAM Report	215000-00191-000-EM-REP-00002
Ref 7	ENVID report	215000-00190-000-EN-REP-00004
Ref 8	Emissions, discharge and waste schedule	215000-00190-000-EN-REP-00001
Ref 9	Environmental Management and monitoring plan	215000-00190-000-EN-PLN-00001
Ref 10	Zero Liquid Discharge Study	415000-00299-00-PR-REP-00004
Ref 11	Drainage Philosophy	215000-00190-000-PR-PHL-00004
Ref 12	Waste Management Plan	215000-00190-000-EN-PLN-00002
Ref 13	Combined Heat and Power Study	415000-00299-00-PR-REP-00001
Ref 14	Waste Heat Utilisation Study	415000-00299-00-PR-REP-000002
Ref 15	Cooling Medium Study	415000-002999000-PR-REP-000003

3. BAT Assessment

The purpose of the initial BAT assessment is to a) collate the available BAT and review for applicability to the PROJECT and b) where applicable BAT is identified, assess the status of the PROJECT in comparison to recommended BAT.

3.1 Definition of BAT

Best Available Techniques (BAT) is defined as the application of the most effective and advanced production processes, methods/ technologies, or operational practices to prevent and, where that is not practicable, to reduce emissions or discharges and other impacts to the environment as a whole. BAT must as a minimum achieve emission or discharge standards stipulated by the UK regulations.

BAT have been published across multiple documents (See following Section 3.2) each of which include techniques for protection of the environment through reduction and control of discharges, emissions and energy use.

Therefore, this assessment has broadly grouped BAT under the following four (4) environmental aspects:

- Atmospheric Emissions;
- Emissions to Water;
- Noise Management; and
- Energy Efficiency.

Due to the significant number of items, only BAT identified as applicable to the design of the PROJECT is to be discussed in the body of this report.

The full list of considered BAT including those identified as non-applicable/not relevant to the PROJECT have been attached in **Appendix A** for information.

3.2 Available BAT Guidance

A number of BAT Reference (BREF) and BAT Conclusions (BATC) documents have been published by the European Council. These can be broadly split into two categories

Sectoral BREFs are reference documents focused on techniques used by specific sectors of industry.

Horizontal BREFs are reference documents with broader relevance to all industry sectors, covering aspects such as Energy Efficiency and Industrial Cooling Systems.

The following BAT documents were identified in the PROJECT Environmental Basis of Design (Ref 1) as having applicability to the PROJECT:

- Energy Efficiency
- Common Waste Gas Management and Treatment in the Chemical Sector
- Common Wastewater and Waste Gas Management and Treatment Systems in the Chemical Sector

- Industrial Cooling Systems
- Emissions from Storage
- Waste Treatment
- Large Combustion Plants.

Currently, there are no existing Sectoral BAT for Carbon Capture, however a review of emerging techniques for Post-combustion Carbon Capture has been published (Ref 2) and referenced by the Environment Agency (EA) which will be included in the review.

Similarly, the EA guidance also references a later (2023) released document titled "Review of emerging techniques for hydrogen production from methane and refinery fuel gas with carbon capture" (Ref 3). Although this primarily focuses on Hydrogen production, the Carbon Capture element has relevance to this project and therefore included in this BAT review for completeness.

The UK Government have published guidance on Carbon Capture best available techniques (Ref 4). Although this does not originate new BAT it does create linkage to the Large Combustion Plant BREF document for control of emissions to air and water and provide general guidance on energy efficiency and monitoring expectations.

A BREF document for Cement production[1] also exists. This is applicable to the existing facility and therefore not captured in this BAT assessment. However. it is understood that MHI are undertaking a similar BAT review which will include the scope of the existing facility.

3.3 Project Reference Documents

This assessment has made heavy reference to a number of key project documents available at the time of writing including the process descriptions discipline basis of design documents, philosophies, plans and studies.

The full list of referenced project documents is given included in Section 2.3.

3.4 BAT Assessment

The following sections list the relevant BAT and notes on the PROJECT's status based on available data produced so far during the PROJECT.

Due to the project being in early FEED, not all aspects of design have been fully matured. In these cases, it was not possible to demonstrate BAT usage (outside of inherent design) and therefore future actions/considerations have been noted.

Each table contains both the existing and emerging BAT from the available documentation. Existing techniques are distinguishable due to having an associated "BAT number" (i.e., 'BAT 2').

Note, for readability the following BAT document names have been shortened in the subsequent tables:-

Shortened	**Full**

[1] Best Available Techniques (BAT) Reference Document for the Production of Cement, Lime and Magnesium Oxide (europa.eu)

Common Waste Gas	Common Waste Gas Management and Treatment in the Chemical Sector
Common Wastewater	Common Wastewater and Waste Gas Management and Treatment Systems in the Chemical Sector
Emerging Techniques for PCC	Review of emerging techniques for Post-combustion Carbon Capture
Emerging Techniques for Blue H2	Review of emerging techniques for hydrogen production from methane and refinery fuel gas with carbon capture.

3.4.1 Atmospheric Emissions

Atmospheric Emissions			
Reference	**Description**	**Project Status**	**Future Actions /Considerations**
Emerging Techniques			
Emerging Techniques for Blue H_2	A design CO_2 capture rate of 95% or greater is expected to be achievable for the hydrogen production and CO_2 capture routes considered for new plant.	Note - wording is for H_2 production, which is not applicable to the scope of this project. However the project's Carbon Capture Unit is to achieve 95% capture rate of the total CO_2 from existing Cement Kiln and from a new Combined Heat and Power (CHP). (Ref 5)	
	This applies to England and Wales only. It does not apply currently to Scotland and Northern Ireland. There was a call for evidence by BEIS and the Welsh Government on decarbonisation readiness from July to September 2021.The government is currently analysing the results (correct as of July 2022). Decarbonisation readiness: call for evidence on the expansion of the 2009 Carbon Capture Readiness requirements - GOV.UK (www.gov.uk). The consultation includes the proposal that the requirement for all combustion processes (with no de minimis) to be decarbonisation ready be included in the Environmental Permitting Regulations (England and Wales) 2016. There are some streams, for example, the flue gases from combustion of residual (tail) gas from the hydrogen purification process with a relatively high CO_2 concentration which may need to be decarbonised in future and should therefore be made decarbonisation ready by maintaining the necessary space and technical retrofit capability for future carbon capture.	Footprint for Carbon capture unit is inherently part of this design	
	A risk-based Other Than Normal Operating Condition (OTNOC) management plan should be implemented which identifies potential scenarios, mitigation measures (for example, around design and maintenance of equipment critical to avoiding emissions), monitoring and periodic assessment. Target availability for systems critical to environmental performance should be established, with proposed configuration supported by reliability, availability, and maintainability assessments.	Assessment of availability will be undertaken as part of the RAM analysis which is scheduled to be developed in FEED (Ref 6)	

Atmospheric Emissions			
Reference	**Description**	**Project Status**	**Future Actions /Considerations**
Emerging Techniques for Blue H_2	Monitoring of emissions to air, will be required based on expected pollutants (for example, ammonia, amine compounds, SO_2, NOx, CO, and so on) with appropriate methods and measuring techniques employed. Monitoring shall consider, for example: A) NOx and CO emissions from combustion B) SO_2 emissions from combustion where the fuel source contains sulphur C) ammonia emissions where SCR / SNCR is employed D) amine / amine degradation products and other volatile solvent emissions E) methane F) hydrogen	The (new) stack will be subject to Continuous emission monitoring of flue gas pollutant concentrations including NOx, SO_2, CO, PM, Ammonia, Amine. Full requirements are detailed in the Environmental Basis of Design.	
	Applicants should clearly identify how the CO_2 capture performance of the plant will be monitored. CO_2 capture performance is expected to be monitored according to standards that are recognised under the UK ETS. Measurements required to monitor CO_2 emissions to atmosphere may, for example, include direct measurement of the flow and composition of fuel gas to combustion systems.	CO_2 metering is included in design of facility which will record quantity of CO_2 sent down export line, and therefore allow for monitoring of CO_2 levels.	
	Strategies to the reduce the potential for loss of containment and minimise environmental impacts should be established, for example: A) use of special procedures and/or temporary equipment to maintain performance when necessary to manage special circumstances such as spills, leaks, and so on B) use of a risk based leak detection and repair programme where applicable in order to identify leaking components and to repair these leaks C) plant design to facilitate monitoring and maintenance activities by ensuring accessibility D) selection of high integrity equipment where available E) plant design to maximise inherent process containment feature	Part of inherent design process for the plant. No containment concerns (i.e., requirement for further mitigations outside those of standard design processes) were identified in the ENVID (Ref 7).	

Atmospheric Emissions			
Reference	**Description**	**Project Status**	**Future Actions /Considerations**
Emerging Techniques for Blue H_2	Applicant should identify venting and purging requirements in each of the processes employed, noting whether either continuous or intermittent, and identifying pollutants expected to be present, including for example CO_2, carbon monoxide, methane, hydrogen, ammonia vapour or methanol vapour	Venting requirements have been identified. Following sources are in design (Ref 7). Normal Operation: 1) O_2 vent from the hydrogen generation unit. Vented locally. 2) Treated flue gas (post-CO_2 removal) including standard combustion pollutants of NOx, SOx, CO etc 3) Ammonia bullet breather vent 4) Steam - intermittent steam venting from the steam system for safety 5) Reclaimer vent captured by CO_2 header and sent to stack. During Start-up/shutdown/abnormal operation: 6) CO_2 venting. CO_2 will be recombined with the untreated and treated flue gas and sent to the new stack for emission to atmosphere. 7) Treated and untreated flue gas via new stack. 8) H_2 venting from the hydrogen generation unit - intermittent venting during start-up/shutdown which will be routed to safe location. 9) Venting from fuel gas system (over pressure) - safe area vent.	

Atmospheric Emissions			
Reference	**Description**	**Project Status**	**Future Actions /Considerations**
Emerging Techniques for Blue H_2	For each Vent emissions point, an environmental risk assessment shall be made, against the applicable Environmental Assessment Level (EAL), in accordance with the relevant Regulator's standard methodologies. This should include justification for venting to atmosphere vs. routing to flare and identification any measures proposed to reduce emissions of pollutants or ensure adequate dispersion.	Selective Catalyst Reduction (SCR) is part of design for the boiler package and will reduce NOx emissions for compliance with permit emission limits. Emissions from existing kiln are regulated by existing permit conditions. O_2 and H_2 have no permit discharge limits. Other vent sources are intermittent and/or very small so limited impact.	
	Methane and hydrogen greenhouse gas emissions shall be eliminated as far as practicable.	Scope of project is to reduce CO_2 emissions by 95% from existing facility.	
Emerging Techniques for PCC	Alkali additions (prior) to the Direct Carbon Capture (DCC) may be used to remove SO_2 in the flue gas where small amounts (1-10 ppm) of SOx might arise from the fuel.	Included in Design of Flue-gas Pre-treatment (Quencher unit). Flue gas (post-boiler) will be quenched with pH regulated circulating water using injected caustic soda (from caustic soda tank) to reduce SO_2 and thereby SO_3 (5% generation rate) (Ref 5)	
	SO_3 and other aerosols may be present only intermittently, and possibly also unpredictably, in flue gases entering a PCC system, and their presence may not be known. Extended (i.e., in order of 1 year) pilot testing using actual flue gases and realistic conditions throughout, and over the full range of operating conditions, is recommended. It may be necessary to ensure that potential problems are adequately assessed and that satisfactory management methods are (and can be) implemented.	Noted, however CC application has matured since guidance was originally written and now more well understood. SO_2 removal prior to contact with amine is in design (refer to above comment)	

Atmospheric Emissions			
Reference	**Description**	**Project Status**	**Future Actions /Considerations**
Emerging Techniques for PCC	Sodium sulphite and thiosulphates additions to DCC can be used to remove NO_2 to prevent nitrosamine and nitramine formation.	The boiler will include SCR with application to reduce NOx and SO_2 emissions. (Ref 5).	
	Ensure "normal" operation CO_2 capture rate is maintained during start-up and shutdown procedures by implementing design provisions such as: A) Segregating the solvent inventory during start-up, with separate solvent circuits around the absorber and stripper B) Providing buffer storage for lean and rich amine to continue capture until Gas Turbine shuts-down C) Heat storage used to cover periods when steam not available D) Provision of auxiliary heating to maintain stripper temperature during periods when plant is offline E) Initiate solvent and water wash flows in absorber prior to CCGT begins firing	Note - the design of this plant differs from the referenced GTCC carbon capture plants in that the CHP can be operated independently of the kilns as opposed to the GTCC example where the heat and power are provided by the GTCC. Therefore not all these techniques are applicable. A) Segregation inventory during start-up is not considered as all the available inventories i.e., fresh solvent tank, solvent tank, and solvent sump tank are used to support whole CCU system (absorber and regenerator). B) During normal operation, the solvent will always circulate in the system and in case the lean solvent in the system needs make-up (concentration reduced), fresh solvent (70% wt) will be supplied to the system from Fresh Solvent Tank. In the case of system shut down for maintenance/inspection, solvent from the system will be transferred to the Solvent Tank C) Not applicable D) Boiler can be operated independently from steam plant to provide for heat requirements. E) Solvent and water systems can be stated independently of the cement facility. Initiating solvent and wash water circulation in absorber requires power from CHP. It has been considered in the Pre-FEED that for first start-up the CHP, ~1.8 MW power will be imported from the grid. Once the CHP can supply power to the CCU, solvent and water wash circulation will be initiated.	

Atmospheric Emissions			
Reference	**Description**	**Project Status**	**Future Actions /Considerations**
	Employ multi-stage water wash system to reduce Amine (and volatile organic compound (VOC) emissions)	Absorber design is to include multi stages of washing to reduce the amine emission on the treated gas. (Ref 5).	
Emerging Techniques for PCC	Amine mist formation in absorber must be prevented. Following techniques can be applied - Brownian diffusion filters - SO_3 removal by acid condensation on surfaces of gas/gas heater - Gradual flue gas cooler	To prevent amine mist formation in the absorber, absorber is designed with multi washing stages and propriety demisters are installed to maximise recovery of amine mist from the treated gas. (Ref 5).	
	To reduce oxidative degradation in the absorber a possible counter measure would be to reduce oxygen levels in flue gas. Options for this are A) (at Source) Increase fuel-air ratio in the CCGT and Aux. Boiler burners B) Removal of dissolved oxygen from rich solvent through membrane to oxygen scavenger (opportunity is still maturing)	Requirement for A) or B) is not anticipated due to design including SCR for boiler to meet emission standards	
	Include water wash stage using acid (dilute sulphuric acid for example) to react with ammonia. Implement after the initial water wash. This process will result in additional waste stream of reject sulphuric acid and causes formation of ammonium salts which will need consideration for correct removal and disposal.	As per above, acid wash will be included in design of the absorber tower.	
	All open-ended lines need caps or secondary valves to seal each line.	Part of standard design procedures	

Atmospheric Emissions				
Reference		**Description**	**Project Status**	**Future Actions /Considerations**
Existing Techniques				
Common Waste Gas	BAT 4	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 integrated waste gas management and treatment strategy is based on the inventory in CWS BAT 2. It takes into account factors such as greenhouse gas emissions and the consumption or reuse of energy, water and materials associated with the use of the different techniques.	This is in core design and objective of the project. The flue gas from the existing kiln and new CHP boiler will undergo the following key treatments:- SCR (CHP boiler package) is used to reduce NOx emissions from the boiler. CCU will recover (up to 95%) of CO_2 from the flue gas streams from the existing kiln and new boiler. Water wash tower will be used to reduce amine emissions. Other emission sources (i.e., O_2 venting, intermittent H_2 venting and N_2 gas blanket venting from storage tanks will not require treatment)	0
	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	Part of design. Normally treated flue gas will be emitted via the new stack. In event where the carbon capture unit is not available, flue gas from the boiler can be routed directly to the new stack. In events where CO_2 export is not possible (startup/shutdown/upset) CO_2 is recombined with the treated flue gas and emitted.	0

Atmospheric Emissions				
Reference	**Description**		**Project Status**	**Future Actions /Considerations**
Common Waste Gas	BAT 6	BAT is to ensure that the waste gas treatment systems are A) appropriately designed (e.g., considering the maximum flow rate and pollutant concentrations), B) operated within their design ranges, and C) maintained (through preventive, corrective, regular and unplanned maintenance) so as to ensure optimal availability, effectiveness and efficiency of the equipment.	Part of inherent design process	0
	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.	CO_2 metering package is included in Design on the export line.	Requirement for flow and temperature monitoring of the flue gas as it enters the carbon capture unit to be confirmed.
	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. A) Cyclone B) Fabric Filter C) Absorption	Quencher column is in design which removes salts from the flue gas. These form a slurry which is sent to the cement plant for use in the cement production.	0
	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. A) Choice of Fuel (primarily targets ... NOx & SOX) B) Low NOx burner (NOx only) C) Optimisation of catalytic or thermal oxidation (CO & NOx) D) Removal of high levels of NOx precursors (NOx) E) Absorption (SOx) F) Selective Catalytic Reduction (NOx) G) Selective non-Catalytic Reduction (NOx)	Option G) SCR is within design to reduce NOx emission levels and ensure compliance with permit levels. SOx and CO emissions from natural gas combustion are not anticipated to pose a compliance issue.	0

Atmospheric Emissions				
Reference	**Description**		**Project Status**	**Future Actions /Considerations**
Common Waste Gas	BAT 17	In order to reduce channelled emissions to air of ammonia from the use of SCR or SNCR for the abatement of NOx emissions (ammonia slip), BAT is to optimise the design and/or operation of SCR or SNCR i.e., optimised reagent to NOX ratio, homogeneous reagent distribution and optimum size of the reagent drops.	BAT consideration is in design of the SCR. Refer to process description (Ref 5) which directly mentions ammonia slip issue and options to reduce, including 1) uniformly distributed inject of Ammonia across catalyst bed 2) potential option for ammonia slip catalysis downstream of SCR for additional NOx removal and also CO reduction which will be explored further in FEED if deemed necessary.	0
	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 SCR/SNCR, 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 (Cl_2, HCl, HCN, HF, NH_3, NOx, SOx) B) Adsorption (HCl, HF, NH_3, SOx) C) SCR (NOx) D) SNCR (NOx) Techniques not primarily used to reduce inorganic compound emissions: E) Catalytic Oxidation (NH_3) F) Thermal Oxidation (NH_3, HCN)	Part of standard design processes and considerations to minimise noise where possible via incorporating noise level requirements in vendor quotes and appropriate site layout to avoid direct line between noisy equipment and neighbours as far as practical and possible.	0

Atmospheric Emissions				
Reference	**Description**		**Project Status**	**Future Actions /Considerations**
Common Waste Gas	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. A) Limiting number of emission sources (minimise pipe lengths, reduce no. of connections, welded fittings etc) B) Use of high-integrity equipment C) Collecting diffuse emissions and treating off-gases D) Facilitating access and/or monitoring activities E) Tightening F) Replacement of leaky equipment and/or parts G) Reviewing and updating process design (i.e., reduce use of solvents, lowering operating Temp, lower VOC content in product) H) Reviewing and updating operating conditions I) Using closed systems J) Using techniques to minimise emissions from surfaces (i.e., periodically skimming open surfaces; stalling anti-evaporation floating elements on open surfaces; using fixed roof tanks & Waste gas treatment	Reduction of any fugitive emissions is stipulated in the Environmental Basis of Design via minimisation of potential leak sources and use of low leak equipment where practical. See also BAT 17 of Common Wastewater	0
Common Wastewater	BAT 15	In order to facilitate the recovery of compounds and the reduction of emissions to air, BAT is to enclose the emission sources and to treat the emissions, where possible.		Requirement for closed drain system on streams which may emit to atmosphere or prove to be odorous to be established

Atmospheric Emissions				
Reference		**Description**	**Project Status**	**Future Actions /Considerations**
Common Wastewater	BAT 16	In order to reduce emissions to air, BAT is to use an integrated waste gas management and treatment strategy that includes process-integrated and waste gas treatment techniques. The integrated waste gas management and treatment strategy is based on the inventory of waste gas streams (see CWW BAT 2) giving priority to process-integrated techniques.	This is in core design and objective of the project. The flue gas from the existing kiln and new CHP boiler will undergo the following key treatments SCR (CHP boiler package) is used to reduce NOx emissions from the boiler. CCU will recover (up to 95%) of CO_2 from the flue gas streams from the existing kiln and new boiler. Water wash tower will be used to reduce amine emissions. Other emission sources (i.e., O_2 venting, intermittent H_2 venting and N_2 gas blanket venting from storage tanks will not require treatment)	0
	BAT 19	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.	Items A-F are applicable to the design phase scope and are part of inherent design considerations. Reduction of any fugitive emissions is stipulated in the Environmental Basis of Design via minimisation of potential leak sources and use of low leak equipment where practical.	0
	BAT 21	In order to prevent or, where that is not practicable, to reduce odour emissions from waste water collection and treatment and from sludge treatment, BAT is to use one or a combination of the techniques given below. A) Minimise residence times, in particular under anaerobic conditions. B) Chemical treatment (e.g. oxidation or precipitation of hydrogen sulphide). C) Optimise aerobic treatment (i.e., controlling the oxygen content; frequent maintenance of the aeration system; use of pure oxygen; removal of scum in tanks). D) Enclosure with collection of the odorous waste gas for further treatment. E) End-of-pipe treatment (i.e., biological treatment; thermal oxidation).	Requirement for odour mitigation will be established in the EIA and feedback into the design.	

Atmospheric Emissions				
Reference	**Description**		**Project Status**	**Future Actions /Considerations**
Common Wastewater	BAT 3	BAT is to locate a tank operating at, or close to, atmospheric pressure aboveground. However, for storing flammable liquids on a site with restricted space, underground tanks can also be considered. For liquefied gases, underground, mounded storage or spheres can be considered, depending on the storage volume.	Part of design. No high-pressure storage tanks as part of design.	0
	BAT 4	BAT is to apply either a tank colour with a reflectivity of thermal or light radiation of at least 70 %, or a solar shield on aboveground tanks which contain volatile substances	Design of storage tanks to be established in FEED	
	BAT 5	BAT is to abate emissions from tank storage, transfer and handling that have a significant negative environmental effect. The principle of 'emissions minimisation in tank storage' is that – within a certain time frame – all emissions from the tank storage, transfer and handling will be abated before they are emitted. This includes the following emissions arising from normal operational activities and from incidents: A) emissions to air B) emissions to soil C) emissions to water D) energy consumption E) waste.	Leak prevention will be covered by inherent proper design of the storage tanks. Hot oil tanks are be blanketed by nitrogen. Ammonia storage bullets will have nitrogen blanket and vent scrubber to reduce odour emissions.	0
Emissions from Storage	BAT 7	BAT is to apply dedicated systems; Dedicated systems are generally not applicable on sites where tanks are used for short to medium-term storage of different products.	Interpretation of this BAT "dedicated systems" is that tanks are regulated to single content type (i.e. store only water) to avoid potential cross contamination. In design. Dedicated tanks for each stored chemical or stream.	0
	BAT 12	For other substances, BAT is to apply a vapour treatment installation, or to install an internal floating roof. Direct contact floating roofs and non-contact floating roofs are BAT.	Ammonia bullets will be fitted with vent scrubbers	0
	BAT 13	For tanks < 50 m^3, BAT is to apply a pressure relief valve set at the highest possible value consistent with the tank design criteria.	PSV pressures are established as part of inherent design process	0

Atmospheric Emissions				
Reference	**Description**		**Project Status**	**Future Actions /Considerations**
Emissions from Storage	BAT 15	For other substances, BAT is to do all, or a combination, of the following techniques, depending on the substances stored: A) apply pressure vacuum relief valves; B) up rate to 56 mbar; C) apply vapour balancing; D) apply a vapour holding tank, or E) apply vapour treatment.	Requirement to be established while tank design matures 0	
	BAT 33	BAT is to abate emissions from tank storage, transfer and handling that have a significant negative environmental effect.	Ammonia bullets will be fitted with vent scrubbers to prevent odour emissions	0
	BAT 39	BAT for valves include: A) correct selection of the packing material and construction for the process application B) with monitoring, focus on those valves most at risk (such as rising stem control valves in continual operation) C) applying rotating control valves or variable speed pumps instead of rising stem control valves D) where toxic, carcinogenic or other hazardous substances are involved, fit diaphragm, bellows, or double walled valves E) route relief valves back into the transfer or storage system or to a vapour treatment system.	Valve design / choice is to be studied in FEED. BAT requirements will be covered by inherent design processes	
	BAT 40	BAT is to use the correct selection of pump and seal types for the process application, preferably pumps that are technologically designed to be tight such as canned motor pumps, magnetically coupled pumps, pumps with multiple mechanical seals and a quench or buffer system, pumps with multiple mechanical seals and seals dry to the atmosphere, diaphragm pumps or bellow pumps.	Specifics on the pump design to be established in FEED. This will be included as part of inherent design/equipment choice, with advisement from vendor to ensure correct design choice for process conditions. 0	
	BAT 41	BAT for compressors transferring non-toxic gases is to apply gas lubricated mechanical seals. BAT for compressors, transferring toxic gases is to apply double seals with a liquid or gas barrier and to purge the process side of the containment seal with an inert buffer gas. In very high pressure services, BAT is to apply a triple tandem seal system.	0	BAT requirements to be incorporated into compressor OEM design.

Atmospheric Emissions				
Reference		**Description**	**Project Status**	**Future Actions /Considerations**
Emissions from Storage	BAT 49	BAT for roads that are used by trucks and cars only, is applying hard surfaces to the roads of, for example, concrete or asphalt, because these can be cleaned easily to avoid dust being swirled up by vehicles. However, applying hard surfaces to the roads is not justified when the roads are used just for big shovel vehicles or when a road is temporary.	Design basis is to pave access roads to the site.	0
Industrial Cooling	BAT 20	BAT for reduction of emissions to Air:- Wet Cooling Towers A) Avoid plume reaching ground level by ensuring plume reaches sufficient height and with minimum discharge velocity at tower outlet B) Avoid plume formation via application of plume suppressing techniques (i.e., reheating of air) C) Avoid affecting indoor air quality via design and positioning of tower outlet to avoid risk of air intake by air conditioning systems D) Reduce drift loss by applying drift eliminators with a loss <0.01% of total recirculating flow	Hybrid cooling includes dry surface coils to reduce visible plumes from the system. Drift losses are expected to be 0.005% well below BAT requirement (Ref 15).	Further study of plume dispersion will be required to advise on A and C.
Large Combustion Plants	BAT 3	BAT is to monitor key process parameters relevant for emissions to air and water including those given below Flue Gas A) Flow - Periodic or continuous determination B) Oxygen Content, temperature and pressure - Periodic or continuous measurement C) Water vapour content - Periodic or continuous measurement Wastewater from flue-gas treatment D) flow, pH and Temperature - Continuous measurement	A-B are in design and monitoring requirements stipulated in the Environmental Basis of Design and Environmental Monitoring and Management Plan.	0

Atmospheric Emissions

Reference	Description		Project Status	Future Actions /Considerations
Large Combustion Plants	BAT 4	BAT is to monitor emission to air with at least the frequency given below 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 quantity. The following should be monitored continuously: A) Oxides of Nitrogen (NOx) B) Carbon Monoxide (CO) C) Sulphur Dioxide (SO_2) D) Dust (Specifically Standard EN 13284-1 and EN 13284-2) E) Methane (CH_4) (natural gas engines) F) HF (boilers burning process fuels from chemical industry) G) PCDD/F (boilers burning process fuels from chemical industry) The following are to be monitored when Selective Catalytic Reduction/Selective non-Catalytic Reduction is employed in the combustion plant: H) NH_3 - Continuous I) SO_3 – at least once per year	Items A-E, H and I are in Design, stipulated by the Environmental Basis of Design monitoring requirements and standards. Items F and G are not applicable to this project.	0
	BAT 6	In order to improve the general environmental performance of combustion plants and to reduce emissions to air of CO and unburnt substances, BAT is to ensure optimised combustion and to use an appropriate combination of the techniques given below Fuel Blending and mixing A) Maintenance of the combustion system B) Advanced Control System C) Good Design of the Combustion Equipment D) Fuel Choice	Part of inherent design of the CHP. Vendor will recommend optimal performance of boiler based on provided process characteristics	0
	BAT 7	In order to reduce emissions of ammonia to air from the use of selective catalytic reduction (SCR) and/or selective non-catalytic reduction (SNCR) for the abatement of NOX emissions, BAT is to optimise the design and/or operation of SCR and/or SNCR (e.g. optimised reagent to NOX ratio, homogeneous reagent distribution and optimum size of the reagent drops). The BAT-associated emission level (BAT-AEL) for emissions of NH3 to air from the use of SCR and/or SNCR is < 3–10 mg/Nm^3 as a yearly average or average over the sampling period. The lower end of the range can be achieved when using SCR and the upper end of the range can be achieved when using SNCR without wet abatement techniques.	BAT consideration is in design of the SCR. Refer to process description (215000-00190-000-PR-REP-0006) which directly mentions ammonia slip issue and options to reduce, including 1) uniformly distributed inject of Ammonia across catalyst bed 2) potential option for ammonia slip catalysis downstream of SCR for additional NOX removal and also CO reduction which will be explored further in FEED if deemed necessary.	0

Atmospheric Emissions				
Reference	**Description**		**Project Status**	**Future Actions /Considerations**
Large Combustion Plants	BAT 8	In order to prevent or reduce emissions to air during normal operating conditions, BAT is to ensure, by appropriate design, operation and maintenance, that the emission abatement systems are used at optimal capacity and availability	SCR OEM will advise operating envelope and recommended replacement schedule.	0
	BAT 9	In order to improve the general environmental performance of combustion and/or gasification plants and to reduce emissions to air, BAT is to include the following elements in the quality assurance/quality control programmes for all the fuels used, as part of the environmental management system (see Large Combustion Plant BAT 1). i) Initial full characterisation of the fuel used in accordance with EN standards. ISO, national or other international standards may be used provided they ensure the provision of data of an equivalent scientific quality; ii) Regular testing of the fuel quality to check that it is consistent with the initial characterisation and according to the plant design specifications. iii) Subsequent adjustment of the plant settings as and when needed and practicable (e.g. integration of the fuel characterisation and control in the advanced control system.	(i) fuel characteristics are known based on same natural gas supply as per existing kiln facility. ii) operational consideration iii) operational consideration	0
	BAT 11	BAT is to appropriately monitor emissions to air and/or to water during OTNOC.	Environmental basis of design stipulates Continuous emission monitoring of the new stack, which will record pollutant levels during the plant normal operational state and otherwise.	0

Atmospheric Emissions				
Reference	**Description**		**Project Status**	**Future Actions /Considerations**
Large Combustion Plants	BAT 12	In order to increase the energy efficiency of combustion, gasification and/or IGCC units operated ≥ 1 500 h/yr, BAT is to use an appropriate combination of the techniques given below: a) Combustion optimisation b) optimisation of the working medium conditions (i.e., pressure/temp) c) Optimisation of the steam cycle d) minimisation of energy consumption e) Preheating of Combustion air f) Fuel Preheating g) Advanced Control Systems h) Feed-water preheating using recovered heat i) Heat recovery by cogeneration (CHP) j) CHP readiness (future potential of heat use) k) fuel-gas condenser l) Heat accumulation m) Wet Stack n) Cooling Tower Discharge o) Fuel Pre-drying p) Minimisation of heat losses q) Advanced Materials r) Steam turbine upgrade s) Supercritical and ultra-supercritical steam conditions	Optimisation techniques (i.e., a, b, c, g, p etc) are captured as part of standard design processes and OEM advisement based on provided process characteristics. Project design is to use CHP with waste heat recovery as default and the flue gas from the existing kiln is used as pre-heated combustion air.	0
	BAT 41	In order to prevent or reduce NOX emissions to air from the combustion of natural gas in boilers, BAT is to use one or a combination of the techniques given below. A) Air and/or fuel staging B) Flue-gas recirculation C) Low-NOX burners (LNB) D) Advanced control system E) Reduction of the combustion air temperature F) Selective non–catalytic reduction (SNCR) G) Selective catalytic reduction (SCR)	Boiler design is to be established in FEED with advisement form OEM. Design will have low-NOx burner technology (C.) and (G) SCR is in design. Overall impact is circa 90% reduction in NOX emissions compared to existing cement plant	0
	BAT 44	In order to prevent or reduce CO emissions to air from the combustion of natural gas, BAT is to ensure optimised combustion and/or to use oxidation catalysts.	No permit compliance issue with CO emissions has been identified.	0

Atmospheric Emissions				
Reference		**Description**	**Project Status**	**Future Actions /Considerations**
Waste Incineration	BAT 3	BAT is to monitor key process parameters relevant for emissions to air and water including those given below. Continuous Monitoring of A) Flue gas - flow, O_2 content, Temperature, pressure, water vapour B) Combustion chamber - Temperature C) Wastewater from wet FGC - Flow, pH, Temperature D) Waste Water from bottom ash treatment plants - Flow. pH, conductivity	A) CEMS is stipulated in design by the Environmental Basis of design B) not applicable C) not applicable D) not applicable	0
	BAT 32	In order to prevent the contamination of uncontaminated water, to reduce emissions to water, and to increase resource efficiency, BAT is to segregate waste water streams and to treat them separately, depending on their characteristics.	Segregation of wastewater streams is in design - refer to drainage philosophy	0
Waste Treatment	BAT 13	In order to prevent or, where that is not practicable, to reduce odour emissions, BAT is to use one or a combination of the techniques given below A) Minimising residence time (open systems only) B) Using Chemical Treatment to destroy or reduce the formation of odorous compounds C) Optimising aerobic treatment (use of pure oxygen; removal of scum in tanks; frequent maintenance of aeration system)	Odour assessment will be undertaken as part of the Environmental Impact assessment and feedback into design if mitigation measures are required.	
	BAT 14	In order to prevent or, where that is not practicable, to reduce diffuse emissions to air, in particular of dust, organic compounds and odour, BAT is to use an appropriate combination of the techniques given below. A) Minimising the number of potential diffuse emission sources (appropriate design of piping layout, favouring use of gravity transfer; limiting drop height of material; wind barriers etc) B) Selection and use of high-integrity equipment (High-integrity seals/gaskets; pumps/compressors with mechanical seals; magnetically driven pumps etc) C) Corrosion prevention (appropriate selection of construction materials and lining. Coating of equipment with corrosion inhibitors) D) Containment, collection and treatment of diffuse emissions (i.e., maintaining the enclosed equipment/buildings under adequate pressure; collecting and directing emissions to an abatement system) E) Dampening - (i.e., for dry material and dust) F) Maintenance (including ensuring access to potentially leaky equipment; regularly controlling protective equipment such as lamellar curtains, fast action doors) G) Cleaning of waste treatment and storage areas H) Leak Detection and Repair Programme	Not fully applicable to the scope of the project, however project design is to implement many of these techniques throughout	0

Table 3-1: Atmospheric Emissions: Emerging and Existing BAT

3.4.2 Emissions to Water

Emissions to Water				
Reference		**Description**	**Project Status**	**Future Actions / Considerations**
Emerging Techniques				
Emerging Techniques for Blue H_2		All wastewater streams are to be identified, including process condensate and other effluents such as steam system blowdown, cooling water blowdown, rain water, oily water, water treatment effluent and water used for cleaning. Suitable segregation strategies and methods of treatment to meet discharge consent limits are to be defined.	Wastewater/effluent stream segregation is part of design. Details of effluent stream handling/drainage shall be detailed in the upcoming drainage philosophy document (Ref 11).	
		Water consumption and volume of contaminated water should be minimised through design of the hydrogen production process, optimisation of water management through segregation of contaminated water streams (from water wash, condensate) and of noncontaminated water streams (once through cooling, rain water).	Wording is for H_2 production therefore not directly applicable, however thematic approach to correct segregation of contaminated and non-contaminated streams is applicable and part of design (Ref 5)	
Existing Techniques				
Common Waste Water	BAT 2	In order to facilitate the reduction of emissions to water and air and the reduction of water usage, BAT is to establish and to maintain an inventory of waste water and waste gas streams, as part of the environmental management system.	Note - Project has zero-discharge design policy, with effluent streams being sent to the existing cement facility for reuse. Air emissions inventory fall under scope of the Emissions, discharge and waste schedule (Ref 8) which will be prepared in FEED.	
	BAT 3	For relevant emissions to water as identified by the inventory of waste water streams (see Common Wastewater BAT 2), BAT is to monitor key process parameters (including continuous monitoring of waste water flow, pH and temperature) at key locations (e.g. influent to pre-treatment and influent to final treatment).	Wastewater/effluent flow metering is to be included in design as per the requirements of the Environmental Basis of Design (Ref 1). Environmental Management and monitoring plan (Ref 9) is to be developed in FEED and include requirement for flow metering to allow for water balance to be determined.	

Emissions to Water

Reference		Description	Project Status	Future Actions / Considerations
Common Waste Water	BAT 7	In order to reduce the usage of water and the generation of waste water, BAT is to reduce the volume and/or pollutant load of waste water streams, to enhance the reuse of waste water within the production process and to recover and reuse raw materials.	Reduction of raw water use is in design with key elements: 1. Choice of re-circulating water cooling rather than once through system. 2. Air cooling will be used where feasible to reduce cooling water requirements. 3. Condensate will be recovered from process and routed to the WWT unit for reuse 4. Raw water intake will supplemented with cooling tower blowdown and waste water from absorption tower (post treatment) (Ref 5)	0
	BAT 8	In order to prevent the contamination of uncontaminated water and to reduce emissions to water, BAT is to segregate uncontaminated waste water streams from waste water streams that require treatment.	In design. Effluent streams are identified against required treatment in the ZLD Study (Ref 10) and process description (Ref 5). Drainage philosophy will be prepared in FEED (Ref 11) which details the drainage routes for contaminated/ uncontaminated effluent streams	
	BAT 9	In order to prevent uncontrolled emissions to water, BAT is to provide an appropriate buffer storage capacity for waste water incurred during other than normal operating conditions based on a risk assessment (taking into account e.g. the nature of the pollutant, the effects on further treatment, and the receiving environment), and to take appropriate further measures (e.g. control, treat, reuse).	Considered in design, wastewater treatment plant will have a Buffer storage tank, with recommended capacity for 6 hours retention at design continuous flow (Ref 10).	0

Emissions to Water				
Reference		**Description**	**Project Status**	**Future Actions / Considerations**
Common Waste Water	BAT 10	In order to reduce emissions to water, BAT is to use an integrated waste water management and treatment strategy that includes an appropriate combination of the techniques in the priority order given below. a) Process-integrated techniques - Techniques to prevent or reduce the generation of water pollutants b) Recovery of pollutants at source - Techniques to recover pollutants prior to their discharge to the waste water collection system c) Waste water pre-treatment - Techniques to abate pollutants before the final waste water treatment. Pre-treatment can be carried out at the source or in combined streams d) Final waste water treatment - Final waste water treatment by, for example, preliminary and primary treatment, biological treatment, nitrogen removal, phosphorus removal and/or final solids removal techniques before discharge to receiving water body	Note - project policy is zero-discharge of waste waters, therefore response given is regarding treatment steps prior to reuse of effluent streams in cooling water. Effluent sent to the wastewater treatment plant (prior to being used as cooling water) will undergo (in order): 1. flocculation and clarifier thickening 2. filter step 3. Chemical treatment (Biocide, corrosion inhibitor, antiscale dosing) $FeCl_3$ and $Ca(OH)_2$ to be used for thickening.	0
	BAT 14	In order to reduce the volume of waste water sludge requiring further treatment or disposal, and to reduce its potential environmental impact, BAT is to use one or a combination of the techniques given below. A) Conditioning - Chemical conditioning (i.e. adding coagulants and/or flocculants) or thermal conditioning (i.e. heating) to improve the conditions during sludge thickening/dewatering. Not applicable to inorganic sludges. B) Thickening/dewatering (i.e., sedimentation, centrifugation, flotation, gravity belts, or rotary drums; Dewatering can be carried out by belt filter presses or plate filter presses). C) Stabilisation (i.e., chemical treatment, thermal treatment, aerobic digestion, or anaerobic digestion). Not applicable to inorganic sludges. Not applicable for short-term handling before final treatment. D) Drying via direct or indirect contact with a heat source. Not applicable to cases where waste heat is not available or cannot be used.	Items (A) and (B) are in design. See comments made to Common wastewater BAT 7 above.	0

Emissions to Water				
Reference		**Description**	**Project Status**	**Future Actions / Considerations**
Emissions from Storage	BAT 20	Corrosion is one of the main causes of equipment failure and can occur both internally and externally on any metal surface. BAT is to prevent corrosion by: A) selecting construction material that is resistant to the product stored B) applying proper construction methods C) preventing rainwater or groundwater entering the tank and if necessary, removing water that has accumulated in the tank D) applying rainwater management to bund drainage E) applying preventive maintenance, and F) where applicable, adding corrosion inhibitors, or applying cathodic protection on the inside of the tank.	OEM for tanks will provide appropriate tank design for the contents. Note - tanks will be dedicated storage units, preventing risk of improper use	0
	BAT 21	To avoid corrosion, BAT is to apply to the outside of the tank: A) a corrosion-resistant coating B) plating, and/or C) a cathodic protection system.	The (new) stack will be subject to Continuous emission monitoring of flue gas pollutant concentrations including NOx, SO_2, CO, PM, Ammonia, Amine. Full requirements are detailed in the Environmental Basis of Design (Ref 1).	0
	BAT 22	BAT is to prevent Stress corrosion cracking (SCC) by: A) stress relieving by post-weld heat treatment, and B) applying a risk based inspection	Part of OEM appropriate design	0
	BAT 24	BAT is to apply leak detection on storage tanks containing liquids that can potentially cause soil pollution. The applicability of the different techniques depends on the tank type. The four different basic techniques that can be used to detect leaks are: A) release prevention barrier system B) inventory checks C) acoustic emission method D) soil vapour monitoring.	A) is in design. Tanks with potential to leak will be situated on concreted areas with appropriate kerbing/ containment/sump for tank capacity. B-D are operational recommendations.	0
	BAT 25	BAT is to achieve a 'negligible risk level' of soil pollution from bottom and bottom-wall connections of aboveground storage tanks. However, on a case-by-case basis, situations might be identified where an 'acceptable risk level' is sufficient.	See comment above	0

Emissions to Water				
Reference		Description	Project Status	Future Actions / Considerations
Emissions from Storage	BAT 27	For building new single walled tanks containing liquids that pose a risk for significant soil pollution or a significant pollution of adjacent watercourses, BAT is to apply a full, impervious, barrier in the bund. Impervious barriers include: A) a flexible membrane, such as HDPE B) a clay mat C) an asphalt surface D) a concrete surface.	Tanks with potential to leak will be situated on concreted areas with appropriate kerbing/containment/sump for tank capacity.	0
	BAT 31	To prevent overfilling due to rainfall in situations where the basin or lagoon is not covered, BAT is to apply a sufficient freeboard	Part of inherent design	0
	BAT 32	Where substances are stored in a basin or lagoon with a risk of soil contamination, BAT is to apply an impervious barrier. This can be a flexible membrane, a sufficient clay layer or concrete.	Design of the attenuation pond is to be established in FEED and consideration for contamination prevention will be taken into account.	
	BAT 34	BAT is to apply aboveground closed piping in new situations. For existing underground piping it is BAT to apply a risk and reliability-based maintenance approach	Part of inherent design process	0
	BAT 35	BAT is to minimise the number of flanges by replacing them with welded connections, within the limitation of operational requirements for equipment maintenance or transfer system flexibility.	Part of inherent design processes	0
	BAT 36	BAT is to prevent corrosion by: A) selecting construction material that is resistant to the product B) applying proper construction methods C) applying preventive maintenance, and D) where applicable, applying an internal coating or adding corrosion inhibitors.	Will be part of tank OEM design - appropriate design for target substance	0
	BAT 37	To prevent the piping from external corrosion, BAT is to apply a one, two, or three layer coating system depending on the site-specific conditions (e.g. close to sea). Coating is normally not applied to plastic or stainless steel pipelines.	Pipeline material selection will be performed as part of FEED	0

Emissions to Water				
Reference		**Description**	**Project Status**	**Future Actions / Considerations**
Industrial Cooling Systems	BAT 6	For reduction of water need/use, BAT is to A) Optimise heat reuse to reduce need for (additional) cooling B) Apply recirculating systems C) Apply hybrid cooling system D) Apply dry-air cooling (evaluation needed, potentially more beneficial for pre-cooling at higher temperatures where water demand would be excessive) E) Optimisation of cycles of concentration (increases water conditioning demand) Note - Use of groundwater is not BAT	Option (B) recirculating system is included in design to provide primary cooling. Design is to have a Hybrid cooling tower (wet-dry) with cooling system designed for 5-stages of concentration. To further reduce water requirements air cooling will be applied where practical. (Ref 15).	0
	BAT 8	Measures should be taken in the design phase of wet cooling system using the following order of approach: A) identify process conditions (pressure, T, corrosiveness of substance), B) identify chemical characteristics of cooling water source, C) select the appropriate material for heat exchanger combining both process conditions and cooling water characteristics, D) select the appropriate material for other parts of the cooling system, E) identify operational requirements of the cooling system, F) select feasible cooling water treatment (chemical composition) using less hazardous chemicals or chemicals that have lower potential for impact on the environment G) apply the biocide selection scheme H) optimise dosage regime by monitoring of cooling water and systems conditions	Process conditions and water quality/characteristics are presented in Cooling Study (Ref 15). Cooling tower will be mainly fabricated from FRP with PVC drift eliminators and filling. Due to Zero-Liquid Discharge requirements, split cooling scheme is viewed as optimal approach (air and hybrid water cooling). Considerations have been highlighted for the chloride content and low pH of the water which will promote oxidization of the stainless steel at lower temperatures which will impact other parts of the cooling system. Note - makeup waters will contain some level of CO_2 which will necessitate requirement for stainless steel. Biocide selection and dosing regime are to be confirmed as treatment package	

Emissions to Water				
Reference		**Description**	**Project Status**	**Future Actions / Considerations**
			design matures.	
Industrial Cooling Systems	BAT 9	BAT is to reduce emissions to water by design and maintenance techniques including: All wet systems: A) Undertake analysis of corrosiveness and process substance as well as of cooling water to select right material. B) Design cooling system to avoid stagnant zones.	Cooling system design is still maturing however A) and B) are both part of the inherent design process. Considerations for the water corrosion levels are already being looked at (see comments to BAT 8 above)	
	BAT 10	Shell & tube heat exchanger: BAT is to reduce emissions to water by design and maintenance techniques including: - Design to facilitate cleaning by having cooling water flow inside tube and heavy fouling medium on tube size/surface	Specifics on the design of the heat exchangers are to be established in FEED.	

Emissions to Water				
Reference		**Description**	**Project Status**	**Future Actions / Considerations**
	BAT 11	Condensers of power plants: BAT is to reduce emissions to water by design and maintenance techniques including: A) Reduce corrosion sensitiveness via application of Ti in condensers which use seawater/brackish water B) Reduce corrosion sensitiveness via use of low corrosion allows (stainless steel with high putting index/copper nickel) C) Use of automated cleaning systems with foam balls or brushes.	Cooling Study (415000-00299000-PR-REP-00003) has identified stainless steal requirement due to CO_2 and low pH in water streams.	0
	BAT 12	Condensers and heat exchangers BAT is to reduce emissions to water by design and maintenance techniques including: A) Reduce deposition (fouling) by keeping water velocity > 0.8 m/s (1.8 m/s new equipment and 1.5 m/s in case of tube bundle refit). B) use of debris filters where clogging is a risk	0	A) minimum water velocity to be verified with feedback from OEM. B) risk of clogging to be looked at.
	BAT 19	It is not BAT to use the following compounds in water treatment: A) chromium compounds B) mercury compounds C) organometallic compounds D) mercaptobenzothiazole E) shock treatment with biocidal substances other than chlorine/bromine/ozone and $h2O_2$	Listed compounds A-E, have been incorporated into the Environmental Basis of Design as compounds to avoid in design.	0
Industrial Cooling Systems	BAT 21	It is not BAT to use asbestos, wood preserves with CCA or TBTO (or similar) in cooling tower.	Asbestos is on the prohibited materials list of the basis of design. Cooling tower construction will not include wood materials and therefore no requirement for wood preserves.	0
	BAT 24	BAT to reduce leakage is:- Temperature differential kept <50 degC across heat exchanger to avoid formation of small cracks (technical solutions required for higher temp. diff.)	Water cooling system controls will allow control of the various operational parameters of the system including temperature to ensure it is kept within recommended design specification.	

Emissions to Water

Reference		Description	Project Status	Future Actions / Considerations
Industrial Cooling Systems	BAT 25	Shell & Tube heat Exchanger BAT to reduce leakage from S&THEx is : A) Monitor process operation to ensure exchanger is operated within design limits B)Apply wielding technology (where applicable) to ensure sufficient strength of tube/tube plate construction	Heat exchanger design is to be established, however A) is operational aspect B) to be advised by OEM	0
	BAT 26	Equipment BAT to reduce leakage from equipment is to reduce corrosion by keeping temperature of metal on cooling side <60 degC.	The cooling system design will allow for control of the system performance parameters including temperature. Optimal set points for these parameters will be established with feedback from the vendors.	0
	BAT 28	Recirculating Cooling Systems BAT to reduce leakage from recirculating systems is to apply constant monitoring of blowdown to control dangerous substances	Environmental Basis of Design (Ref 1) requires that adequate monitoring of wastewater effluent flow and quality to the wastewater treatment facility be implemented to ensure proper treatment of the facility.	Metering and monitoring requirements to be matured through FEED.
	BAT 29	Wet recirculating cooling systems BAT to reduce biological growth is to A) Reduce light reaching cooling water B) Avoid stagnant zones through design and apply optimised chemical treatment C) Clean using a combination of mechanical and chemical methods following outbreak D) Implement periodic monitoring of pathogens in cooling system	Part of inherent design of cooling tower/system. Cooling water undergoes biocide treatment (specifics of which to be determined).	0
Large Combustion Plants	BAT 13	In order to reduce water usage and the volume of contaminated waste water discharged, BAT is to use one or both of the techniques given below A) Water recycling B) Dry bottom ash handling (no water cooling)	A) Wastewater recycling is in design. Example absorber blowdown is captured, treated and reused in process as cooling water. B) not applicable to the project.	0

Emissions to Water				
Reference		**Description**	**Project Status**	**Future Actions / Considerations**
Large Combustion Plants	BAT 14	In order to prevent the contamination of uncontaminated waste water and to reduce emissions to water, BAT is to segregate waste water streams and to treat them separately, depending on the pollutant content	In design. Segregation of wastewater streams shall be included in design (ref process description). Details of effluent stream handling/drainage shall be detailed in the upcoming drainage philosophy document (Ref 11).	
	BAT 16	In order to reduce the quantity of waste sent for disposal from the combustion and/or gasification process and abatement techniques, BAT is to organise operations so as to maximise, in order of priority and taking into account life-cycle thinking: ● waste prevention, e.g. maximise the proportion of residues which arise as by-products; ● waste preparation for reuse, e.g. according to the specific requested quality criteria; ● waste recycling; ● other waste recovery (e.g. energy recovery), by implementing an appropriate combination of techniques such as a) Generation of gypsum as a by-product b) Recycling or recovery of residues in the construction sector c) Energy recovery by using waste in the fuel mix d) Preparation of spent catalyst for reuse	Item (b) is applicable and within scope of the plant design. Wastewaters and recovered sludges from the Carbon Capture plant will be routed to the existing cement facility for use (directly and indirectly) in production of cement.	0
Waste Incineration	BAT 12	In order to reduce the environmental risks associated with the reception, handling and storage of waste, BAT is to use both of the techniques given below. A) Impermeable surfaces with an adequate drainage infrastructure B) Adequate waste storage capacity	In design - see responses to other BAT docs	0

Emissions to Water				
Reference		**Description**	**Project Status**	**Future Actions / Considerations**
Waste Treatment	BAT 4	In order to reduce the environmental risk associated with the storage of waste, BAT is to use all of the techniques given below Optimised Storage Location; including techniques such as A) the storage is located as far as technically and economically possible from sensitive receptors, watercourses, etc.; B) the storage is located in such a way so as to eliminate or minimise the unnecessary handling of wastes within the plant (e.g. the same wastes are handled twice or more or the transport distances on site are unnecessarily long). Adequate Storage Capacity C) the maximum waste storage capacity is clearly established and not exceeded taking into account the characteristics of the wastes (e.g. regarding the risk of fire) and the treatment capacity; D) The quantity of waste stored is regularly monitored against the maximum allowed storage capacity; E) the maximum residence time of waste is clearly established. Safe storage operation F) equipment used for loading, unloading and storing waste is clearly documented and labelled; G) wastes known to be sensitive to heat, light, air, water, etc. are protected from such ambient conditions; H) containers and drums are fit for purpose and stored securely. Separate area for storage and handling of packaged hazardous waste I) When relevant, a dedicated area is used for storage and handling of packaged hazardous waste.	A Waste Management Plan (Ref 12) will be developed in FEED to cover the storage and handling of waste for the plant.	

Emissions to Water				
Reference		**Description**	**Project Status**	**Future Actions / Considerations**
Waste Treatment	BAT 19	In order to optimise water consumption, to reduce the volume of waste water generated and to prevent or, where that is not practicable, to reduce emissions to soil and water, BAT is to use an appropriate combination of the techniques given below. A) Water management (water-saving plans; optimising use of washing water; reducing the use of water for vacuum generation) B) Water recirculation C) Impermeable surface (to avoid contamination of soil and/or adjacent water to storage area) D) Techniques to reduce the likelihood and impact of overflows and failures from tanks and vessels (i.e., overflow detectors, overflow pipes directed to contained drainage system; secondary containment) E) Roofing of waste storage and treatment areas (avoid rainwater getting in causing overflow) F) Segregation of water streams (Each water stream (e.g. surface run-off water, process water) is collected and treated separately) G) Adequate drainage infrastructure H) Design and maintenance provisions to allow detection and repair of leaks I) Appropriate buffer storage capacity	Project is implementing design choices based on potential for water saving including B) Use of recirculating water cooling; reuse of wastewater streams (example blowdown from absorber is treated and used as BFW). Recovery of condensate. F) Segregation of effluent streams with rationalisation of treatment based on stream characteristics. G+H) drainage design to be established in FEED. I) Buffer storage has been included in wastewater treatment design for 6 hours of normal flow rate.	
	BAT 21	In order to prevent or limit the environmental consequences of accidents and incidents, BAT is to use all of the techniques given below, as part of the accident management plan (see WT BAT 1). A) Protection measures (i.e., protection of the plant against malevolent acts; fire and explosion protection system; accessibility and operability of control equipment in emergency situations) B) Management of incidental/accidental emissions (Procedures are established and technical provisions are in place to manage (in terms of possible containment) emissions from accidents and incidents such as emissions from spillages, firefighting water, or safety valves.) C) Incident/accident registration and assessment system (i.e., logging and procedures to identify, respond and lean from incidents)	The (new) stack will be subject to Continuous emission monitoring of flue gas pollutant concentrations including NOx, SO_2, CO, PM, Ammonia, Amine. Full requirements are detailed in the Environmental Basis of Design (Ref 1).	0

Emissions to Water				
Reference		**Description**	**Project Status**	**Future Actions / Considerations**
Waste Treatment	BAT 52	In order to improve the overall environmental performance, BAT is to monitor the waste input as part of the waste pre-acceptance and acceptance procedures (see Waste treatment BAT 2).	Environmental Basis of Design (Ref 1) requires that adequate monitoring of wastewater effluent flow and quality to the wastewater treatment facility be implemented to ensure proper treatment of the facility.	Metering and monitoring requirements to be matured through FEED.

Table 3-2: Emissions to Water: Emerging and Existing BAT

3.4.3 Noise Emissions

The nature of BAT for noise control and management is broadly applicable across all industries outside of select few process specific items. As such, the general noise mitigation BAT is repeated across several documents. To avoid duplication, these have been collated and responded to as a single item.

Noise Emissions				
Reference		**Description**	**Project Status**	**Future Actions / Considerations**
Emerging & Existing Techniques				
Emerging Techniques for Blue H_2		BAT is to be implemented for prevention or reduction of noise, with a plan for management of noise developed as appropriate to the local environment. Noise reduction techniques to be considered where necessary to include use of acoustic insulation or enclosures or screening through use of embankments or walls.	Part of standard design processes and considerations to minimise noise where possible via incorporating noise level requirements in vendor quotes and appropriate site layout to avoid direct line between noisy equipment and neighbours as far as practical and possible. Action was raised in ENVID (#4) to identify sound sources for facility and undertake noise assessment to determine noise levels at neighbouring sites/residential areas. (Ref 7)	
		Equipment generating noise should be identified at the design stage, and their environmental performance should be considered for intended operations, including: A) an environmental noise assessment B) a noise management plan C) plant design to consider the selection of enclosures of noisy equipment or operations D) plant design to consider the location of noisy equipment or operations E) plant design to consider the use of embankments to screen the source of noise F) plant design to consider the use of noise protection wall		
Common Waste Water Also identical to Large Combustion Plant (BAT 17) Waste Incineration (BAT 37) Waste Treatment (BAT 18)	BAT 23	In order to prevent or, where that is not practicable, to reduce noise emissions, BAT is to use one or a combination of the techniques given below. A) Appropriate location of equipment and buildings B) Operational measures (i.e., improved inspection and maintenance of equipment; closing doors and windows of enclosed areas; equipment operation by experienced staff; avoidance of noisy activities at night etc) C) Low-noise equipment D) Noise-control equipment (i.e., insulation, low-noise rated equipment, silencers etc) E) Noise abatement - Inserting obstacles between emitters and receivers	A-E are part of the inherent site layout design considerations to minimise noise levels.	

Noise Emissions				
Reference		**Description**	**Project Status**	**Future Actions / Considerations**
Industrial Cooling Systems	BAT 23	Mechanical Draught Cooling Towers BAT for reduction of noise emissions:- A) Reduce fan noise through application of low-noise fans with large diameter and reduced tip speed (<40 m/s). B) Reduce noise from diffuser via using sufficient height or installation of sound attenuators (only applicable to low noise levels i.e., < 5 dbA) C) Apply attenuation measures to inlet and outlet (applicable to sound levels > 15 dBA)	Cooling system design is maturing.	Design of cooling tower is to be established. Techniques A-C shall be considered in vendor specifications where feasible. Noise levels are to be established and fed into the overall site noise assessment to identify requirement for further mitigation measures.

Table 3-3: Noise Emissions: Existing and Emerging BAT

3.4.4 Energy Efficiency

Energy Efficiency			
Reference	**Description**	**Project Status**	**Future Actions / Considerations**
Emerging Techniques			
Emerging Techniques for PCC	The flue gas may be cooled by heat transfer to low pressure steam, heat transfer fluids or in a gas/gas heater. Recovered heat could be used to offset some of the solvent regeneration energy (although temperatures will limit the scope for this), to reheat the flue gases post absorber. The following hierarchy of cooling methods should be applied A) Direct Water Cooling B) Wet Cooling Towers C) Hybrid Cooling Towers D) Dry Cooling (i.e., direct air-cooled condensers and dry cooling towers)	Waste heat recovery included in Design. Heat will be recovered from two new exchangers, one from kiln flue gases out of cement plant pre-heating tower (PHT) and another recovering heat from the hot air leaving the clinker cooler. Heat Transfer Fluid (HTF) will be used to recover the heat and produce low pressure steam in HTF Evaporator. LP Steam is used in regenerator and reclaimer (Ref 5) Cooling will be primarily met by the recirculating hybrid (wet-dry) cooling system. Air cooling will be used where practical to reduce water requirements (Ref 15).	
	The choice of CO_2 compressors should be based on expected duty. Integrally geared units should be used for maximum efficiency and rationalisation of required number of compression trains. Feasible use of waste heat generated from compressors should be considered as additional efficiency improvement.	Specifics on the compressors are still in development and will be established in FEED.	Project to consider option for use of heat recovery from compressors (if practical)
Existing Techniques			

Energy Efficiency				
Reference		Description	Project Status	Future Actions / Considerations
Energy Efficiency	BAT 5	BAT is to use appropriate tools or methodologies to assist with identifying and quantifying energy optimisation, such as: A) energy models, databases and balances B) a technique such as pinch methodology C) estimates and calculations	Engineering studies will be carried out as part of the inherent design process to determine energy savings in design where applicable. Current studies are the • Combined heat and power study (Ref 13) • Waste heat utilisation study (Ref 14) • Cooling Medium Study (Ref 15)	0

Energy Efficiency				
Reference		Description	Project Status	Future Actions / Considerations
Energy Efficiency	BAT 6	BAT is to identify opportunities to optimise energy recovery within the installation, between systems within the installation (see Energy Efficiency BAT 7) and/or with a third party (or parties).	Design is to send flue gas from the kiln to the boiler rather than bringing air into the burners resulting in lower amounts of flue gas being generated, reduced NOx emissions and reducing energy requirements for treatment. Waste heat recovery included in Design. Heat will be recovered from two new exchangers, one from kiln flue gases out of cement plant pre-heating tower (PHT) and another recovering heat from the hot air leaving the clinker cooler. Heat Transfer Fluid (HTF) will be used to recover the heat and produce low pressure steam in HTF Evaporator. LP Steam is used in regenerator and reclaimer (Ref 5) Suggested use of a mechanical vapor recompressor (MVR) evaporator in place of a multi-effect evaporator for the re-compression of the secondary vapor from the Ultrafiltration/Reverse Osmosis units. Theoretical energy savings of 50% energy and 90% cooling water requirement. (Ref 10)	0

Energy Efficiency				
Reference		**Description**	**Project Status**	**Future Actions / Considerations**
Energy Efficiency	BAT 7	BAT is to optimise energy efficiency by taking a systems approach to energy management in the installation. Systems to be considered for optimising as a whole are, for example: BAT is to optimise energy efficiency by taking a systems approach to energy management in the installation. Systems to be considered for optimising as a whole are, for example: A) process units B) heating systems (steam/hot water) C) Cooling and vacuum D) motor driven system etc. - process units - heating systems (steam/hot water) - cooling and vacuum - motor driven system etc	Part of inherent design engineering process. Studies to look at various aspects of the project where technology package options exist and recommend best option based on number of criteria including practicality, energy, cost etc. Examples include Combined heat and power study (Ref 13) Waste heat utilisation study (Ref 14) and Cooling Medium Study (Ref 15).	0
	BAT 10	BAT is to optimise energy efficiency when planning a new installation, unit or system or a significant upgrade by considering all of the following: A) the energy-efficient design (EED) should be initiated at the early stages of the conceptual design/basic design phase, even though the planned investments may not be well-defined. The EED should also be taken into account in the tendering process B) the development and/or selection of energy-efficient technologies - additional data collection may need to be carried out as part of the design project or separately to supplement existing data or fill gaps in knowledge C) The EED work should be carried out by an energy expert D) The initial mapping of energy consumption should also address which parties in the project organisations influence the future energy consumption, and should optimise the energy efficiency design of the future plant with them. For example, the staff in the (existing) installation who may be responsible for specifying design parameters.	A) part of inherent design of the facility. See comments made to EE BAT 6 and 7 above B) Energy efficiency is criteria for choice of technology/packages and covered in comparative studies (see Energy Efficiency BAT 7). C) Design is carried out by suitably experienced engineers, and as part of Worley process reviewed by disciplines. D) High level energy consumption mapping to be undertaken as part of the GHG and Energy Use report in FEED. Further refinement can be undertaken in later stages once design is fixed.	
	BAT 11	BAT is to seek to optimise the use of energy between more than one process or system, within the installation or with a third party.	Waste heat recovery is included in design. Refer to comments on BAT above for more specifics.	0

Energy Efficiency				
Reference		**Description**	**Project Status**	**Future Actions / Considerations**
Energy Efficiency	BAT 17	BAT is to optimise the energy efficiency of combustion by relevant techniques such as those specific to sectors given in vertical BREFs	Part of design. Note the LCP BAT will be reviewed as part of this BAT assessment	0
	BAT 18	BAT for steam systems is to optimise the energy efficiency by using techniques such as those specific to sectors given in vertical BREFs	Part of standard design processes and considerations to minimise noise where possible via incorporating noise level requirements in vendor quotes and appropriate site layout to avoid direct line between noisy equipment and neighbours as far as practical and possible.	0
	BAT 20	BAT is to seek possibilities for cogeneration, inside and/or outside the installation (with a third party)	Combined Heat and Power system is embedded in design.	0
	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 below, according to applicability: A) Installing capacitors in the AC circuits to decrease the magnitude of reactive power B) Minimising the operation of idling or lightly loaded motors C) Avoiding the operation of equipment above its rated voltage D) When replacing motors, using energy efficient motors	Electrical design of the plant is maturing. Aspects A-C would be covered by inherent design processes. D) is not applicable as no motors are being replaced	
	BAT 22	BAT is to check the power supply for harmonics and apply filters if required	Part of inherent electrical design processes.	
	BAT 23	BAT is to optimise the power supply efficiency by using techniques such as those in below, according to applicability: A) Ensure power cables have the correct dimensions for the power demand B) keep online transformer(s) operating at a load above 40 - 50 % of the rated power C) Use high-efficiency/low loss transformers D) Place equipment with a high current demand as close as possible to the power source (e.g. transformer)	These aspects would be covered as part of the inherent electrical design process. A) sizing calculations will be undertaken B) right sizing of the transformer for the intended operation is part of design process – electrical load lists will be produced to inform site demand C) Electrical design criteria indicates Tier 2 to meet Ecodesign directive D) Electrical team are included in site layout discussions to ensure location of equipment is adequate for this.	

Energy Efficiency				
Reference		**Description**	**Project Status**	**Future Actions / Considerations**
Energy Efficiency	BAT 24	BAT is to optimise electric motors in the following order Installation/Refurbishment A) Using energy-efficient motors B) Proper motor Sizing C) Installing variable speed drives (VSD) D) Installing high-efficiency transmission/reducers E) Use of direct coupling where possible ; synchronous belts or cogged v-belts in place of v-gelts; helical gears in place or worm gears F) energy efficient motor report or replacement with an energy efficient motor G) Rewinding: avoid rewinding and replace with an energy efficient motor or use certified rewinding contractor power quality control System operation and Maintenance H) Lubrication, adjustments, tuning	Design/choice of motors is to be progressed with feedback from vendors. However, energy efficiency, correctly sized and where practical VSD motors are to be part of motor choice.	0
	BAT 25	BAT is to optimise compressed air systems (CAS) using the techniques such as those below, according to applicability Installation and refurbishment A) overall system design, including multi-pressure systems B) upgrade compressor C) improve cooling, drying and filtering D) reduce frictional pressure losses (for example increasing piping diameter) Improvement of drives (i.e., installing high energy efficiency motors and speed control) E) use of sophisticated control systems F) Recover waste heat for use in other functions G) use external cool air as intake H) storage of compressed air near highly fluctuation uses System Operation and Maintenance I) optimise certain end use devices J) reduce air leaks K) more frequent filter replacement L) optimise working pressure	Compressed air system design is still in early days and will be established within FEED.	

Energy Efficiency				
Reference		**Description**	**Project Status**	**Future Actions / Considerations**
Energy Efficiency	BAT 26	BAT is to optimise pumping systems by using the techniques below, according to applicability A) Avoid oversizing when selecting pumps and replacing oversized pumps B) Match the correct choice of pump to the correct motor for the duty C) Design of pipework system D) Control and regulation system E) Shutdown unnecessary pumps F) Use VSD G) Use multiple pumps (staged cut in) H) Regular maintenance I) Minimise the number of valves and bends commensurate with keeping ease of operation and maintenance J) Avoid using too many bends (especially tight bends) k) Ensuring the pipework diameter is not too small	Specifics are yet to be looked at however these aspects would be covered as part of the inherent design philosophy of pumping system.	.

Energy Efficiency				
Reference		**Description**	**Project Status**	**Future Actions / Considerations**
Energy Efficiency	BAT 27	BAT is to optimise heating, ventilation and air conditioning systems by using techniques such as: - for heating, see EE BAT 18 and 19 - for pumping, see EE BAT 26 - for cooling, chilling and heat exchangers, see EE BAT 19 for ventilation, space heating and cooling, techniques below according to applicability. Design and control Overall system design, identify and equip areas separately for general, specific and process ventilation. A) Optimise the number, shape and size of intakes B) use fans of high efficiency designed to operate at optimal rate C) manage airflow, including considering dual flow ventilation D) Air system design: ducts are of sufficient size, circular ducts, avoid long runs and obstacles/ bends etc E) Optimise electric motors and consider installing VSD F) Use automatic control systems. Integrate with centralised technical management systems G) Integration of air filters into air duct system and heat recovery from exhaust air (heat exchangers) H) reduce heating/cooling needs through insulation, efficiency glazing, air infiltration reduction, auto closing doors, reduction of set point for heating and raising it for cooling etc.. I) improve the efficiency of heating systems through recovery/use of wasted heat, heat pumps, radiative and local heating systems coupled with reduced temperature set points in non-occupied areas J) improve efficiency of cooling systems through the use of free cooling Maintenance K) stop or reduce ventilation where possible L) ensure system is airtight M) check system is balanced N) manage airflow	HVAC system design is to be matured in FEED. Design of HVAC to refer to BAT requirements listed here.	

Energy Efficiency

Reference		Description	Project Status	Future Actions / Considerations
Energy Efficiency	BAT 28	BAT is to optimise artificial lighting systems by using the techniques such as those below, according to applicability Analysis and design A) Identify illumination requirements in terms of intensity and spectral content requirement for the intended task B) plan space and activities in order to optimise use of natural light C) Selection of fixtures and lamps according to specific requirements for the intended use Operation, control and Maintenance D) use lighting management control systems including occupancy sensors, timers etc. E) Train building occupants to utilise lighting equipment in the most efficient manner	Artificial lighting design is to be matured. Design of lighting systems is to take note of these BAT recommendations in design.	
	BAT 29	BAT is to optimise drying, separation and concentration processes by using techniques such as those below according to applicability, and to seek opportunities to use mechanical separation in conjunction with thermal processes: <u>Design</u> A) Select optimum separation technology or combination of techniques (below) to meet specific process requirements <u>Operation</u> B) Use of surplus heat from other processes C) Use a combination of techniques i) Mechanical processes, e.g. filtration, membrane filtration ii) Thermal processes e.g. direct/indirect heated dryers, multiple effect iii) direct drying (convective) iv) Superheated steam v) Heat Recovery including MVR and heat pumps D) Optimise insulation of the dying system E) Radiation processes e.g. infrared, high frequency and microwave Control F) Process automation in thermal drying process	B) in design, capturing waste heat from the kiln /clinker flue gas via hot oil system to use in the CCU for absorber regeneration. C) Variety of techniques to reuse waste heat is part of the design including -Super heated steam is generated in the CHP boiler. This can also be letdown in event LP steam is not available. - Use of Mechanical Vapor Recompression (MVR) evaporator is under consideration. The MVR would be used to re-compress the overhead vapor (low pressure and temp) from the distillation unit and use this as a heat source to further the vaporisation of the liquid in the distillation vessel. Would save on energy and water requirements. D) Insultation requirements are part of considerations for optimum design process. E) not applicable	0

Energy Efficiency

Reference		Description	Project Status	Future Actions / Considerations
Industrial Cooling	BAT 1	It is BAT in the design phase of a cooling system: A) To reduce resistance to water and airflow B) To apply high efficiency/low energy equipment C) To reduce the amount of energy demanding equipment D) To apply optimised cooling water treatment in once-through systems and wet cooling towers to keep surfaces clean and avoid scaling, fouling and corrosion	Water cooling system design is still maturing and details will be established in FEED.	0
	BAT 3	For energy efficiency of cooling systems, BAT is to A) Apply option for variable operation (i.e., correct sizing and cooling technology for application) B) Apply modulation of air/water flow to avoid instability cavitation in system (corrosion and erosion) C) Apply pumping heads and fans with reduced energy consumption	Water cooling system design is still maturing and details will be established in FEED. Optimisation of cooling tower design to be undertaken in FEED with feedback from OEM.	
	BAT 4	Wet Cooling Systems For Energy Efficiency of wet cooling system, BAT is to A) Optimise water treatment and pipe surface treatment	Water cooling system design is still maturing and details will be established in FEED. Optimisation of cooling tower design to be undertaken in FEED with feedback from OEM	.
Large Combustion Plants	BAT 40	In order to increase the energy efficiency of natural gas combustion, BAT is to use an appropriate combination of the techniques given in LCP BAT 12 and below. - Combined Cycle	The heat generated by the boiler will be used to raise steam to run a steam turbine generator produce electrical power for the Carbon Capture unit	0

Energy Efficiency				
Reference		**Description**	**Project Status**	**Future Actions / Considerations**
Waste Treatment	BAT 2	In order to improve the overall environmental performance of the plant, BAT is to use all of the techniques given below. A) Set up and implement waste characterisation and pre-acceptance procedures B) Set up and implement waste acceptance procedures C) Set up and implement a waste tracking system and inventory D) Set up and implement an output quality management system E) Ensure waste segregation F) Ensure waste compatibility prior to mixing or blending of waste G) Sort incoming solid waste	Interpretation is this BAT is for waste storage facilities, and therefore not fully applicable to the scope of this project. However, generally the plant will be required to implement appropriate waste management procedures for the temporary storage of contaminated effluents, spent containers from chemical delivery (if not immediately returned) etc. Also general (Domestic) wastes from the office blocks (paper, cardboard, plastic, food) etc. The Waste Management plan (Ref 12) is in scope for FEED and will provide the framework for waste management in the project.	

Table 3-4: Energy Efficiency: Emerging and Existing BAT

4. Summary

4.1 Overview

This assessment has collated BAT given in existing BREF and BATC guidance that have relevance to the scope of the Project. As noted in the outset of this assessment, there is no published BAT or BREF specifically addressing post combustion carbon capture in EU guidance and therefore the applicable BAT originates from the Horizonal BAT documents (i.e., those generally applicable across all industries).

However, for a thorough review of future readiness for potential upcoming BAT on carbon capture, the two BAT review studies of emerging technologies for post-combustion carbon capture (Ref 2) and for Hydrogen production with Carbon Capture (Ref 3) have been included in the scope of this assessment.

The list of BAT was screened by applicability to the scope of the project. Those BAT found relevant to the PROJECT design were then categorised by environmental aspect i.e., techniques for minimising emissions to Air and Water, Noise control and improving energy efficiency.

The PROJECT design was then scrutinized against these applicable techniques and use of BAT assessed.

The screened BAT with relevance to the PROJECT are listed in the tables in Section 3 of this report while the full list including non-relevant items has been provided in **Appendix A**.

4.2 BAT Use in Design

The use of BAT in the project design has been assessed using available engineering data available in early FEED phase in the design cycle and indicates good alignment with the horizontal BAT techniques.

The thematic drive of BAT is the reduction of emissions, resource use and energy. The design/project concept includes clear wins in this regard, some of which translate to benefits in efficiency and resources for the existing facility.

The key items include (but not limited to):

- Use of Combined Heat and Power (CHP) with savings in heat/power generation requirements, footprint etc.
- Use of flue gas from existing kiln as combustion air in the CHP boiler (thereby minimising further generation of NOx emissions)
- Use of Waste Heat Recovery to utilise process heat from the existing facility
- Carbon Capture to lower greenhouse gas emissions
- No routine flaring in design

- Use of SCR technology to reduce NOx emissions (from CHP boiler and existing kiln)
- Zero liquid discharge to the environment: Reuse of resources by sending effluent streams to existing cement plant for use in cement production

4.3 Items for Further Consideration

Due to the current stage of the project (early FEED), not all aspects of the design have been looked at in finer detail and therefore it was not possible to evidence these are aligned with BAT at this stage.

This was found to generally apply to individual pieces of equipment such as the motors, pumps, compressors, tank choice, valves etc. It is understood these items will be looked at throughout FEED once the project has reached the point of engagement with specific vendors.

Environmental aspects (i.e., energy and resource efficiency, emissions, waste and noise) form part of the inherent considerations in the choice of equipment balanced alongside technical aspects (i.e., fit for purpose design) and economic considerations. As such it is anticipated that the more general BAT conditions (i.e., opt for energy efficient choice, rationalize number of valves/flanges to reduce potential for leaks etc.) will be captured by inherent design procedure and therefore were not listed for further consideration.

The exception to the above was BAT that stipulate specific choices or requirements (for example keeping fan speed below 40 m/s in the cooling tower to control noise). It was considered prudent to highlight these for consideration in design.

The following items were identified for further consideration.

#	Consideration	Triggering BAT	Report Page
1	Investigate requirement for monitoring of flow and temperature of **flue gas** being sent to the Carbon Capture unit, downstream of the boiler.	Common Waste Gas BAT 7	15
2	Investigate requirement for close drain systems of streams with potential emissions to air (including odorous sources i.e., contaminated site runoff)	Common Waste Gas BAT 15	17
3	Compressor seal choice to align with BAT requirements.	Emissions from Storage BAT 41	20
4	Compressor seal choice to consider BAT requirements.	Emissions from Storage BAT 41	20
5	Assessment of plume height and dispersion from cooling water tower will need to be undertaken to understand potential of a) plume reaching ground level b) plume being drawn into HVAC intakes.	Industrial Cooling BAT 20	21
6	Minimum water velocity in heat exchangers to be confirmed to be above 1.8 m/s in design. Consider requirement for debris filters (due to potential build up of PM in water washes)	Industrial Cooling Systems BAT 12	31
7	Metering and monitoring requirements at inlet (and outlet) of wastewater treatment unit to be matured in FEED.	Industrial Cooling Systems BAT 28	34
		Waste Treatment BAT 52	38

#	Consideration	Triggering BAT	Report Page
8	BAT recommendations for reduction of noise from water cooling tower to be considered in design including limiting fan speed, installing sound attenuators on diffuser, inlet and outlet as applicable.	Industrial Cooling Systems BAT 23	39
9	Project to consider option for use of heat recovery from compressors (if practical)	Emerging Techniques for PCC	41

Appendix A. BAT Assessment Sheet

Emerging Techniques for Post-Combustion Carbon Capture				Screening			
Aspect	Reference	Issue	Options	Implementation Stage	Applicability	Project Status	Recommendations
Atmospheric Emissions	PCC	Reducing SOx Emissions SO_2 and SO3 may arise from odorizes in natural gas or waste gases fired in CCGT plant. SO_2 will react with amines to form heat stable salts (HSS). SO3 will also form HSS and sulphuric acid mist. SO3 if captured by solvent will need to be neutralized.	Alkali additions (prior) to the Direct Carbon Capture (DCC) may be used to remove SO_2 in the flue gas where small amounts (1-10 ppm) of SOx might arise from the fuel.	Design	Applicable	Included in Design of Flue-gas Pre-treatment (Quencher unit). Flue gas (post-boiler) will be quenched with pH regulated circulating water using injected caustic soda (from caustic soda tank) to reduce SO_2 and thereby SO3 (5% generation rate) (Ref Process Description 215000-00190-000-PR-REP-0006)	
Atmospheric Emissions	PCC	Reducing SOx Emissions SO_2 and SO3 may arise from odorizes in natural gas or waste gases fired in CCGT plant. SO_2 will react with amines to form heat stable salts (HSS). SO3 will also form HSS and sulphuric acid mist. SO3 if captured by solvent will need to be neutralized.	SO_3 and other aerosols may be present only intermittently, and possibly also unpredictably, in flue gases entering a PCC system, and their presence may not be known. Extended (i.e., in order of 1 year) pilot testing using actual flue gases and realistic conditions throughout, and over the full range of operating conditions, is recommended. It may be necessary to ensure that potential problems are adequately assessed and that satisfactory management methods are (and can be) implemented.	Design	Applicable	Noted, however CC application has matured since guidance was originally written and now more well understood. SO_2 removal prior to contact with amine is in design (refer to above comment)	
Atmospheric Emissions	PCC	Reducing Amine/Nitro-amine/nitramine Emissions NO_2 will be present in the flue gas which will react with solvent in the capture process to form N-amines.	Sodium sulphite and thiosulphates additions to DCC can be used to remove NO_2 to prevent nitrosamine and nitramine formation.	Design	Applicable	The boiler will include SCR with application to reduce NOx and SO_2 emissions. (Ref Process Description 215000-00190-000-PR-REP-0006)	
Atmospheric Emissions	PCC	Reducing Amine/Nitro-amine/nitramine Emissions NO_2 will be present in the flue gas which will react with solvent in the capture process to form N-amines.	Employ multi-stage water wash system to reduce Amine (and volatile organic compound (VOC) emissions)	Design	Applicable	Absorber design is to include multi stages of washing to reduce the amine emission on the treated gas. (Ref Process Description 215000-00190-000-PR-REP-0006)	
Atmospheric Emissions	PCC	Reducing Amine/Nitro-amine/nitramine Emissions NO_2 will be present in the flue gas which will react with solvent in the capture process to form N-amines.	Amine mist formation in absorber must be prevented. Following techniques can be applied - Brownian diffusion filters - SO_3 removal by acid condensation on surfaces of gas/gas heater - Gradual flue gas cooler	Design	Applicable	To prevent amine mist formation in the absorber, absorber is designed with multi washing stages and propriety demisters are installed to maximise recovery of amine mist from the treated gas. (Ref Process Description 215000-00190-000-PR-REP-0006)	
Atmospheric Emissions	PCC	Reducing Amine/Nitro-amine/nitramine Emissions NO_2 will be present in the flue gas which will react with solvent in the capture process to form N-amines.	To reduce oxidative degradation in the absorber a possible counter measure would be to reduce oxygen levels in flue gas. Options for this are A) (at Source) Increase fuel-air ratio in the CCGT and Aux. Boiler burners B) Removal of dissolved oxygen from rich solvent through membrane to oxygen scavenger (opportunity is still maturing)	Design	Applicable	Requirement for A) or B) is not anticipated due to design including SCR for boiler to meet emission standards	
Atmospheric Emissions	PCC	Ammonia Emissions	Include water wash stage using acid (dilute sulphuric acid for example) to react with ammonia. Implement after the initial water wash. This process will result in additional waste stream of reject sulphuric acid and causes formation of ammonium salts which will need consideration for correct removal and disposal.	Design	Applicable	Acid wash will be included in design of the absorber tower.	
Atmospheric Emissions	PCC	CO_2 capture rate	Ensure "normal" operation CO_2 capture rate is maintained during start-up and shutdown procedures by implementing design provisions such as: A) Segregating the solvent inventory during start-up, with separate solvent circuits around the absorber and stripper B) Providing buffer storage for lean and rich amine to continue capture until Gas Turbine shuts-down C) Heat storage used to cover periods when steam not available D) Provision of auxiliary heating to maintain stripper temperature during periods when plant is offline E) Initiate solvent and water wash flows in absorber prior to CCGT begins firing	Design	Applicable	Note - the design of this plant differs from the referenced GTCC carbon capture plants in that the CHP can be operated independently of the kilns as opposed to the GTCC example where the heat and power are provided by the GTCC. Therefore not all these techniques are applicable. A) Segregation inventory during start-up is not considered as all the available inventories i.e., fresh solvent tank, solvent tank, and solvent sump tank are used to support whole CCU system (absorber and regenerator). B) During normal operation, the solvent will always circulate in the system and in case the lean solvent in the system needs make-up (concentration reduced), fresh solvent (70% wt) will be supplied to the system from Fresh Solvent Tank. In the case of system shut down for maintenance/inspection, solvent from the system will be transferred to the Solvent Tank C) Not applicable D) Boiler can be operated independently from steam plant to provide for heat requirements. E) Solvent and water systems can be stated independently of the cement facility. Initiating solvent and wash water circulation in absorber requires power from CHP. It has been considered in the Pre-FEED that for first start-up the CHP, ~1.8 MW power will be imported from the grid. Once the CHP can supply power to the CCU, solvent and water wash circulation	
Atmospheric Emissions	PCC	Venting and Fugitives	All open-ended lines need caps or secondary valves to seal each line	Design	Applicable	Part of standard design procedures	

Emerging Techniques for Post-Combustion Carbon Capture				Screening			
Aspect	Reference	Issue	Options	Implementation Stage	Applicability	Project Status	Recommendations
Atmospheric Emissions	PCC		Process stream components such as piping joints, flanges drain valves and capped lines will need to be maintained and monitored under an appropriate Leak Detection and Repair (LDAR) system.	Operation			
Atmospheric Emissions	PCC	Monitoring	Stack emissions will need to be measured continuously to verify, as far as possible, satisfactory plant operation. (Note - Refer to LCP BAT 4)	Operation			
Energy Efficiency	PCC	Monitoring	Resolution limits for continuous emission monitoring systems (CEMS) will need to be established from offline analysis of absorber flue gas. Samples should be taken at times considered representative of "normal" plant operation. Identifying "normal" performance will be based on number of indicators, such as - Amine and other emissions that can be measured by online instruments - Absorber exit flue gas temperature & humidity - Water wash temperature & pH values - Water wash circulating flows - Incoming flue gas properties	Operation			
Energy Efficiency	PCC	Cooling (flue gas)	The flue gas may be cooled by heat transfer to low pressure steam, heat transfer fluids or in a gas/gas heater. Recovered heat could be used to offset some of the solvent regeneration energy (although temperatures will limit the scope for this), to reheat the flue gases post absorber. The following hierarchy of cooling methods should be applied A) Direct Water Cooling B) Wet Cooling Towers C) Hybrid Cooling Towers D) Dry Cooling (i.e., direct air-cooled condensers and dry cooling towers)	Design	Applicable	Waste heat recovery included in Design. Heat will be recovered from two new exchangers, one from kiln flue gases out of cement plant pre-heating tower (PHT) and another recovering heat from the hot air leaving the clinker cooler. Heat Transfer Fluid (HTF) will be used to recover the heat and produce low pressure steam in HTF Evaporator. LP Steam is used in regenerator and reclaimer (ref process description 215000-00190-000-PR-REP-0006) Cooling will primarily met by the recirculating hybrid (wet-dry) cooling system. Air cooling will be used where practical to reduce water requirements (Ref cooling medium study 415000-	
Energy Efficiency	PCC	CO_2 Compressors	The choice of CO_2 compressors should be based on expected duty. Integrally geared units should be used for maximum efficiency and rationalisation of required number of compression trains. Feasible use of waste heat generated from compressors should be considered as additional efficiency improvement.	Design	Applicable	Specifics on the compressors are still in development and will be established in FEED.	Project to consider option for use of heat recovery from compressors (if practical)

Aspect	Techniques/ Technology / Approach				Implementation Stage	Applicability	Project Status	Recommended actions
Atmospheric Emissions	ETBH	CO_2 Capture		A design CO_2 capture rate of 95% or greater is expected to be achievable for the hydrogen production and CO_2 capture routes considered for new plant.	Design	Applicable	Note - wording is for H_2 production, which is not applicable to the scope of this project. However the project's Carbon Capture Unit is to achieve 95% capture rate of the total CO_2 from existing Cement Kiln and from a new Combined Heat and Power (CHP).	
Atmospheric Emissions	ETBH	Decarbonisation readiness and future proofing		This applies to England and Wales only. It does not apply currently to Scotland and Northern Ireland. There was a call for evidence by BEIS and the Welsh Government on decarbonisation readiness from July to September 2021.The government is currently analysing the results (correct as of July 2022). Decarbonisation readiness: call for evidence on the expansion of the 2009 Carbon Capture Readiness requirements - GOV.UK (www.gov.uk). The consultation includes the proposal that the requirement for all combustion processes (with no de minimis) to be decarbonisation ready be included in the Environmental Permitting Regulations (England and Wales) 2016. There are some streams, for example, the flue gases from combustion of residual (tail) gas from the hydrogen purification process with a relatively high CO_2 concentration which may need to be decarbonised in future and should therefore be made decarbonisation ready by maintaining the necessary space and technical retrofit capability for future carbon capture.	Design	Applicable	Footprint for Carbon capture unit is inherently part of this design	
Emissions to Water	ETBH	Water Use		All waste water streams are to be identified, including process condensate and other effluents such as steam system blowdown, cooling water blowdown, rain water, oily water, water treatment effluent and water used for cleaning. Suitable segregation strategies and methods of treatment to meet discharge consent limits are to be defined.	Design	Applicable	Wastewater/effluent stream segregation is part of design (ref process description) Details of effluent stream handling/drainage shall be detailed in drainage philosophy 215000-00190-000-PR-PHL-00004.	
Emissions to Water	ETBH	Water Use		Water consumption and volume of contaminated water should be minimised through design of the hydrogen production process, optimisation of water management through segregation of contaminated water streams (from water wash, condensate) and of noncontaminated water streams (once through cooling, rain water).	Design	Applicable	Wording is for H_2 production therefore not directly applicable, however thematic approach to correct segregation of contaminated and non-contaminated streams is applicable and part of design (ref process description)	
Emissions to Water	ETBH	Water Treatment		Water treatment should follow the most apt source of emissions limits on a case by case basis, between the existing BAT conclusions for common waste water and waste gas treatment / management systems in the chemical sector (2016/902/EU) and BAT conclusions for the refining of mineral oil and gas (2014/738/EU) and the associated BRef.	Design	Not Applicable	Part of standard design processes and considerations to minimise noise where possible via incorporating noise level requirements in vendor quotes and appropriate site layout to avoid direct line between	
Atmospheric Emissions	ETBH	Reliability/availability		A risk-based Other Than Normal Operating Condition (OTNOC) management plan should be implemented which identifies potential scenarios, mitigation measures (for example, around design and maintenance of equipment critical to avoiding emissions), monitoring and periodic assessment. Target availability for systems critical to environmental performance should be established, with proposed configuration supported by reliability, availability, and maintainability assessments.	Design	Applicable	Assessment of availability will be undertaken in FEED. RAM analysis will be performed as part of FEED. Ref RAM report - 215000-00191-000-EM-REP-00002	
Atmospheric Emissions	ETBH	RAM		It is expected that all hydrogen production plants will provide a level of flexibility, at least for example in terms of production capacity range. Applicants should identify performance at steady-state across the proposed production capacity range from minimum turndown to maximum production. Flexible operating scenarios, including 'off-design' scenarios, where environmental performance will be reduced, or where additional emissions are expected, should also be identified, with examples including: A) rapid changes in capacity B) demand for hydrogen below minimum turndown production capacity with the need for hydrogen to be temporarily flared	Design	Not Applicable	No H_2 production in scope	
Atmospheric Emissions	ETBH	Monitoring		Monitoring of emissions to air, will be required based on expected pollutants (for example, ammonia, amine compounds, SO_2, NOx, CO, and so on) with appropriate methods and measuring techniques employed. Monitoring shall consider, for example: A) NOx and CO emissions from combustion B) SO_2 emissions from combustion where the fuel source contains sulphur C) ammonia emissions where SCR / SNCR is employed D) amine / amine degradation products and other volatile solvent emissions E) methane F) hydrogen	Design	Applicable	The (new) stack will be subject to Continuous emission monitoring of flue gas pollutant concentrations including NOx, SO_2, CO, PM, Ammonia, Amine. Full requirements are detailed in the Environmental Basis of Design.	
Atmospheric Emissions	ETBH			Monitoring of emissions to water, will be required based on expected impurities (for example, ammonia, amine compounds, methanol, CO_2, and so on) with appropriate methods and measuring techniques employed. Monitoring standards for discharges to water should follow the existing BAT conclusions for Common Waste Water and Waste Gas Treatment / Management System in the Chemical Sector (2016/902/EU)	Design	Not Applicable	No discharges of wastewater in design	
Atmospheric Emissions	ETBH	CO_2 Capture Monitoring		Applicants should clearly identify how the CO_2 capture performance of the plant will be monitored. CO_2 capture performance is expected to be monitored according to standards that are recognised under the UK ETS. Measurements required to monitor CO_2 emissions to atmosphere may, for example, include direct measurement of the flow and composition of fuel gas to combustion systems.	Design	Applicable	CO_2 metering is included in design of facility which will record quantity of CO_2 sent down export line, and therefore allow for monitoring of CO_2 levels.	
Atmospheric Emissions	ETBH			Strategies to reduce flaring and associated emissions should be established, including: A) flaring rather than venting, where emissions cannot be eliminated and where practicable, to minimise emissions of higher global warming potential gases such as methane and hydrogen B) plant design to maximise equipment availability and reliability C) minimising emissions under start-up, shutdown, and abnormal operations. Means of achieving this include: o use of a flare gas recovery system with adequate capacity o routing gas that would be flared to alternative users o use of high integrity relief valves o other measures to limit flaring to other than normal operations D) managing production of off-gas and balance against requirements for fuel gas using advanced process control and so on E) special procedures to define operations including start-up and shutdown, maintenance work and cleaning. F) robust commissioning and handover procedures to ensure that the plant is installed in line with the design requirements G) robust return-to-service procedures to ensure that the plant is recommissioned and handed over in line with the operational requirements H) flaring devices design to enable smokeless and reliable operations and to ensure an efficient combustion of excess gases when flaring under other than normal operations I) monitoring and reporting of gas sent to flaring and associated parameters of combustion	Design	Not Applicable	No flaring in design	

Aspect	Techniques/ Technology / Approach				Implementation Stage	Applicability	Project Status	Recommended actions
Atmospheric Emissions	ETBH			Applicant should identify venting and purging requirements in each of the processes employed, noting whether either continuous or intermittent, and identifying pollutants expected to be present, including for example CO_2, carbon monoxide, methane, hydrogen, ammonia vapour or methanol vapour	Design	Applicable	Venting requirements have been identified. Following sources are in design Normal Operation: 1) O_2 vent from the hydrogen generation unit. Vented locally. 2) Treated flue gas (post-CO_2 removal) including standard combustion pollutants of NOx, SOx, CO etc 3) Ammonia bullet breather vent 4) Steam - intermittent steam venting from the steam system for safety 5) Reclaimer vent captured by CO_2 header and sent to stack. During Start-up/shutdown/abnormal operation: 6) CO_2 venting. CO_2 will be recombined with the untreated and treated flue gas and sent to the new stack for emission to atmosphere. 7) Treated and untreated flue gas via new stack. 8) H_2 venting from the hydrogen generation unit - intermittent venting during start-up/shutdown which will be routed to safe location. 9) Venting from fuel gas system (over pressure) - safe area vent. Reference ENVID Workshop/ENVID report 215000-	
Atmospheric Emissions	ETBH			For each Vent emissions point, an environmental risk assessment shall be made, against the applicable Environmental Assessment Level (EAL), in accordance with the relevant Regulator's standard methodologies. This should include justification for venting to atmosphere vs. routing to flare and identification any measures proposed to reduce emissions of pollutants or ensure adequate dispersion.	Design	Applicable	Selective Catalyst Reduction (SCR) is part of design for the boiler package and will reduce NOx emissions for compliance with permit emission limits. Emissions from existing kiln are regulated by existing permit conditions. O_2 and H_2 have no permit discharge limits. Other vent sources are intermittent and/or very small so limited impact.	
Atmospheric Emissions	ETBH			Methane and hydrogen greenhouse gas emissions shall be eliminated as far as practicable.	Design	Applicable	Scope of project is to reduce CO_2 emissions by 95% from existing facility.	
Atmospheric Emissions	ETBH	Loss of Containment		Strategies to the reduce the potential for loss of containment and minimise environmental impacts should be established, for example: A) use of special procedures and/or temporary equipment to maintain performance when necessary to manage special circumstances such as spills, leaks, and so on B) use of a risk based leak detection and repair programme where applicable in order to identify leaking components and to repair these leaks C) plant design to facilitate monitoring and maintenance activities by ensuring accessibility D) selection of high integrity equipment where available E) plant design to maximise inherent process containment feature	Design	Applicable	Part of inherent design process for the plant. No containment concerns (i.e., requirement for further mitigations outside those of standard design processes) were identified in the ENVID.	
Atmospheric Emissions	ETBH	LDAR		A leak detection and repair programme should be proposed, using industry best practice to manage releases from joints, flanges, seals and glands, and so on. The proposals shall be appropriate to the capture solvents and other fluids used in the process.	Operation			
Noise Emissions	ETBH			BAT is to be implemented for prevention or reduction of noise, with a plan for management of noise developed as appropriate to the local environment. Noise reduction techniques to be considered where necessary to include use of acoustic insulation or enclosures or screening through use of embankments or walls.	Design	Applicable	Part of standard design processes and considerations to minimise noise where possible via incorporating noise level requirements in vendor quotes and appropriate site layout to avoid direct line between noisy equipment and neighbours as far as practical and possible. Action was raised in ENVID (#4) to identify sound sources for facility and undertake noise assessment to determine noise levels at neighbouring sites/residential areas. (Ref ENVID report 215000-	
Noise Emissions	ETBH			Equipment generating noise should be identified at the design stage, and their environmental performance should be considered for intended operations, including: A) an environmental noise assessment B) a noise management plan C) plant design to consider the selection of enclosures of noisy equipment or operations D) plant design to consider the location of noisy equipment or operations E) plant design to consider the use of embankments to screen the source of noise F) plant design to consider the use of noise protection wall	Design	Applicable	ENVID actions were identified (see above)	

Energy Efficiency Reference Document					Screening			
Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status	Further Actions
Energy Efficiency	General	EE	BAT 1	BAT is to implement and adhere to an energy efficiency management system (ENEMS) that incorporates, as appropriate to the local circumstances, all of the following features A) commitment of top management B) definition of an energy efficiency policy for the installation by top management D) planning and establishing objectives and targets D) implementation and operation of procedures E) benchmarking F) checking performance and taking corrective action G) review of the ENEMS and its continuing suitability, adequacy and effectiveness by top management	Operation			
Energy Efficiency	General	EE	BAT 2	BAT is to continuously minimise the environmental impact of an installation by planning actions and investments on an integrated basis and for the short, medium and long term, considering the cost-benefits and cross-media effects.	Operation			
Energy Efficiency	Monitoring and Maintenance	EE	BAT 3	BAT is to identify the aspects of an installation that influence energy efficiency by carrying out an audit. It is important that an audit is coherent with a systems approach (see EE BAT 7).	Operation			
Energy Efficiency	Monitoring and Maintenance	EE	BAT 4	When carrying out an audit, BAT is to ensure that the audit identifies the following aspects A) energy use and type in the installation and its component systems and processes B) energy-using equipment, and the type and quantity of energy used in the installation C) possibilities to minimise energy D) possibilities to use alternative sources or use of energy that is more efficient E) possibilities to apply energy surplus to other processes and/or systems F) possibilities to upgrade heat quality	Operation			
Energy Efficiency	General	EE	BAT 5	BAT is to use appropriate tools or methodologies to assist with identifying and quantifying energy optimisation, such as: A) energy models, databases and balances B) a technique such as pinch methodology C) estimates and calculations	Design	Applicable	Engineering studies will be carried out as part of the inherent design process to determine energy savings in design where applicable. Current studies are the Combined heat and power study (415000-00299-00-PR-REP-00001) Waste heat utilisation study (415000-00299-00-PR-REP-000002) Cooling Medium Study (415000-002999000-PR-REP-000003)	
Energy Efficiency	General	EE	BAT 6	BAT is to identify opportunities to optimise energy recovery within the installation, between systems within the installation (see EE BAT 7) and/or with a third party (or parties).	Design	Applicable	Design is to send flue gas from the kiln to the boiler rather than bringing air into the burners resulting in lower amounts of flue gas being generated, reduced NOx emissions and reducing energy requirements for treatment. Waste heat recovery included in Design. Heat will be recovered from two new exchangers, one from kiln flue gases out of cement plant pre-heating tower (PHT) and another recovering heat from the hot air leaving the clinker cooler. Heat Transfer Fluid (HTF) will be used to recover the heat and produce low pressure steam in HTF Evaporator. LP Steam is used in regenerator and reclaimer (ref process description 215000-00190-000-PR-REP-0006) Suggested use of a mechanical vapor recompressor (MVR) evaporator in place of a multi-effect evaporator for the re-compression of the secondary vapor from the Ultrafiltration/Reverse Osmosis units. Theoretical energy savings of 50% energy and	
Energy Efficiency	General	EE	BAT 7	BAT is to optimise energy efficiency by taking a systems approach to energy management in the installation. Systems to be considered for optimising as a whole are, for example: BAT is to optimise energy efficiency by taking a systems approach to energy management in the installation. Systems to be considered for optimising as a whole are, for example: A) process units B) heating systems (steam/hot water) C) Cooling and vacuum D) motor driven system etc. - process units - heating systems (steam/hot water) - cooling and vacuum	Design	Applicable	Part of inherent design engineering process. Studies to look at various aspects of the project where technology package options exist and recommend best option based on number of criteria including practicality, energy, cost etc. Examples include Combined heat and power study (415000-00299-00-PR-REP-00001) Waste heat utilisation study (415000-00299-00-PR-REP-000002) Cooling Medium Study (415000-002999000-	

Energy Efficiency Reference Document					Screening			
Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status	Further Actions
Energy Efficiency	Monitoring and Maintenance	EE	BAT 8	BAT is to establish energy efficiency indicators by carrying out all of the following A) identifying suitable energy efficiency indicators for the installation, and where necessary, individual processes, systems and/or units, and measure their change over time or after the implementation of energy efficiency measures B) identifying and recording appropriate boundaries associated with the indicators C) identifying and recording factors that can cause variation in the energy efficiency of the relevant process, systems and/or units	Operation			
Energy Efficiency	Monitoring and Maintenance	EE	BAT 9	BAT is to carry out systematic and regular comparisons with sector, national or regional benchmarks, where validated data are available	Operation			
Energy Efficiency	General	EE	BAT 10	BAT is to optimise energy efficiency when planning a new installation, unit or system or a significant upgrade by considering all of the following: A) the energy-efficient design (EED) should be initiated at the early stages of the conceptual design/basic design phase, even though the planned investments may not be well-defined. The EED should also be taken into account in the tendering process B) the development and/or selection of energy-efficient technologies - additional data collection may need to be carried out as part of the design project or separately to supplement existing data or fill gaps in knowledge C) The EED work should be carried out by an energy expert D) The initial mapping of energy consumption should also address which parties in the project organisations influence the future energy consumption, and should optimise the energy efficiency design of the future plant with them. For example, the staff in the (existing) installation who may be responsible for specifying design parameters.	Design	Applicable	A) part of inherent design of the facility. See comments made to EE BAT 6 and 7 above B) Energy efficiency is criteria for choice of technology/packages and covered in comparative studies (see EE BAT 7). C) Design is carried out by suitably experienced engineers, and as part of Worley process reviewed by disciplines. D) High level energy consumption mapping to be undertaken as part of the GHG and Energy	
Energy Efficiency	General	EE	BAT 11	BAT is to seek to optimise the use of energy between more than one process or system, within the installation or with a third party.	Design	Applicable	Waste heat recovery is included in design. Refer to comments on BAT above for more specifics	
Energy Efficiency	General	EE	BAT 12	BAT is to maintain the impetus of the energy efficiency programme by using a variety of techniques, such as: A) Implementing a specific energy efficiency management system (see EE BAT 1) B) Accounting for energy usage based on real (metered) values, which places both the obligation and credit for energy efficiency on the user/bill payer C) The creation of financial profit centres for energy efficiency (see Section 2.5) D) Benchmarking E) A fresh look at existing management systems, such as using operational excellence F) Using change management techniques	Operation			
Energy Efficiency	General	EE	BAT 13	BAT is to maintain expertise in energy efficiency and energy-using systems by using techniques such as: A) Recruitment of skilled staff and/or training of staff. Training can be delivered by in-house staff, by external experts, by formal courses or by self-study/development B) Taking staff off-line periodically to perform fixed term/specific investigations (in their original installation or in others) C) Sharing in-house resources between sites (see Section 2.5) D) Use of appropriately skilled consultants for fixed term investigations E) Outsourcing specialist systems and/or functions	Operation			
Energy Efficiency	General	EE	BAT 14	BAT is to ensure that the effective control of processes is implemented by techniques such as: A) Having systems in place to ensure that procedures are known, understood and complied with B) Ensuring that the key performance parameters are identified, optimised for energy efficiency and monitored C) Documenting or recording these parameters.	Operation			
Energy Efficiency	Monitoring and Maintenance	EE	BAT 15	BAT is to carry out maintenance at installations to optimise energy efficiency by applying all of the following: 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 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	Operation			
Energy Efficiency	Monitoring and Maintenance	EE	BAT 16	BAT is to establish and maintain documented procedures to monitor and measure, on a regular basis, the key characteristics of operations and activities that can have a significant impact on energy efficiency	Operation			
Energy Efficiency	Heat and Steam	EE	BAT 17	BAT is to optimise the energy efficiency of combustion by relevant techniques such as those specific to sectors given in vertical BREFs	Design	Applicable	Part of design. Note the LCP BAT will be reviewed as part of this BAT assessment	

Energy Efficiency Reference Document					Screening			
Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status	Further Actions
Energy Efficiency	Heat and Steam	EE	BAT 18	BAT for steam systems is to optimise the energy efficiency by using techniques such as those specific to sectors given in vertical BREFs	Design	Applicable	Part of standard design processes and considerations to minimise noise where possible via incorporating noise level requirements in vendor quotes and appropriate site layout to avoid direct line between noisy equipment and neighbours as far as practical and possible. Action was raised in ENVID (#4) to identify sound sources for facility and undertake noise assessment to determine noise levels at	
Energy Efficiency	Heat	EE	BAT 19	BAT is to maintain the efficiency of heat exchangers by both: A) monitoring the efficiency periodically, and B) preventing or removing fouling	Operation			
Energy Efficiency	Power Supply	EE	BAT 20	BAT is to seek possibilities for cogeneration, inside and/or outside the installation (with a third party)	Design	Applicable	Combined Heat and Power system is embedded in design.	
Energy Efficiency	Power Supply	EE	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 below, according to applicability: A) Installing capacitors in the AC circuits to decrease the magnitude of reactive power B) Minimising the operation of idling or lightly loaded motors C) Avoiding the operation of equipment above its rated voltage D) When replacing motors, using energy efficient motors	Design	Applicable	Electrical design of the plant is maturing. Aspects A-C would be covered by inherent design processes. D) is not applicable as no motors are being replaced	
Energy Efficiency	Power Supply	EE	BAT 22	BAT is to check the power supply for harmonics and apply filters if required	Design	Applicable	Part of inherent electrical design.	
Energy Efficiency	Power Supply	EE	BAT 23	BAT is to optimise the power supply efficiency by using techniques such as those in below, according to applicability: A) Ensure power cables have the correct dimensions for the power demand B) keep online transformer(s) operating at a load above 40 - 50 % of the rated power C) Use high-efficiency/low loss transformers D) Place equipment with a high current demand as close as possible to the power source (e.g. transformer)	Design	Applicable	These aspects would be covered as part of the inherent electrical design process. A) sizing calculations will be undertaken B) right sizing of the transformer for the intended operation is part of design process – electrical load lists will be produced to inform site demand C) Electrical design criteria indicates Tier 2 to meet Ecodesign directive D) Electrical team are included in site layout	
Energy Efficiency	Motors	EE	BAT 24	BAT is to optimise electric motors in the following order Installation/Refurbishment A) Using energy-efficient motors B) Proper motor Sizing C) Installing variable speed drives (VSD) D) Installing high-efficiency transmission/reducers E) Use of direct coupling where possible ; synchronous belts or cogged v-belts in place of v-gelts; helical gears in place or worm gears F) energy efficient motor report or replacement with an energy efficient motor G) Rewinding: avoid rewinding and replace with an energy efficient motor or use certified rewinding contractor power quality control System operation and Maintenance	Design	Applicable	Design/choice of motors is to be progressed with feedback from vendors. However, energy efficiency, correctly sized and where practical VSD motors are to be part of motor choice.	
Energy Efficiency	Compressed Air	EE	BAT 25	BAT is to optimise compressed air systems (CAS) using the techniques such as those below, according to applicability Installation and refurbishment A) overall system design, including multi-pressure systems B) upgrade compressor C) improve cooling, drying and filtering D) reduce frictional pressure losses (for example increasing piping diameter) Improvement of drives (i.e., installing high energy efficiency motors and speed control) E) use of sophisticated control systems F) Recover waste heat for use in other functions G) use external cool air as intake H) storage of compressed air near highly fluctuation uses System Operation and Maintenance I) optimise certain end use devices J) reduce air leaks	Design	Applicable	Compressed air system design is still in early days and will be established within FEED.	Design of the compressed air system is to take into account these BAT requirements.

Energy Efficiency Reference Document					Screening			
Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status	Further Actions
Energy Efficiency	Pumping	EE	BAT 26	BAT is to optimise pumping systems by using the techniques below, according to applicability A) Avoid oversizing when selecting pumps and replacing oversized pumps B) Match the correct choice of pump to the correct motor for the duty C) Design of pipework system D) Control and regulation system E) Shutdown unnecessary pumps F) Use VSD G) Use multiple pumps (staged cut in) H) Regular maintenance I) Minimise the number of valves and bends commensurate with keeping ease of operation and maintenance J) Avoid using too many bends (especially tight bends) k) Ensuring the pipework diameter is not too small	Design	Applicable	Specifics are yet to be looked at however these aspects would be covered as part of the inherent design philosophy of pumping system.	
Energy Efficiency	HVAC	EE	BAT 27	BAT is to optimise heating, ventilation and air conditioning systems by using techniques such as: - for heating, see EE BAT 18 and 19 - for pumping, see EE BAT 26 - for cooling, chilling and heat exchangers, see EE BAT 19 for ventilation, space heating and cooling, techniques below according to applicability <u>Design and control</u> Overall system design, identify and equip areas separately for general, specific and process ventilation. A) Optimise the number, shape and size of intakes B) use fans of high efficiency designed to operate at optimal rate C) manage airflow, including considering dual flow ventilation D) Air system design: ducts are of sufficient size, circular ducts, avoid long runs and obstacles/ bends etc E) Optimise electric motors and consider installing VSD F) Use automatic control systems. Integrate with centralised technical management systems G) Integration of air filters into air duct system and heat recovery from exhaust air (heat exchangers) H) reduce heating/cooling needs through insulation, efficiency glazing, air infiltration reduction, auto closing doors, reduction of set point for heating and raising it for cooling etc.. I) improve the efficiency of heating systems through recovery/use of wasted heat, heat pumps, radiative and local heating systems coupled with reduced temperature set points in non-occupied areas J) improve efficiency of cooling systems through the use of free cooling <u>Maintenance</u> K) stop or reduce ventilation where possible L) ensure system is airtight M) check system is balanced	Design	Applicable	HVAC system design is to be matured in FEED. Design of HVAC to refer to BAT requirements listed here.	
Energy Efficiency	Lighting	EE	BAT 28	BAT is to optimise artificial lighting systems by using the techniques such as those below, according to applicability Analysis and design A) Identify illumination requirements in terms of intensity and spectral content requirement for the intended task B) plan space and activities in order to optimise use of natural light C) Selection of fixtures and lamps according to specific requirements for the intended use Operation, control and Maintenance D) use lighting management control systems including occupancy sensors, timers etc. E) Train building occupants to utilise lighting equipment in the most efficient manner	Design	Applicable	Artificial lighting design is to be matured. Design of lighting systems is to take note of these BAT recommendations in design.	
Energy Efficiency	Drying	EE	BAT 29	BAT is to optimise drying, separation and concentration processes by using techniques such as those below according to applicability, and to seek opportunities to use mechanical separation in conjunction with thermal processes: <u>Design</u> A) Select optimum separation technology or combination of techniques (below) to meet specific process requirements <u>Operation</u> B) Use of surplus heat from other processes C) Use a combination of techniques i) Mechanical processes, e.g. filtration, membrane filtration ii) Thermal processes e.g. direct/indirect heated dryers, multiple effect iii) direct drying (convective) iv) Superheated steam v) Heat Recovery including MVR and heat pumps D) Optimise insulation of the dying system E) Radiation processes e.g. infrared, high frequency and microwave <u>Control</u> F) Process automation in thermal drying process	Design	Applicable	B) in design, capturing waste heat from the kiln /clinker flue gas via hot oil system to use in the CCU for absorber regeneration. C) Variety of techniques to reuse waste heat is part of the design including -Super heated steam is generated in the CHP boiler. This can also be letdown in event LP steam is not available. - Use of Mechanical Vapor Recompression (MVR) evaporator is under consideration. The MVR would be used to re-compress the overhead vapor (low pressure and temp) from the distillation unit and use this as a heat source to further the vaporisation of the liquid in the distillation vessel. Would save on energy and water requirements. D) Insultation requirements are part of considerations for optimum design process.	

Common Waste Gas Treatment and Management Systems in the Chemical Sector					Screening			
Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status	Further recommendations
Operation/Management	Management	CWG	BAT 1	In order to improve the overall environmental performance, BAT is to implement and adhere to an environmental management system (EMS)	Operation			
Operation/Management	Management	CWG	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 emissions to air, as part of the environmental management system (see CWS BAT 1)	Operation			
Operation/Management	Management	CWG	BAT 3	In order to reduce the frequency of the occurrence of Other Than Normal Operating Conditions (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 CWS BAT 1).	Operation			
Atmospheric Emissions		CWG	BAT 4	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 integrated waste gas management and treatment strategy is based on the inventory in CWS BAT 2. It takes into account factors such as greenhouse gas emissions and the consumption or reuse of energy, water and materials associated with the use of the different techniques.	Design	Applicable	This is in core design and objective of the project. The flue gas from the existing kiln and new CHP boiler will undergo the following key treatments - SCR (CHP boiler package) is used to reduce NOX emissions from the boiler. - CCU will recover (up to 95%) of CO_2 from the flue gas streams from the existing kiln and new boiler. - Waterwash tower will be used to reduce amine emissions. Other emission sources (i.e., O_2 venting, intermittent H2 venting and N2 gas blanket venting from storage tanks will not require treatment)	
Atmospheric Emissions		CWG	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	Design	Applicable	Part of design. Normally treated flue gas will be emitted via the new stack. In event where the carbon capture unit is not available, flue gas from the boiler can be routed directly to the new stack. In events where CO_2 export is not possible (startup/shutdown/upset) CO_2 is recombined with the treated flue gas and emitted.	
Atmospheric Emissions		CWG	BAT 6	BAT is to ensure that the waste gas treatment systems are A) appropriately designed (e.g. considering the maximum flow rate and pollutant concentrations), B) operated within their design ranges, and C) maintained (through preventive, corrective, regular and unplanned maintenance) so as to ensure optimal availability, effectiveness and efficiency of the equipment.	Design	Applicable	Part of inherent design process	
Atmospheric Emissions	Monitoring	CWG	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.	Design	Applicable	CO_2 metering package is included in Design	Requirement for flow and temperature monitoring of the flue gas as it enters the carbon capture unit to be [illegible]
Atmospheric Emissions	Monitoring	CWG	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. SEE COMMON WASTE GAS Table 1	Operation			
Atmospheric Emissions	Organic Compounds sent to Waste Treatment	CWG	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. a. Absorption (regenerative) b. Adsorption (regenerative) c. Condensation Recovery may be restricted where the energy demand is excessive due to the low concentration of the compound(s) concerned in the process off-gas(es). Reuse may be restricted due to product quality specifications.	Design	Applicable	CO_2 capture is part of design. No further practical use for the treated flue gas in design.	
Atmospheric Emissions	Organic Compounds sent to Waste Treatment	CWG	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.	Design	Not Applicable	See comment to BAT 9 above	
Atmospheric Emissions	Organic Compounds sent to Waste Treatment	CWG	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. a. Adsorption - Generally applicable. b. Absorption -Generally applicable. c. Catalytic oxidation - Applicability may be restricted by the presence of catalyst poisons in the waste gases. d. Condensation - Generally applicable. e. Thermal oxidation - Applicability of recuperative and regenerative thermal 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. f. Bioprocesses - Only applicable to the treatment of biodegradable compounds.	Design	Not Applicable	H2 is vented intermittently and in small quantities during start-up/shutdown/upset conditions. No alternative disposal route practical (i.e., flare would be more environmentally impactful for disposing of such intermittent vents)	
Atmospheric Emissions	thermal treatment	CWG	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. A) Optimised Catalytic /thermal oxidation B) Rapid Waste-gas cooling C) Adsorption using activated carbon D) Absorption E) Selective Catalytic reduction (SCR)	Design	Not Applicable	Flue gas not anticipated to contain chlorine or chlorinated compounds	

<table>
<tr><th colspan="6">Common Waste Gas Treatment and Management Systems in the Chemical Sector</th><th colspan="2">Screening</th><th colspan="2"></th></tr>
<tr><th>Aspect</th><th></th><th colspan="2">BAT Reference</th><th>Description</th><th>Implementation Stage</th><th>Applicability</th><th>Project Status</th><th>Further recommendations</th></tr>
<tr><td>Atmospheric Emissions</td><td>thermal treatment</td><td>CWG</td><td>BAT 13</td><td>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.
A) Cyclone
B) Fabric Filter
C) Absorption</td><td>Design</td><td>Applicable</td><td>Quencher column is in design which removes salts from the flue gas. These form a slurry which is sent to the cement plant for use in the cement production.</td><td></td></tr>
<tr><td>Atmospheric Emissions</td><td>thermal treatment</td><td>CWG</td><td>BAT 14</td><td>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.
A) Absolute Filter
B) Absorption
C) Fabric Filter
D) High Efficiency Air Filter
E) Cyclone
F) Electrostatic precipitator</td><td>Design</td><td>Not Applicable</td><td>Natural gas combustion results in low levels of PM. Not anticipated to be a emission limit compliance issue.
No identified required for further mitigation measures.</td><td></td></tr>
<tr><td>Atmospheric Emissions</td><td>thermal treatment</td><td>CWG</td><td>BAT 15</td><td>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.</td><td>Design</td><td>Not Applicable</td><td>No practical use of low levels of inorganic compounds.</td><td></td></tr>
<tr><td>Atmospheric Emissions</td><td>thermal treatment</td><td>CWG</td><td>BAT 16</td><td>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.
A) Choice of Fuel (primarily targets ... NOx & SOX)
B) Low NOx burner (NOx only)
C) Optimisation of catalytic or thermal oxidation (CO & NOx)
D) Removal of high levels of NOx precursors (NOx)
E) Absorption (SOx)
F) Selective Catalytic Reduction (NOx)
G) Selective non-Catalytic Reduction (NOx)</td><td>Design</td><td>Applicable</td><td>Option G) SCR is within design to reduce NOx emission levels and ensure compliance with permit levels.
SOx and CO emissions from natural gas combustion are not anticipated to pose a compliance issue.</td><td></td></tr>
<tr><td>Atmospheric Emissions</td><td>ammonia</td><td>CWG</td><td>BAT 17</td><td>In order to reduce channelled emissions to air of ammonia from the use of SCR or SNCR for the abatement of NOX emissions (ammonia slip), BAT is to optimise the design and/or operation of SCR or SNCR
i.e., optimised reagent to NOX ratio, homogeneous reagent distribution and optimum size of the reagent drops.</td><td>Design</td><td>Applicable</td><td>BAT consideration is in design of the SCR.
Refer to process description (215000-00190-000-PR-REP-0006) which directly mentions ammonia slip issue and options to reduce, including
1) uniformly distributed inject of Ammonia across catalyst bed
2) potential option for ammonia slip catalysis downstream of SCR for additional NOX removal and also CO reduction which will be explored further in FEED if deemed</td><td></td></tr>
<tr><td>Atmospheric Emissions</td><td></td><td>CWG</td><td>BAT 18</td><td>In order to reduce channelled emissions to air of inorganic compounds other than channelled emissions to air of ammonia from the use of SCR/SNCR, 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 (Cl_2, HCl, HCN, HF, NH3, NOX, SOX)
B) Adsorption (HCl, HF, NH3, SOx)
C) SCR (NOx)
D) SNCR (NOx)
Techniques not primarily used to reduce inorganic compound emissions:
E) Catalytic Oxidation (NH3)
F) Thermal Oxidation (NH3, HCN)</td><td>Design</td><td>Applicable</td><td>Part of standard design processes and considerations to minimise noise where possible via incorporating noise level requirements in vendor quotes and appropriate site layout to avoid direct line between noisy equipment and neighbours as far as practical and possible.

Action was raised in ENVID (#4) to identify sound sources for facility and undertake noise assessment to determine noise levels at neighbouring sites/residential areas. (Ref ENVID report 215000-00190-000-EN-REP-00004)</td><td></td></tr>
<tr><td>Atmospheric Emissions</td><td>Management</td><td>CWG</td><td>BAT 19</td><td>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 WT BAT 1).</td><td>Operation</td><td></td><td></td><td></td></tr>
<tr><td>Atmospheric Emissions</td><td>Monitoring</td><td>CWG</td><td>BAT 20</td><td>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.

A) Use of emission factors
B) Use of mass balance</td><td>Operation</td><td></td><td></td><td></td></tr>
<tr><td>Atmospheric Emissions</td><td>Monitoring</td><td>CWG</td><td>BAT 21</td><td>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 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 identification and quantification of the relevant solvent inputs and outputs, including the associated uncertainty
B) Implementation of a solvent tracking system
C) Monitoring of changes that may influence the uncertainty of the solvent mass balance data.</td><td>Operation</td><td></td><td>The (new) stack will be subject to Continuous emission monitoring of flue gas pollutant concentrations including NOx, SO_2, CO, PM, Ammonia, Amine.
Full requirements are detailed in the Environmental Basis of Design.</td><td></td></tr>
<tr><td>Atmospheric Emissions</td><td>Fugitives</td><td>CWG</td><td>BAT 22</td><td>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.
<table>
<tr><th>Type of sources of diffuse VOC emissions [51] [52]</th><th>Type of VOCs</th><th>Standard(s)</th><th>Minimum monitoring frequency</th></tr>
<tr><td rowspan="2">Sources of fugitive emissions</td><td>VOCs classified as CMR 1A or 1B</td><td rowspan="2">EN 15446 [58]</td><td>Once every year [53] [54] [55]</td></tr>
<tr><td>VOCs not classified as CMR 1A or 1B</td><td>Once during the period covered by each LDAR programme (see BAT 19 point iii.) [56]</td></tr>
<tr><td rowspan="2">Sources of non-fugitive emissions</td><td>VOCs classified as CMR 1A or 1B</td><td rowspan="2">EN 17628</td><td>Once every year</td></tr>
<tr><td>VOCs not classified as CMR 1A or 1B</td><td>Once every year [57]</td></tr>
</table></td><td>Operation</td><td></td><td></td><td></td></tr>
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<table>
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<tr><th>Aspect</th><th></th><th colspan="2">BAT Reference</th><th>Description</th><th>Implementation Stage</th><th>Applicability</th><th>Project Status</th><th>Further recommendations</th></tr>
<tr><td>Atmospheric Emissions</td><td>Fugitives</td><td>CWG</td><td>BAT 23</td><td>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.
A) Limiting number of emission sources (minimise pipe lengths, reduce no. of connections, welded fittings etc)
B) Use of high-integrity equipment
C) Collecting diffuse emissions and treating off-gases
D) Facilitating access and/or monitoring activities
E) Tightening
F) Replacement of leaky equipment and/or parts
G) Reviewing and updating process design (i.e., reduce use of solvents, lowering operating Temp, lower VOC content in product)
H) Reviewing and updating operating conditions
I) Using closed systems
J) Using techniques to minimise emissions from surfaces (i.e., periodically skimming open surfaces; stalling anti-evaporation floating elements on open surfaces; using fixed roof tanks & Waste gas treatment</td><td>Design</td><td>Applicable</td><td>Reduction of any fugitive emissions is stipulated in the Environmental Basis of Design via minimisation of potential leak sources and use of low leak equipment where practical.

Also see BAT 17 of Common Wastewater Management</td><td></td></tr>
<tr><td>Atmospheric Emissions</td><td>Polyolefin production</td><td>CWG</td><td>BAT 24</td><td>BAT is to monitor the TVOC concentration in polyolefin products, at least once every year for each representative polyolefin grade produced during the same year, 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.</td><td>Design</td><td>Not Applicable</td><td>No applicable - Polyolefin production is not part of facility.</td><td></td></tr>
<tr><td>Atmospheric Emissions</td><td>Polyolefin production</td><td>CWG</td><td>BAT 25</td><td>In order to increase resource efficiency and to reduce emissions to air of organic compounds, BAT is to use all of the techniques given below, as far as applicable.

A) Chemical agents with low boiling points
Solvents and suspension agents with low boiling points are used.
B) Lowering the VOC content in the polymer
The VOC content in the polymer is lowered, e.g. by using low-pressure separation, stripping or closed-loop nitrogen purge systems, devolatilization extrusion (see Section 1.4.3). The techniques for lowering the VOC content depend on the type of polymer product and production process.
C) Collection and treatment of process off-gases
Process off-gases arising from the use of technique b. as well as from the finishing step, e.g. extrusion and degassing silos, are collected and sent to recovery</td><td>Design</td><td>Not Applicable</td><td>No applicable - Polyolefin production is not part of facility.</td><td></td></tr>
<tr><td>Atmospheric Emissions</td><td>Monitoring</td><td>CWG</td><td>BAT 26</td><td>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 scient
<table>
<tr><th>Substance</th><th>Emission points</th><th>Standard(s)</th><th>Minimum monitoring frequency (63)</th><th>Monitoring associated with</th></tr>
<tr><td rowspan="2">VCM</td><td>Any stack with a VCM mass flow of ≥ 25 g/h</td><td>Generic EN standards (64)</td><td>Continuous (65)</td><td rowspan="2">BAT 29</td></tr>
<tr><td>Any stack with a VCM mass flow of < 25 g/h</td><td>No EN standard available</td><td>Once every 6 months (66) (67)</td></tr>
</table></td><td>Design</td><td>Not Applicable</td><td>Not applicable - Flue gas is not anticipated to contain Vinyl chloride monomers (VCM)</td><td></td></tr>
<tr><td>Atmospheric Emissions</td><td>Production of polyvinyl chloride</td><td>CWG</td><td>BAT 27</td><td>BAT is to monitor the residual vinyl chloride monomer (VCM) concentration in PVC slurry/latex, at least once every year for each representative PVC grade produced during the same year, in accordance with EN standards (EN ISO 6401)</td><td>Design</td><td>Not Applicable</td><td>Not applicable - Vinyl chloride monomers (VCM) production is not part of facility scope</td><td></td></tr>
<tr><td>Atmospheric Emissions</td><td>Production of polyvinyl chloride</td><td>CWG</td><td>BAT 28</td><td>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 the vinyl chloride monomer from process off-gases by using one or a combination of the techniques given below, and to reuse the recovered monomer.
A) Absorption (regenerative)
B) Adsorption (regenerative)
C) Condensation</td><td>Design</td><td>Not Applicable</td><td>Not applicable - Vinyl chloride monomers (VCM) production is not part of facility scope</td><td></td></tr>
<tr><td>Atmospheric Emissions</td><td>Production of polyvinyl chloride</td><td>CWG</td><td>BAT 29</td><td>In order to reduce channelled emissions to air of vinyl chloride monomer from the recovery of vinyl chloride monomer, BAT is to use one or a combination of the techniques given below.
A) Absorption
B) Adsorption
C) Condensation
D) Thermal Oxidation</td><td>Design</td><td>Not Applicable</td><td>Not applicable - Vinyl chloride monomers (VCM) production is not part of facility scope</td><td></td></tr>
<tr><td>Atmospheric Emissions</td><td>Production of polyvinyl chloride</td><td>CWG</td><td>BAT 30</td><td>In order to reduce emissions to air of vinyl chloride monomer, BAT is to use all of the techniques given below.

A) Appropriate VCM storage facilities
-- storing VCM in refrigerated tanks at atmospheric pressure or in pressurised tanks at ambient temperature;
--using refrigerated reflux condensers or connecting tanks for VCM recovery (see BAT 28) and/or abatement
B) Vapour Balancing
C) Minimisation of emissions of residual VCM from equipment
-- reducing the frequency and duration of reactor openings;
-- venting off-gases from latex storage tanks and from connections to VCM recovery
-- draining the liquid content of the reactor to closed vessels prior to opening the reactor
-- cleaning the reactor with water prior to opening and draining the water to the stripping system.
D) Lowering the VCM content in the polymer by stripping</td><td>Design</td><td>Not Applicable</td><td>Not applicable - Vinyl chloride monomers (VCM) production is not part of facility scope</td><td></td></tr>
<tr><td>Atmospheric Emissions</td><td>Production of synthetic rubbers</td><td>CWG</td><td>BAT 31</td><td>BAT is to monitor the TVOC concentration in synthetic rubbers, at least once every year for each representative synthetic rubber grade produced during the same year, 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.</td><td>Design</td><td>Not Applicable</td><td>Not applicable - synthetic rubbers are not being produced in the project</td><td></td></tr>
<tr><td>Atmospheric Emissions</td><td>Production of synthetic rubbers</td><td>CWG</td><td>BAT 32</td><td>In order to reduce emissions to air of organic compounds, BAT is to use one or a combination of the techniques given below:
A) Lowering VOC content in the polymer (via stripping or devolatilisation extrusion)
B) Collection and treatment of process off-gases (off-gasses sent to recovery/abatement)</td><td>Design</td><td></td><td>Not applicable - synthetic rubbers are not being produced in the project</td><td></td></tr>
</table>

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<tr><td>Atmospheric Emissions</td><td>Production of viscose using CS3</td><td>CWG</td><td>BAT 33</td><td>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.
<table>
<tr><th>Substance (71)</th><th>Emission points</th><th>Standard(s)</th><th>Minimum monitoring frequency</th><th>Monitoring associated with</th></tr>
<tr><td rowspan="2">Carbon disulphide (CS_2)</td><td>Any stack with a mass flow of ≥ 1 kg/h</td><td>Generic EN standards (72)</td><td>Continuous (73)</td><td rowspan="4">BAT 35</td></tr>
<tr><td>Any stack with a mass flow of < 1 kg/h</td><td>No EN standard available</td><td>Once every year (74)</td></tr>
<tr><td rowspan="2">Hydrogen sulphide (H_2S)</td><td>Any stack with a mass flow of ≥ 50 g/h</td><td>Generic EN standards (72)</td><td>Continuous (73)</td></tr>
<tr><td>Any stack with a mass flow of < 50 g/h</td><td>No EN standard available</td><td>Once every year (74)</td></tr>
</table></td><td>Design</td><td>Not Applicable</td><td>Not Applicable - viscose is not being produced in facility.</td><td></td></tr>
<tr><td>Atmospheric Emissions</td><td>Production of viscose using CS3</td><td>CWG</td><td>BAT 34</td><td>In order to increase resource efficiency and to reduce the mass flow of CS2 and H2S sent to the final waste gas treatment, BAT is to recover CS2 by using technique a. and/or technique b. or a combination of technique c. with technique(s) a. and/or b., given below and to reuse the CS2, or, alternatively, to use technique d.
A) Absorption (regenerative) [H2S]
B) Adsorption (regenerative) [H2S, CS2]
C) Condensation [H2S, CS2]
D) Production of sulphuric acid [H2S, CS2]</td><td>Design</td><td>Not Applicable</td><td>Not Applicable - viscose is not being produced in facility.</td><td></td></tr>
<tr><td>Atmospheric Emissions</td><td>Production of viscose using CS3</td><td>CWG</td><td>BAT 35</td><td>In order to reduce channelled emissions to air of CS2 and H2S, BAT is to use one or a combination of the techniques given below.
A) Absorption [H2S]
B) Bioprocesses [CS2, H2S]
C) Thermal oxidation [CS2, H2S]</td><td>Design</td><td>Not Applicable</td><td>Not Applicable - viscose is not being produced in facility.</td><td></td></tr>
<tr><td>Atmospheric Emissions</td><td>Production of viscose using CS3</td><td>CWG</td><td>BAT 36</td><td>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.
A) Choice of Fuel (NOx & SOX, dust)
B) Low NOx burner (NOx only)
C) Optimised Combustion (CO & NOx)

Secondary techniques
D) Absorption (SOx, dust)
E) Fabric filter or absolute filter (dust)
F) Selective Catalytic Reduction (NOx)
G) Selective non-Catalytic Reduction (NOx)</td><td>Design</td><td>Not Applicable</td><td>Not Applicable - viscose is not being produced in facility.</td><td></td></tr>
</table>

Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector					Screening			
Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status	Further Recommendations
Operation/Management	General	CWW	BAT 1	In order to improve the overall environmental performance, BAT is to implement and adhere to an environmental management system (EMS)	Operation			
Emissions to Water	General	CWW	BAT 2	In order to facilitate the reduction of emissions to water and air and the reduction of water usage, BAT is to establish and to maintain an inventory of waste water and waste gas streams, as part of the environmental management system.	Design	Applicable	Note - Project has zero-discharge design policy, with effluent streams being sent to the existing cement facility for reuse. Air emissions fall under scope of the Emissions, discharge and waste schedule 215000-00190-000-EN-REP-00001 which will be prepared in FEED.	
Emissions to Water	General	CWW	BAT 3	For relevant emissions to water as identified by the inventory of waste water streams (see BAT 2), BAT is to monitor key process parameters (including continuous monitoring of waste water flow, pH and temperature) at key locations (e.g. influent to pre-treatment and influent to final treatment).	Design	Applicable	Wastewater/effluent flow metering is to be included in design as per the requirements of the Environmental Basis of Design (215000-00190-000-EN-BOD-00001). Environmental Management and monitoring plan (215000-00190-000-EN-PLN-00001) is to be developed in FEED and include requirement for flow metering to allow for water balance to be determined	
Emissions to Water	General	CWW	BAT 4	BAT is to monitor emissions to water in accordance with EN standards with at least the minimum frequency given below. 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. (see table below)	Design	Not Applicable	Project has a zero-discharge policy. All wastewater and process effluent streams are to be sent to existing cement facility for reuse. Note - sewage effluent to be tied into existing sewage system	
Atmospheric Emissions	Monitoring	CWW	BAT 5	BAT is to periodically monitor diffuse VOC emissions to air from relevant sources by using an appropriate combination of the techniques I – III or, where large amounts of VOC are handled, all of the techniques I – III. I). sniffing methods (e.g. with portable instruments according to EN 15446) associated with correlation curves for key equipment; II). optical gas imaging methods; III). calculation of emissions based on emissions factors, periodically validated (e.g. once every two years) by measurements. Where large amounts of VOCs are handled, the screening and quantification of emissions from the installation by periodic campaigns with optical absorption-based techniques, such as Differential absorption light detection and ranging (DIAL) or Solar occultation flux (SOF), is a useful complementary technique to the techniques I to III.	Operation			
Atmospheric Emissions	General	CWW	BAT 6	BAT is to periodically monitor odour emissions from relevant sources in accordance with EN standards. Emissions can be monitored by dynamic olfactometry according to EN 13725. Emission monitoring may be complemented by measurement/estimation of odour exposure or estimation of odour impact.	Operation			

BAT 4 table:

Substance/parameter		Standard(s)	Minimum monitoring frequency (1) (2)
Total organic carbon (TOC) (3)		EN 1484	Daily
Chemical oxygen demand (COD) (3)		No EN standard available	
Total suspended solids (TSS)		EN 872	
Total nitrogen (TN) (4)		EN 12260	
Total inorganic nitrogen (N_{inorg}) (4)		Various EN standards available	
Total phosphorus (TP)		Various EN standards available	
Adsorbable organically bound halogens (AOX)		EN ISO 9562	Monthly
Metals	Cr	Various EN standards available	
	Cu		
	Ni		
	Pb		
	Zn		
	Other metals, if relevant		
Toxicity (5)	Fish eggs (*Danio rerio*)	EN ISO 15088	To be decided based on a risk assessment, after an initial characterisation
	Daphnia (*Daphnia magna Straus*)	EN ISO 6341	
	Luminescent bacteria (*Vibrio fischeri*)	EN ISO 11348–1, EN ISO 11348–2 or EN ISO 11348–3	
	Duckweed (*Lemna minor*)	EN ISO 20079	
	Algae	EN ISO 8692, EN ISO 10253 or EN ISO 10710	

(1) Monitoring frequencies may be adapted if the data series clearly demonstrate a sufficient stability.
(2) The sampling point is located where the emission leaves the installation.
(3) TOC monitoring and COD monitoring are alternatives. TOC monitoring is the preferred option because it does not rely on the use of very toxic compounds.
(4) TN and N_{inorg} monitoring are alternatives.
(5) An appropriate combination of these methods can be used.

Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector					Screening			
Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status	Further Recommendations
Emissions to Water	Usage and generation	CWW	BAT 7	In order to reduce the usage of water and the generation of waste water, BAT is to reduce the volume and/or pollutant load of waste water streams, to enhance the reuse of waste water within the production process and to recover and reuse raw materials.	Design	Applicable	Reduction of raw water use is in design with key elements: - Choice of re-circulating water cooling rather than once through system. - Air cooling will be used where feasible to reduce cooling water requirements. - Condensate will be recovered from process and routed to the WWT unit for reuse - Raw water intake will supplemented with cooling tower blowdown and waste water from absorption tower (post treatment) (ref process description - 215000-00190-000-PR-REP-0006)	
Emissions to Water	Collection and segregation	CWW	BAT 8	In order to prevent the contamination of uncontaminated water and to reduce emissions to water, BAT is to segregate uncontaminated waste water streams from waste water streams that require treatment.	Design	Applicable	In design. Effluent streams are identified against required treatment in the ZLD Study (415000-00299-00-PR-REP-00004) and process description (215000-00190-000-PR-REP-0006). Drainage philosophy will be prepared in FEED (215000-00190-000-PR-PHL-00004) which details the drainage routes for contaminated/ uncontaminated effluent streams	
Emissions to Water	Collection and segregation	CWW	BAT 9	In order to prevent uncontrolled emissions to water, BAT is to provide an appropriate buffer storage capacity for waste water incurred during other than normal operating conditions based on a risk assessment (taking into account e.g. the nature of the pollutant, the effects on further treatment, and the receiving environment), and to take appropriate further measures (e.g. control, treat, reuse).	Design	Applicable	Considered in design, the wastewater treatment plant will have a Buffer storage tank, with recommended capacity for 6 hours retention at design continuous flow (415000-00299-00-PR-REP-00004)	
Emissions to Water	Waste Water Treatment	CWW	BAT 10	In order to reduce emissions to water, BAT is to use an integrated waste water management and treatment strategy that includes an appropriate combination of the techniques in the priority order given below. a) Process-integrated techniques - Techniques to prevent or reduce the generation of water pollutants b) Recovery of pollutants at source - Techniques to recover pollutants prior to their discharge to the waste water collection system c) Waste water pre-treatment - Techniques to abate pollutants before the final waste water treatment. Pre-treatment can be carried out at the source or in combined streams d) Final waste water treatment - Final waste water treatment by, for example, preliminary and primary treatment, biological treatment, nitrogen removal, phosphorus removal and/or final solids removal techniques before discharge to receiving water body	Design	Applicable	Note - project policy is zero-discharge of waste waters. Comment here is regarding treatment steps prior to reuse of effluent streams in cooling water. Effluent sent to the WWT (prior to being used as cooling water) will undergo (in order): 1. flocculation and clarifier thickening 2. filter step 3. Chemical treatment (Biocide, corrosion inhibitor, antiscale dosing) $FeCl_3$ and $Ca(OH)_2$ to be used for thickening.	
Emissions to Water	Waste Water Treatment	CWW	BAT 11	In order to reduce emissions to water, BAT is to pre-treat waste water that contains pollutants that cannot be dealt with adequately during final waste water treatment by using appropriate techniques. Waste water pre-treatment is carried out as part of an integrated waste water management and treatment strategy (see CWW BAT 10) and is generally necessary to: A) protect the final waste water treatment plant (e.g. protection of a biological treatment plant against inhibitory or toxic compounds); B) remove compounds that are insufficiently abated during final treatment (e.g. toxic compounds, poorly/non-biodegradable organic compounds, organic compounds that are present in high concentrations, or metals during biological treatment); C) remove compounds that are otherwise stripped to air from the collection system or during final treatment (e.g. volatile halogenated organic compounds, benzene); D) remove compounds that have other negative effects (e.g. corrosion of equipment; unwanted reaction with other substances; contamination of waste water sludge) In general, pre-treatment is carried out as close as possible to the source in order to avoid dilution, in particular for metals. Sometimes, waste water streams with appropriate characteristics can be segregated and collected in order to undergo a dedicated combined pre-treatment.	Design	Not Applicable	No pre-treatment required	

<table>
<tr><th colspan="5">Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector</th><th colspan="2">Screening</th><th colspan="2"></th></tr>
<tr><th>Aspect</th><th></th><th colspan="2">BAT Reference</th><th>Description</th><th>Implementation Stage</th><th>Applicability</th><th>Project Status</th><th>Further Recommendations</th></tr>
<tr><td>Emissions to Water</td><td>Waste Water Treatment</td><td>CWW</td><td>BAT 12</td><td>In order to reduce emissions to water, BAT is to use an appropriate combination of final waste water treatment techniques.
<table>
<tr><th></th><th>Technique (1)</th><th>Typical pollutants abated</th><th>Applicability</th></tr>
<tr><td colspan="4">Preliminary and primary treatment</td></tr>
<tr><td>a</td><td>Equalisation</td><td>All pollutants</td><td rowspan="3">Generally applicable.</td></tr>
<tr><td>b</td><td>Neutralisation</td><td>Acids, alkalis</td></tr>
<tr><td>c</td><td>Physical separation, e.g. screens, sieves, grit separators, grease separators or primary settlement tanks</td><td>Suspended solids, oil/grease</td></tr>
<tr><td colspan="4">Biological treatment (secondary treatment), e.g.</td></tr>
<tr><td>d</td><td>Activated sludge process</td><td rowspan="2">Biodegradable organic compounds</td><td rowspan="2">Generally applicable.</td></tr>
<tr><td>e</td><td>Membrane bioreactor</td></tr>
<tr><td colspan="4">Nitrogen removal</td></tr>
<tr><td>f</td><td>Nitrification/denitrification</td><td>Total nitrogen, ammonia</td><td>Nitrification may not be applicable in case of high chloride concentrations (i.e. around 10 g/l) and provided that the reduction of the chloride concentration prior to nitrification would not be justified by the environmental benefits. Not applicable when the final treatment does not include a biological treatment.</td></tr>
<tr><td colspan="4">Phosphorus removal</td></tr>
<tr><td>g</td><td>Chemical precipitation</td><td>Phosphorus</td><td>Generally applicable.</td></tr>
<tr><td colspan="4">Final solids removal</td></tr>
<tr><td>h</td><td>Coagulation and flocculation</td><td rowspan="4">Suspended solids</td><td rowspan="4">Generally applicable.</td></tr>
<tr><td>i</td><td>Sedimentation</td></tr>
<tr><td>j</td><td>Filtration (e.g. sand filtration, microfiltration, ultrafiltration)</td></tr>
<tr><td>k</td><td>Flotation</td></tr>
<tr><td colspan="4">(1) The descriptions of the techniques are given in Section 4.6.1</td></tr>
</table></td><td>Design</td><td>Not Applicable</td><td>Not fully applicable to the project as wastewater streams are not discharged to environment/receiving water.

However for the WWT and raw water treatment systems coagulation and flocculation and filtration are used.</td><td></td></tr>
<tr><td>Emissions to Water</td><td>Management</td><td>CWW</td><td>BAT 13</td><td>In order to prevent or, where this is not practicable, to reduce the quantity of waste being sent for disposal, BAT is to set up and implement a waste management plan as part of the environmental management system (see CWW BAT 1) that, in order of priority, ensures that waste is prevented, prepared for reuse, recycled or otherwise recovered.</td><td>Operation</td><td></td><td></td><td></td></tr>
<tr><td>Emissions to Water</td><td>General</td><td>CWW</td><td>BAT 14</td><td>In order to reduce the volume of waste water sludge requiring further treatment or disposal, and to reduce its potential environmental impact, BAT is to use one or a combination of the techniques given below.

A) Conditioning - Chemical conditioning (i.e. adding coagulants and/or flocculants) or thermal conditioning (i.e. heating) to improve the conditions during sludge thickening/dewatering. Not applicable to inorganic sludges.
B) Thickening/dewatering (i.e., sedimentation, centrifugation, flotation, gravity belts, or rotary drums; Dewatering can be carried out by belt filter presses or plate filter presses.)
C) Stabilisation (i.e., chemical treatment, thermal treatment, aerobic digestion, or anaerobic digestion). Not applicable to inorganic sludges. Not applicable for short-term handling before final treatment.
D) Drying via direct or indirect contact with a heat source. Not applicable to cases where waste heat is not available or cannot be used.</td><td>Design</td><td>Applicable</td><td>Items (A) and (B) are in design. See comments made to CWW BAT 7 above.</td><td></td></tr>
<tr><td>Atmospheric Emissions</td><td>Waste gas</td><td>CWW</td><td>BAT 15</td><td>In order to facilitate the recovery of compounds and the reduction of emissions to air, BAT is to enclose the emission sources and to treat the emissions, where possible.</td><td>Design</td><td>Applicable</td><td></td><td>Drainage philosophy will document requirement for closed drain systems of potentially contaminated/odorous effluent streams</td></tr>
<tr><td>Atmospheric Emissions</td><td>Waste gas</td><td>CWW</td><td>BAT 16</td><td>In order to reduce emissions to air, BAT is to use an integrated waste gas management and treatment strategy that includes process-integrated and waste gas treatment techniques. The integrated waste gas management and treatment strategy is based on the inventory of waste gas streams (see CWW BAT 2) giving priority to process-integrated techniques.</td><td>Design</td><td>Applicable</td><td>This is in core design and objective of the project. The flue gas from the existing kiln and new CHP boiler will undergo the following key treatments
- SCR (CHP boiler package) is used to reduce NOX emissions from the boiler.
- CCU will recover (up to 95%) of CO_2 from the flue gas streams from the existing kiln and new boiler.
- Waterwash tower will be used to reduce amine emissions.

Other emission sources (i.e., O_2 venting, intermittent H2 venting and N2 gas blanket venting from storage tanks will not require treatment)</td><td></td></tr>
<tr><td>Atmospheric Emissions</td><td>Flaring</td><td>CWW</td><td>BAT 17</td><td>In order to prevent emissions to air from flares, BAT is to use flaring only for safety reasons or non-routine operational conditions (e.g. start-ups, shutdowns) by using one or both of the techniques given below.

A) Correct plant design - This includes the provision of a gas recovery system with sufficient capacity and the use of high-integrity relief valves. Generally applicable to new plants. Gas recovery systems may be retrofitted in existing plants.

B) Plant management - This includes balancing the fuel gas system and using advanced process control. Generally applicable.</td><td>Design</td><td>Not Applicable</td><td>No flaring in design of plant</td><td></td></tr>
</table>

Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector					Screening			
Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status	Further Recommendations
Atmospheric Emissions	Flaring	CWW	BAT 18	In order to reduce emissions to air from flares when flaring is unavoidable, BAT is to use one or both of the techniques given below. A) Correct design of flaring devices - Optimisation of height, pressure, assistance by steam air or gas, type of flare tips (either enclosed or shielded), etc., aimed to enable smokeless and reliable operation and to ensure the efficient combustion of excess gases. B) Monitoring and recording as part of flare management - Continuous monitoring of the gas sent to flaring, measurements of gas flow and estimations of other parameters (e.g. composition, heat content, ratio of assistance, velocity, purge gas flow rate, pollutant emissions (e.g. NOX, CO, hydrocarbons, noise)).	Design	Not Applicable	Part of standard design processes and considerations to minimise noise where possible via incorporating noise level requirements in vendor quotes and appropriate site layout to avoid direct line between noisy equipment and neighbours as far as practical and possible. Action was raised in ENVID (#4) to identify sound sources for facility and undertake noise assessment to determine noise levels at neighbouring sites/residential areas. (Ref ENVID report 215000-00190-000-EN-REP-00004)	
Atmospheric Emissions	Diffuse VOC emissions	CWW	BAT 19	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. Technique / Applicability *Techniques related to plant design* a Limit the number of potential emission sources b Maximise process-inherent containment features c Select high-integrity equipment (see the description in Section 4.6.2) d Facilitate maintenance activities by ensuring access to potentially leaky equipment (a–d) Applicability may be restricted in the case of existing plants due to operability requirements. *Techniques related to plant/equipment construction, assembly and commissioning* e Ensure well-defined and comprehensive procedures for plant/equipment construction and assembly. This includes using the designed gasket stress for flanged joint assembly (see the description in Section 4.6.2) f Ensure robust plant/equipment commissioning and handover procedures in line with the design requirements (e–f) Generally applicable. *Techniques related to plant operation* g Ensure good maintenance and timely replacement of equipment h Use a risk-based leak detection and repair (LDAR) programme (see the description in Section 4.6.2) i As far as it is reasonable, prevent diffuse VOC emissions, collect them at source, and treat them (g–i) Generally applicable.	Design	Applicable	Items A-F are applicable to the design phase scope and are part of inherent design considerations. Reduction of any fugitive emissions is stipulated in the Environmental Basis of Design via minimisation of potential leak sources and use of low leak equipment where practical.	
Atmospheric Emissions	Odour	CWW	BAT 20	In order to prevent or, where that is not practicable, to reduce odour emissions, BAT is to set up, implement and regularly review an odour management plan, as part of the environmental management system (see CWW BAT 1), that includes all of the following elements: I. a protocol containing appropriate actions and timelines; II. a protocol for conducting odour monitoring; III. a protocol for response to identified odour incidents; IV. an odour prevention and reduction programme designed to identify the source(s), to measure/estimate odour exposure, to characterise the contributions of the sources, and to implement prevention and/or reduction measures.	Operation			
Atmospheric Emissions	Odour	CWW	BAT 21	In order to prevent or, where that is not practicable, to reduce odour emissions from waste water collection and treatment and from sludge treatment, BAT is to use one or a combination of the techniques given below. A) Minimise residence times, in particular under anaerobic conditions. B) Chemical treatment (e.g. oxidation or precipitation of hydrogen sulphide). C) Optimise aerobic treatment (i.e.,. controlling the oxygen content; frequent maintenance of the aeration system; use of pure oxygen; removal of scum in tanks). D) Enclosure with collection of the odorous waste gas for further treatment. E) End-of-pipe treatment (i.e., biological treatment; thermal oxidation).	Design	Applicable		Requirement for odour mitigation will be established in the EIA and feedback into the design.
Noise Emissions	Noise	CWW	BAT 22	In order to prevent or, where that is not practicable, to reduce noise emissions, BAT is to set up and implement a noise management plan, as part of the environmental management system (see CWW BAT 1), that includes all of the following elements: I. a protocol containing appropriate actions and timelines; II. a protocol for conducting noise monitoring; III. a protocol for response to identified noise incidents; IV. a noise prevention and reduction programme designed to identify the source(s), to measure/estimate noise exposure, to characterise the contributions of the sources and to implement prevention and/or reduction measures. The applicability is restricted to cases where noise nuisance can be expected or has been substantiated.	Operation			
Noise Emissions	Noise	CWW	BAT 23	In order to prevent or, where that is not practicable, to reduce noise emissions, BAT is to use one or a combination of the techniques given below. A) Appropriate location of equipment and buildings B) Operational measures (i.e., improved inspection and maintenance of equipment; closing doors and windows of enclosed areas; equipment operation by experienced staff; avoidance of noisy activities at night etc) C) Low-noise equipment D) Noise-control equipment (i.e., insulation, low-noise rated equipment, silencers etc) E) Noise abatement - Inserting obstacles between emitters and receivers	Design	Applicable	A-E are pare of the inherent site layout design considerations to minimise noise levels.	

Industrial Cooling BREF					Screening			
Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status	Further Recommendations
Energy Efficiency	General	IC	BAT 1	It is BAT in the design phase of a cooling system: A) To reduce resistance to water and airflow B) To apply high efficiency/low energy equipment C) To reduce the amount of energy demanding equipment D) To apply optimised cooling water treatment in once-through systems and wet cooling towers to keep surfaces clean and avoid scaling, fouling and corrosion	Design	Applicable	Water cooling system design is still maturing and details will be established in FEED.	
Emissions to Water	General	IC	BAT 2	It is BAT to use once-through systems for processes requiring large cooling capacity (e.g., >10 MW_{th}). In the case of rivers and/or estuaries once-through can be acceptable if A) Extension of heat plume in the surface water leaves passage for fish migration; B) Cooling water intake is designed aiming at reduced fish entrainment; C) heat load does not interfere with other users of receiving surface water.	Design	Not Applicable	Not applicable - Recirculating water cooling has been decided for the basis of the facility cooling design	
Energy Efficiency	Energy Efficiency	IC	BAT 3	For energy efficiency of cooling systems, BAT is to A) Apply option for variable operation (i.e., correct sizing and cooling technology for application) B) Apply modulation of air/water flow to avoid instability cavitation in system (corrosion and erosion) C) Apply pumping heads and fans with reduced energy consumption	Design	Applicable	Water cooling system design is still maturing and details will be established in FEED.	
Energy Efficiency	Energy Efficiency	IC	BAT 4	Wet Cooling Systems For Energy Efficiency of wet cooling system, BAT is to A) Optimise water treatment and pipe surface treatment	Design	Applicable	Water cooling system design is still maturing and details will be established in FEED.	
Energy Efficiency	Energy Efficiency	IC	BAT 5	For energy efficiency of once-through cooling systems, BAT is to avoid recirculation of warm water plume in rivers and minimise it in estuaries and on marine sites	Design	Not Applicable	Not applicable - Recirculating water cooling has been decided for the basis of the facility cooling design	
Emissions to Water	Reduction of water usage	IC	BAT 6	For reduction of water need/use, BAT is to A) Optimise heat reuse to reduce need for (additional) cooling B) Apply recirculating systems C) Apply hybrid cooling system D) Apply dry-air cooling (evaluation needed, potentially more beneficial for pre-cooling at higher temperatures where water demand would be excessive) E) Optimisation of cycles of concentration (increases water conditioning demand)	Design	Applicable	Option (B) recirculating system is included in design to provide primary cooling . Hybrid cooling tower (wet-dry) design with cooling system designed for 5-stages of concentration. To further reduce water requirements, air cooling will be applied where practical.(ref Cooling Medium study 415000-00299000-PR-REP-0000)	
Emissions to Water	Entrapment of fish and other marine organisms	IC	BAT 7	For the projection of fish and other marine organisms from entrapment at the intake, BAT is to A) Undertake analysis of the biotope in surface water source to identify appropriate position and design of intake and selection of protection technique B) In design of intake channels, optimise water velocities in intake channel to limit sedimentation; watch for seasonal occurrence of macrofouling	Design	Not Applicable	Not applicable - Raw water is sourced from boreholes. No river abstraction	
Emissions to Water	general	IC	BAT 8	Measures should be taken in the design phase of wet cooling system using the following order of approach: A) identify process conditions (pressure, T, corrosiveness of substance), B) identify chemical characteristics of cooling water source, C) select the appropriate material for heat exchanger combining both process conditions and cooling water characteristics, D) select the appropriate material for other parts of the cooling system, E) identify operational requirements of the cooling system, F) select feasible cooling water treatment (chemical composition) using less hazardous chemicals or chemicals that have lower potential for impact on the environment G) apply the biocide selection scheme H) optimise dosage regime by monitoring of cooling water and systems conditions	Design	Applicable	Process conditions and water quality/characteristics are presented in Cooling Study (415000-00299000-PR-REP-00003). Cooling tower will be mainly fabricated from FRP with PVC drift eliminators and filling. Due to Zero-Liquid Discharge requirements, split cooling scheme is viewed as optimal approach (air and hybrid water cooling) Considerations have been highlighted for the chloride content and low pH of the water which will promote oxidization of the stainless steel at lower temperatures which will impact other parts of the cooling system. Note - makeup waters will contain some level of CO_2 which will necessitate requirement for stainless steel	
Emissions to Water	General	IC	BAT 9	BAT is to reduce emissions to water by design and maintenance techniques including: All wet systems: A) Undertake analysis of corrosiveness and process substance as well as of cooling water to select right material B) Design cooling system to avoid stagnant zones	Design	Applicable	A) Corrosion requirements of the water streams have been identified. B) Cooling system design will be matured in FEED.	
Emissions to Water	General	IC	BAT 10	Shell & tube heat exchanger: BAT is to reduce emissions to water by design and maintenance techniques including: - Design to facilitate cleaning by having cooling water flow inside tube and heavy fouling medium on tube size/surface	Design	Applicable	Specifics on the design of the heat exchangers are to be established in FEED.	
Emissions to Water	General	IC	BAT 11	Condensers of power plants: BAT is to reduce emissions to water by design and maintenance techniques including: A) Reduce corrosion sensitiveness via application of Ti in condensers which use seawater/brackish water B) Reduce corrosion sensitiveness via use of low corrosion allows (stainless steel with high putting index/copper nickel) C) Use of automated cleaning systems with foam balls or brushes.	Design	Applicable	Cooling Study (415000-00299000-PR-REP-00003) has identified stainless steal requirement due to CO_2 and low pH in water streams.	
Emissions to Water	General	IC	BAT 12	Condensers and heat exchangers BAT is to reduce emissions to water by design and maintenance techniques including: A) Reduce deposition (fouling) by keeping water velocity > 0.8 m/s (1.8 m/s new equipment and 1.5 m/s in case of tube bundle refit). B) use of debris filters where clogging is a risk	Design	Applicable		A) minimum water velocity to be verified with feedback from OEM. B) risk of clogging to be looked at

Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status	Further Recommendations
Emissions to Water	General	IC	BAT 13	Once-through systems BAT is to reduce emissions to water by design and maintenance techniques including: A) reduce corrosion sensitiveness by applying carbon steel in cooling water systems (if corrosion allowance can be met). Not applicable for brackish water B) Reduce corrosion sensitiveness by applying reinforced glass fibre plastics, coated reinforced concrete or coated carbon steel in case of underground conduits C) reduce corrosion sensitiveness by applying Ti for tubes of Shell&tube heat exchanger in high corrosive environment (alternatively high quality stainless steel)	Design	Not Applicable	Not applicable. Project has opted for recirculating water system.	
Emissions to Water	General	IC	BAT 14	BAT is to reduce emissions to water by design and maintenance techniques including: Open wet cooling Towers: - Reduce fouling in salt water conditions: Fill (wet deck) materials should be open low fouling with a high load capacity, where combinations of film (upper parts) and non-film (lower parts) have shown to be effective.	Design	Not Applicable	Raw water being used is not salt water.	
Emissions to Water	General	IC	BAT 15	Natural draught wet cooling towers BAT is to reduce emissions to water by design and maintenance techniques including: - fill (wet deck) choice under consideration of local water quality (i.e., high solid content, scale) to reduce anti-fouling treatment requirements	Design	Not Applicable	Design is not natural draught cooling	
Emissions to Water	Water treatment	IC	BAT 16	BAT is to reduce emissions to water through optimised cooling water treatment via A) reduce additive application through monitoring and control of water chemistry B) Monitor macrofouling for optimising biocide dosage	Design	Not Applicable	Not applicable due to zero liquid discharge policy	
Emissions to Water	Water treatment	IC	BAT 17	Once through cooling Systems BAT is to reduce emissions to water through optimised cooling water treatment via A) limit application of biocides (No use of biocides with sea water below 10-12 degC) B) Reduction of Free Oxidant (FO) Emission via use of variation of residence times and water velocities with associated FO level of 0.1 mg/l at outlet (24-h average). C) For intermittent or shock continuous chlorination of sea water the FO limit is 0.2 mg/l (24-h) or 0.5 mg/l (1-h avg).	Design	Not Applicable	Not applicable. Project has opted for recirculating water system.	
Emissions to Water	Water treatment	IC	BAT 18	Open Wet Cooling Towers: BAT is to reduce emissions to water through optimised cooling water treatment via:- A) Reduce amount of hypochlorite by operating at pH of between 7 and 9 of the cooling water B) Reduce amount of biocide and reduce blowdown by application of side stream biofiltration C) Reduce emission of fast hydrolysing bioxides by temporarily closing blowdown after dosage D) Use of ozone with treatment levels lower than 0.1 mg/l.	Design		Part of standard design processes and considerations to minimise noise where possible via incorporating noise level requirements in vendor quotes and appropriate site layout to avoid direct line between noisy equipment and neighbours as far as practical and possible. [illegible]	
Emissions to Water	Water treatment	IC	BAT 19	It is not BAT to use the following compounds in water treatment: A) chromium compounds B) mercury compounds C) organometallic compounds D) mercaptobenzothiazole E) shock treatment with biocidal substances other than chlorine/bromine/ozone and $h2O_2$	Design	Applicable	Listed compounds A-E, have been incorporated into the Environmental Basis of Design as compounds to avoid in design.	
Atmospheric Emissions	cooling	IC	BAT 20	BAT for reduction of emissions to Air:- Wet Cooling Towers A) Avoid plume reaching ground level by ensuring plume reaches sufficient height and with minimum discharge velocity at tower outlet B) Avoid plume formation via application of plume suppressing techniques (i.e., reheating of air) C) Avoid affecting indoor air quality via design and positioning of tower outlet to avoid risk of air intake by air conditioning systems D) Reduce drift loss by applying drift eliminators with a loss <0.01% of total recirculating flow	Design	Applicable	Hybrid cooling includes dry surface coils to reduce visible plumes from the system. Drift losses are expected to be 0.005% well below BAT requirement (Ref cooling study 415000-00299000-PR-REP-00003)	Further study of plume dispersion will be required to advise on A and C.
Emissions to Water		IC	BAT 21	It is not BAT to use asbestos, wood preserves with CCA or TBTO (or similar) in cooling tower.	Design	Applicable	Asbestos is on the prohibited materials list of the basis of design. Cooling tower construction will not include wood materials and therefore no requirement for wood	
Noise Emissions	Noise/General	IC	BAT 22	Natural draught cooling towers BAT for the reduction of noise emissions - Use design and techniques to reduce noise of cascading water at air inlet - Use of noise attenuation/earth barrier to reduce noise emission around tower base	Design	Not Applicable	Not applicable - design is not natural draught cooling tower	
Noise Emissions	Noise/General	IC	BAT 23	Mechanical Draught Cooling Towers BAT for reduction of noise emissions:- A) Reduce fan noise through application of low-noise fans with large diameter and reduced tip speed (<40 ms) B) Reduce noise from diffuser via using sufficient height or installation of sound attenuators (only applicable to low noise levels i.e., < 5 dbA) C) Apply attenuation measures to inlet and outlet (applicable to sound levels > 15 dBA)	Design	Applicable		These are to be considered in design of the water tower if noise levels are found to be noncompliant with limits or prove to be nusiance to neighbours.
Emissions to Water	Leakage	IC	BAT 24	BAT to reduce leakage is:- - Temperature differential kept <50 degC across heat exchanger to avoid formation of small cracks (technical solutions required for higher temp. diff.)	Design	Applicable	Water cooling system controls will allow control of the various operational parameters of the system including temperature to ensure it is kept within recommended design specification.	

Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status	Further Recommendations
Emissions to Water	Leakage	IC	BAT 25	Shell & Tube heat Exchanger BAT to reduce leakage from S&THEx is : A) Monitor process operation to ensure exchanger is operated within design limits B)Apply wielding technology (where applicable) to ensure sufficient strength of tube/tube plate construction	Design	Applicable	Heat exchanger design is to be established, however A) is operational aspect B) to be advised by OEM	
Emissions to Water	Leakage	IC	BAT 26	Equipment BAT to reduce leakage from equipment is to reduce corrosion by keeping temperature of metal on cooling side <60 degC .	Design	Applicable	The cooling system design will allow for control of the system performance parameters including temperature. Optimal set points for these parameters will be established with feedback from the vendors.	
Emissions to Water	Leakage	IC	BAT 27	Once through Cooling Systems BAT to reduce leakage from once-through systems is to A) Apply preventative maintenance (inspection by means of eddy current or other non-destructive inspection technique) B) Apply indirect cooling; recirculating cooling; air cooling If direct cooling is required, BAT is to implement automatic analytical monitoring for direct cooling systems.	Design	Not Applicable	Not applicable - Recirculating water cooling has been decided for the basis of the facility cooling design	
Emissions to Water	Leakage	IC	BAT 28	Recirculating Cooling Systems BAT to reduce leakage from recirculating systems is to apply constant monitoring of blowdown to control dangerous substances	Design	Applicable	Environmental Basis of Design requires that adequate monitoring of wastewater effluent flow and quality to the wastewater treatment facility be implemented to ensure proper treatment of the facility.	Metering and monitoring requirements to be matured through FEED.
Emissions to Water	General	IC	BAT 29	Wet recirculating cooling systems BAT to reduce biological growth is to A) Reduce light reaching cooling water B) Avoid stagnant zones through design and apply optimised chemical treatment C) Clean using a combination of mechanical and chemical methods following outbreak D) Implement periodic monitoring of pathogens in cooling system	Design	Applicable	Part of inherent design of cooling tower/system. Cooling water undergoes biocide treatment (specifics of which to be determined).	
Emissions to Water	General	IC	BAT 30	Open wet cooling towers BAT to reduce biological growth/infection is for operators to wear nose and mouth protection	Operation			

Large Combustion Plant BATC					Screening			
Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status	Recommendations
Operation/Management	Management	LCP	BAT 1	In order to improve the overall environmental performance, BAT is to implement and adhere to an environmental management system (EMS).	Operation			
Energy Efficiency		LCP	BAT 2	BAT is to determine the net electrical efficiency and/or the net total fuel utilisation and/or the net mechanical energy efficiency of the gasification, IGCC and/or combustion units by carrying out a performance test at full load(1), according to EN standards, after the commissioning of the unit and after each modification that could significantly affect the net electrical efficiency and/or the net total fuel utilisation and/or the net mechanical energy efficiency of the unit. 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.	Operation			
Atmospheric Emissions	Monitoring	LCP	BAT 3	BAT is to monitor key process parameters relevant for emissions to air and water including those given below Flue Gas A) Flow - Periodic or continuous determination B) Oxygen Content, temperature and pressure - Periodic or continuous measurement C) Water vapour content - Periodic or continuous measurement Waste water from flue-gas treatment D) flow, pH and Temperature - Continuous measurement	Design	Applicable	A-B are in design and monitoring requirements stipulated in the Environmental Basis of Design and Environmental Monitoring and Management Plan.	
Atmospheric Emissions	Monitoring	LCP	BAT 4	BAT is to monitor emission to air with at least the frequency given below 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 quantity. The following should be monitored continuously: A) Oxides of Nitrogen (NOx) B) Carbon Monoxide (CO) C) Sulphur Dioxide (SO_2) D) Dust (Specifically Standard EN 13284-1 and EN 13284-2) E) Methane (CH4) (natural gas engines) F) HF (boilers burning process fuels from chemical industry) G) PCDD/F (boilers burning process fuels from chemical industry) The following are to be monitored when Selective Catalytic Reduction/Selective non-Catalytic Reduction is employed in the combustion plant: H) NH3 - Continuous I) SO3 – at least once per year	Design	Applicable	Items A-E, H and I are in Design, stipulated by the Environmental Basis of Design monitoring requirements and standards. Items F and G are not applicable to this project.	
Emissions to Water	Monitoring	LCP	BAT 5	BAT is to monitor emissions to water from flue-gas treatment 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 quantity. BAT is to monitor the following substances at minimum once every month. A) Total Organic Carbon (TOC) B) Chemical Oxygen Demand (COD) C) Total Suspended Solids (TSS) D) Fluoride E) Sulphates, Sulphides and Sulphites F) Metals and metalloids (ASs, Cd, Cr, Cu, Ni, Pb, Zn, Hg) G) Chloride H) Total Nitrogen	Design	Not Applicable	Not applicable - project is zero-discharge policy meaning no discharges of wastewater streams to environment/receiving water.	
Atmospheric Emissions	General	LCP	BAT 6	In order to improve the general environmental performance of combustion plants and to reduce emissions to air of CO and unburnt substances, BAT is to ensure optimised combustion and to use an appropriate combination of the techniques given below Fuel Blending and mixing A) Maintenance of the combustion system B) Advanced Control System C) Good Design of the Combustion Equipment D) Fuel Choice	Design	Applicable	Part of inherent design of the CHP. Vendor will recommend optimal performance of boiler based on provided process characteristics	
Atmospheric Emissions	Ammonia	LCP	BAT 7	In order to reduce emissions of ammonia to air from the use of selective catalytic reduction (SCR) and/or selective non-catalytic reduction (SNCR) for the abatement of NOX emissions, BAT is to optimise the design and/or operation of SCR and/or SNCR (e.g. optimised reagent to NOX ratio, homogeneous reagent distribution and optimum size of the reagent drops). The BAT-associated emission level (BAT-AEL) for emissions of NH3 to air from the use of SCR and/or SNCR is < 3–10 mg/Nm3 as a yearly average or average over the sampling period. The lower end of the range can be achieved when using SCR and the upper end of the range can be achieved when using SNCR without wet abatement techniques.	Design	Applicable	BAT consideration is in design of the SCR. Refer to process description (215000-00190-000-PR-REP-0006) which directly mentions ammonia slip issue and options to reduce, including 1) uniformly distributed inject of Ammonia across catalyst bed 2) potential option for ammonia slip catalysis downstream of SCR for additional NOX removal and also CO reduction which will be explored further in FEED if deemed necessary.	
Atmospheric Emissions	General	LCP	BAT 8	In order to prevent or reduce emissions to air during normal operating conditions, BAT is to ensure, by appropriate design, operation and maintenance, that the emission abatement systems are used at optimal capacity and availability	Design	Applicable	SCR OEM will advise operating envelope and recommended replacement schedule.	
Atmospheric Emissions	General	LCP	BAT 9	In order to improve the general environmental performance of combustion and/or gasification plants and to reduce emissions to air, BAT is to include the following elements in the quality assurance/quality control programmes for all the fuels used, as part of the environmental management system (see BAT 1). i) Initial full characterisation of the fuel used in accordance with EN standards. ISO, national or other international standards may be used provided they ensure the provision of data of an equivalent scientific quality; ii) Regular testing of the fuel quality to check that it is consistent with the initial characterisation and according to the plant design specifications. iii) Subsequent adjustment of the plant settings as and when needed and practicable (e.g. integration of the fuel characterisation and control in the advanced control system.	Design	Applicable		
Atmospheric Emissions	General	LCP	BAT 10	In order to reduce emissions to air and/or to water during other than normal operating conditions (OTNOC), BAT is to set up and implement a management plan as part of the environmental management system (see BAT 1), commensurate with the relevance of potential pollutant releases, that includes the following elements: A) appropriate design of the systems considered relevant in causing OTNOC that may have an impact on emissions to air, water and/or soil (e.g. low-load design concepts for reducing the minimum start-up and shutdown loads for stable generation in gas turbines); B) set-up and implementation of a specific preventive maintenance plan for these relevant systems; C) review and recording of emissions caused by OTNOC and associated circumstances and implementation of corrective actions if necessary; D) periodic assessment of the overall emissions during OTNOC (e.g. frequency of events, duration, emissions quantification/estimation) and implementation of corrective actions if necessary.	Operation			
Atmospheric Emissions	Monitoring	LCP	BAT 11	BAT is to appropriately monitor emissions to air and/or to water during OTNOC.	Design	Applicable	Environmental basis of design stipulates Continuous emission monitoring of the new stack, which will record pollutant levels continuously across all operational/non-operational conditions.	

Large Combustion Plant BATC					Screening			
Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status	Recommendations
Atmospheric Emissions		LCP	BAT 12	In order to increase the energy efficiency of combustion, gasification and/or IGCC units operated ≥ 1 500 h/yr, BAT is to use an appropriate combination of the techniques given below: a) Combustion optimisation b) optimisation of the working medium conditions (i.e., pressure/temp) c) Optimisation of the steam cycle d) minimisation of energy consumption e) Preheating of Combustion air f) Fuel Preheating g) Advanced Control Systems h) Feed-water preheating using recovered heat i) Heat recovery by cogeneration (CHP) j) CHP readiness (future potential of heat use) k) fuel-gas condenser l) Heat accumulation m) Wet Stack n) Cooling Tower Discharge o) Fuel Pre-drying p) Minimisation of heat losses q) Advanced Materials r) Steam turbine upgrade	Design	Applicable	Optimisation techniques (i.e., a, b, c, g, p etc) are captured as part of standard design processes and OEM advisement based on provided process characteristics. Project design is to use CHP with waste heat recovery as default and the flue gas from the existing kiln is used as pre-heated combustion air.	
Emissions to Water	Water	LCP	BAT 13	In order to reduce water usage and the volume of contaminated waste water discharged, BAT is to use one or both of the techniques given below A) Water recycling B) Dry bottom ash handling (no water cooling)	Design	Applicable	A) In design. Project design includes policy of zero-discharge. Wastewater streams are recycled (example absorber blowdown is captured, treated and reused in process as cooling water). B) not applicable to the project	
Emissions to Water		LCP	BAT 14	In order to prevent the contamination of uncontaminated waste water and to reduce emissions to water, BAT is to segregate waste water streams and to treat them separately, depending on the pollutant content	Design	Applicable	In design. Segregation of wastewater streams shall be included in design (ref process description). Details of effluent stream handling/drainage shall be detailed in drainage philosophy 215000-00190-000-PR-PHL-00004.	
Emissions to Water		LCP	BAT 15	In order to reduce emissions to water from flue-gas treatment, BAT is to use an appropriate combination of the techniques given below, and to use secondary techniques as close as possible to the source in order to avoid dilution. Primary Technique: Optimise combustion (BAT 6) and flue-gas treatment systems (BAT 7). Secondary Techniques: - Absorption on activated carbon - Aerobic biological treatment - Anoxic/anaerobic biological treatment - coagulation and flocculation - Crystallisation - Filtration (i.e., sand filtration microfiltration, ultrafiltration) - Flotation - Ion exchange - Neutralisation - Oxidation - Precipitation - Sedimentation	Design	Not Applicable	Not applicable. Project has zero-discharge policy. No discharges to receiving water in design.	
Emissions to Water	General	LCP	BAT 16	In order to reduce the quantity of waste sent for disposal from the combustion and/or gasification process and abatement techniques, BAT is to organise operations so as to maximise, in order of priority and taking into account life-cycle thinking: - waste prevention, e.g. maximise the proportion of residues which arise as by-products; - waste preparation for reuse, e.g. according to the specific requested quality criteria; - waste recycling; - other waste recovery (e.g. energy recovery), by implementing an appropriate combination of techniques such as a) Generation of gypsum as a by-product b) Recycling or recovery of residues in the construction sector c) Energy recovery by using waste in the fuel mix d) Preparation of spent catalyst for reuse	Design	Applicable	Item (b) is within scope of the plant design. Wastewaters and recovered sludges from the Carbon Capture plant will be routed to the existing cement facility for use (directly and indirectly) in production of cement.	
Noise Emissions	General	LCP	BAT 17	In order to reduce noise emissions, BAT is to use one or a combination of the techniques given below. A) Operational measures (i.e., improved inspection/maintenance, closing doors/window, avoid noisy activities at night) B) Low Noise equipment C) Noise attenuation D) Noise control equipment (insulation, enclosures, soundproofing) E) Appropriate location of equipment and buildings	Design	Applicable	Part of standard design processes and considerations to minimise noise where possible via incorporating noise level requirements in vendor quotes and appropriate site layout to avoid direct line between noisy equipment and neighbours as far as practical and possible. Action was raised in ENVID (#4) to identify sound sources for facility and undertake noise assessment to determine noise levels at neighbouring sites/residential areas. (Ref ENVID report 215000-00190-000-EN-REP-00004)	
Atmospheric Emissions	Solid Fuels	LCP	BAT 18	In order to improve the general environmental performance of the combustion of coal and/or lignite, and in addition to BAT 6, BAT is to use the technique given below. Integrated combustion process ensuring high boiler efficiency and including primary techniques for NOX reduction (e.g. air staging, fuel staging, low-NOX burners (LNB) and/or flue-gas recirculation)	Design	Not Applicable	Plant will not combust solid fuels	
Energy Efficiency	Solid Fuels	LCP	BAT 19	In order to increase the energy efficiency of the combustion of coal and/or lignite, BAT is to use an appropriate combination of the techniques given in LCP BAT 12 and below. - Dry bottom ash handling	Design	Not Applicable	Plant will not combust solid fuels	

Large Combustion Plant BATC					Screening			
Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status	Recommendations
Atmospheric Emissions	Solid Fuels	LCP	BAT 20	In order to prevent or reduce NOX emissions to air while limiting CO and N2O emissions to air from the combustion of coal and/or lignite, BAT is to use one or a combination of the techniques given below. - Combustion optimisation - Combination of other primary techniques for NOx reduction (air staging, fuel staging, flue gas recirculation, low-NOx burners(- Selective non-catalytic reduction (SNCR) - Selective catalytic reduction (SCR) - Combined Techniques for NOx and SOx reduction (fuel dependant)	Design	Not Applicable	Plant will not combust solid fuels	
Atmospheric Emissions	Solid Fuels	LCP	BAT 21	In order to prevent or reduce SO_X, HCl and HF emissions to air from the combustion of coal and/or lignite, BAT is to use one or a combination of the techniques given below. - Boiler sorbent injection (in-furnace or in-bed) - Duct sorbent injection - Spray dry absorber - Circulating fluidised bed (CFB) dry scrubber - Wet Scrubbing - Wet flue-gas desulphurisation (FGD) - Seawater FGD - Combined techniques for NOX and SOX reduction - Replacement or removal of the gas-gas heater located downstream of the wet FGD - Fuel Choice	Design	Not Applicable	Plant will not combust solid fuels	
Atmospheric Emissions	Solid Fuels	LCP	BAT 22	In order to reduce dust and particulate-bound metal emissions to air from the combustion of coal and/or lignite, BAT is to use one or a combination of the techniques given below. - Electrostatic precipitator (ESP) - Bag Filter - Boiler sorbent injection (in-furnace or in-bed) - Dry or semi-dry FGD system - Wet flue-gas desulphurisation	Design	Not Applicable	Plant will not combust solid fuels	
Atmospheric Emissions	Solid Fuels	LCP	BAT 23	In order to prevent or reduce mercury emissions to air from the combustion of coal and/or lignite, BAT is to use one or a combination of the techniques given below. General Techniques: - Electrostatic precipitator (ESP) - Bag Filter - Dry or semi-dry FGD system - Wet flue-gas desulphurisation - Selective Catalytic Reduction Specific Techniques to reduce mercury emissions - Carbon Sorbent (i.e., activated carbon or halogenated activated carbon) - Use of halogenated additives in the fuel or injected in the furnace - Fuel pre-treatment	Design	Not Applicable	Plant will not combust solid fuels	
Atmospheric Emissions	Solid biomass	LCP	BAT 24	In order to prevent or reduce NOX emissions to air while limiting CO and N2O emissions to air from the combustion of solid biomass and/or peat, BAT is to use one or a combination of the techniques given below. - Combustion optimisation - Low-NOX burners (LNB) - Air staging - Fuel staging - Flue-gas recirculation - Selective non-catalytic reduction (SNCR)	Design	Not Applicable	Plant will not combust solid fuels	
Atmospheric Emissions	Solid biomass	LCP	BAT 25	In order to prevent or reduce SOX, HCl and HF emissions to air from the combustion of solid biomass and/or peat, BAT is to use one or a combination of the techniques given below. - Boiler sorbent injection (in-furnace or in-bed) - Duct sorbent injection (DSI) - Spray dry absorber (SDA) - Circulating fluidised bed (CFB) dry scrubber - Wet scrubbing - Flue-gas condenser - Wet flue-gas desulphurisation (wet FGD)	Design	Not Applicable	Plant will not combust solid fuels	
Atmospheric Emissions	Solid biomass	LCP	BAT 26	In order to reduce dust and particulate-bound metal emissions to air from the combustion of solid biomass and/or peat, BAT is to use one or a combination of the techniques given below. - Electrostatic precipitator (ESP) - Bag Filter - Dry or semi-dry FGD system - Wet flue-gas desulphurisation - Fuel Choice	Design	Not Applicable	Plant will not combust solid fuels	
Atmospheric Emissions	Solid biomass	LCP	BAT 27	In order to prevent or reduce mercury emissions to air from the combustion of solid biomass and/or peat, BAT is to use one or a combination of the techniques given below. Specific Techniques - Carbon sorbent (e.g. activated carbon or halogenated activated carbon) injection in the flue-gas - Use of halogenated additives in the fuel or injected in the furnace - Fuel choice Co Benefit from techniques primarily used to reduce emissions of other pollutants - Electrostatic precipitator (ESP) - Bag Filter - Dry or semi-dry FGD system - Wet flue-gas desulphurisation	Design	Not Applicable	Plant will not combust solid fuels	
Atmospheric Emissions	Liquid Fuels	LCP	BAT 28	In order to prevent or reduce NOX emissions to air while limiting CO emissions to air from the combustion of HFO and/or gas oil in boilers, BAT is to use one or a combination of the techniques given below. - Air staging - Fuel staging - Flue-gas recirculation - Low-NOX burners (LNB) - Water/steam addition - Selective non-catalytic reduction (SNCR) - Selective catalytic reduction (SCR) - Advanced control system - Fuel choice	Design	Not Applicable	Plant will not combust gas oil	

Large Combustion Plant BATC					Screening			
Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status	Recommendations
Atmospheric Emissions	Liquid Fuels	LCP	BAT 29	In order to prevent or reduce SOX, HCl and HF emissions to air from the combustion of HFO and/or gas oil in boilers, BAT is to use one or a combination of the techniques given below. - Duct sorbent injection (DSI) - Spray dry absorber (SDA) - Flue-gas condenser - Wet flue-gas desulphurisation (wet FGD) - Seawater FGD - Fuel choice	Design	Not Applicable	Plant will not combust gas oil	
Atmospheric Emissions	Liquid Fuels	LCP	BAT 30	In order to reduce dust and particulate-bound metal emissions to air from the combustion of HFO and/or gas oil in boilers, BAT is to use one or a combination of the techniques given below. - Electrostatic precipitator (ESP) - Bag Filter - Multicyclones - Dry or semi-dry FGD system - Wet flue-gas desulphurisation - Fuel Choice	Design	Not Applicable	Plant will not combust gas oil	
Energy Efficiency	Liquid Fuels	LCP	BAT 31	In order to increase the energy efficiency of HFO and/or gas oil combustion in reciprocating engines, BAT is to use an appropriate combination of the techniques given in LCP BAT 12 and below. - Combined Cycle (not applicable to units operated <1500 h/y)	Design	Not Applicable	Plant will not combust gas oil. No direct fired engines in design	
Atmospheric Emissions	Liquid Fuels	LCP	BAT 32	In order to prevent or reduce NOX emissions to air from the combustion of HFO and/or gas oil in reciprocating engines, BAT is to use one or a combination of the techniques given below. - Low-NOX combustion concept in diesel engines - Exhaust-gas recirculation (EGR) - Water/steam addition - Selective catalytic reduction (SCR)	Design	Not Applicable	Plant will not combust gas oil. No direct fired engines in design	
Atmospheric Emissions	Liquid Fuels	LCP	BAT 33	In order to prevent or reduce emissions of CO and volatile organic compounds to air from the combustion of HFO and/or gas oil in reciprocating engines, BAT is to use one or both of the techniques given below. -Combustion optimisation -Oxidation catalysts	Design	Not Applicable	Plant will not combust gas oil. No direct fired engines in design	
Atmospheric Emissions	Liquid Fuels	LCP	BAT 34	In order to prevent or reduce SOX, HCl and HF emissions to air from the combustion of HFO and/or gas oil in reciprocating engines, BAT is to use one or a combination of the techniques given below. - Fuel choice - Duct sorbent injection (DSI) -Wet flue-gas desulphurisation (wet FGD)	Design	Not Applicable	Plant will not combust gas oil. No direct fired engines in design	
Atmospheric Emissions	Liquid Fuels	LCP	BAT 35	In order to prevent or reduce dust and particulate-bound metal emissions from the combustion of HFO and/or gas oil in reciprocating engines, BAT is to use one or a combination of the techniques given below. - Fuel choice - Electrostatic precipitator (ESP) - Bag Filter	Design	Not Applicable	Plant will not combust gas oil. No direct fired engines in design	
Energy Efficiency	Liquid Fuels	LCP	BAT 36	In order to increase the energy efficiency of gas oil combustion in gas turbines, BAT is to use an appropriate combination of the techniques given in BAT 12 and below - Combined Cycle	Design	Not Applicable	Plant will not combust gas oil. No gas turbines in design.	
Atmospheric Emissions	Liquid Fuels	LCP	BAT 37	In order to prevent or reduce NOX emissions to air from the combustion of gas oil in gas turbines, BAT is to use one or a combination of the techniques given below. - Water/steam addition - Low-NOX burners (LNB) - Selective catalytic reduction (SCR)	Design	Not Applicable	Plant will not combust gas oil. No gas turbines in design.	
Atmospheric Emissions	Liquid Fuels	LCP	BAT 38	In order to prevent or reduce CO emissions to air from the combustion of gas oil in gas turbines, BAT is to use one or a combination of the techniques given below - Combustion optimisation - Oxidation catalysts	Design	Not Applicable	Plant will not combust gas oil. No gas turbines in design.	
Atmospheric Emissions	Liquid Fuels	LCP	BAT 39	In order to prevent or reduce SOX and dust emissions to air from the combustion of gas oil in gas turbines, BAT is to use the technique given below. - Fuel Choice	Design	Not Applicable	Plant will not combust gas oil. No gas turbines in design.	
Energy Efficiency	Gaseous Fuels	LCP	BAT 40	In order to increase the energy efficiency of natural gas combustion, BAT is to use an appropriate combination of the techniques given in LCP BAT 12 and below. - Combined Cycle	Design	Applicable	The heat generated by the boiler will be used to raise steam to run a steam turbine generator produce electrical power for the Carbon Capture unit	
Atmospheric Emissions	Gaseous Fuels	LCP	BAT 41	In order to prevent or reduce NOX emissions to air from the combustion of natural gas in boilers, BAT is to use one or a combination of the techniques given below. A) Air and/or fuel staging B) Flue-gas recirculation C) Low-NOX burners (LNB) D) Advanced control system E) Reduction of the combustion air temperature F) Selective non–catalytic reduction (SNCR) G) Selective catalytic reduction (SCR)	Design	Applicable	Boiler design is to be established in FEED with advisement form OEM. Design will have low-NOx burner technology (C.) and (G) SCR is in design. Overall impact is circa 90% reduction in NOX emissions compared to existing cement plant	
Atmospheric Emissions	Gaseous Fuels	LCP	BAT 42	In order to prevent or reduce NOX emissions to air from the combustion of natural gas in gas turbines, BAT is to use one or a combination of the techniques given below. A)Advanced control system B) Water/steam addition C) Dry low-NOX burners (DLN) D) Low-load design concept E) Low-NOX burners (LNB) F) Selective catalytic reduction (SCR)	Design	Not Applicable	No Gas turbines in design	
Atmospheric Emissions	Gaseous Fuels	LCP	BAT 43	In order to prevent or reduce NOX emissions to air from the combustion of natural gas in engines, BAT is to use one or a combination of the techniques given below. A) Advanced control system B) Lean burn concept C) Advanced lean-burn concept D) Selective Catalytic reduction (SCR)	Design	Not Applicable	No gas fired engines in design	

Large Combustion Plant BATC					Screening			
Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status	Recommendations
Atmospheric Emissions	Gaseous Fuels	LCP	BAT 44	In order to prevent or reduce CO emissions to air from the combustion of natural gas, BAT is to ensure optimised combustion and/or to use oxidation catalysts.	Design	Applicable	No permit compliance issue with CO emissions has been identified.	
Atmospheric Emissions	Gaseous Fuels	LCP	BAT 45	In order to reduce non-methane volatile organic compounds (NMVOC) and methane (CH4) emissions to air from the combustion of natural gas in spark-ignited lean-burn gas engines, BAT is to ensure optimised combustion and/or to use oxidation catalysts.	Design	Not Applicable	No gas engines in design	
Energy Efficiency	Iron and steel process gases	LCP	BAT 46	In order to increase the energy efficiency of the combustion of iron and steel process gases, BAT is to use an appropriate combination of the techniques given in LCP BAT 12 and below. - Process gas management system (integrated steelworks only)	Design	Not Applicable	Not applicable to scope of project/facility operations	
Atmospheric Emissions	Iron and steel process gases	LCP	BAT 47	In order to prevent or reduce NOX emissions to air from the combustion of iron and steel process gases in boilers, BAT is to use one or a combination of the techniques given below. A) Low-NOX burners (LNB) B) Air staging C) Fuel staging D) Flue-gas recirculation E) Process gas management system F) Advanced control system G) Selective non-catalytic reduction (SNCR) H) Selective catalytic reduction (SCR)	Design	Not Applicable	Not applicable to scope of project/facility operations	
Atmospheric Emissions	Iron and steel process gases	LCP	BAT 48	In order to prevent or reduce NOX emissions to air from the combustion of iron and steel process gases in CCGTs, BAT is to use one or a combination of the techniques given below. - Process gas management system - Advanced control system - Water/steam addition -Dry low-NOX burners(DLN) - Low-NOX burners (LNB) - Selective catalytic reduction (SCR)	Design	Not Applicable	Not applicable to scope of project/facility operations	
Atmospheric Emissions	Iron and steel process gases	LCP	BAT 49	In order to prevent or reduce CO emissions to air from the combustion of iron and steel process gases, BAT is to use one or a combination of the techniques given below. - Combustion optimisation - Oxidation Catalysts (CCGTs only)	Design	Not Applicable	Not applicable to scope of project/facility operations	
Atmospheric Emissions	Iron and steel process gases	LCP	BAT 50	In order to prevent or reduce SOX emissions to air from the combustion of iron and steel process gases, BAT is to use a combination of the techniques given below . - Process gas management system and auxiliary fuel choice - Coke oven gas pre-treatment at the iron- and steel-works (coke oven gas combustion plants only)	Design	Not Applicable	Not applicable to scope of project/facility operations	
Atmospheric Emissions	Iron and steel process gases	LCP	BAT 51	In order to reduce dust emissions to air from the combustion of iron and steel process gases, BAT is to use one or a combination of the techniques given below. - Fuel choice/management - Blast furnace gas pre-treatment at the iron- and steel-works (Only applicable if blast furnace gas is combusted) -Basic oxygen furnace gas pre-treatment at the iron- and steel-works (Only applicable if basic oxygen furnace gas is combusted) - Electrostatic precipitator (ESP) (Only applicable to combustion plants combusting a significant proportion of auxiliary fuels with a high ash content) - Bag filter (same as above)	Design	Not Applicable	Not applicable to scope of project/facility operations	
Energy Efficiency	Gas / Liquid Fuels Offshore	LCP	BAT 52	In order to improve the general environmental performance of the combustion of gaseous and/or liquid fuels on offshore platforms, BAT is to use one or a combination of the techniques given below. - Process optimisation - Control pressure losses - Load control - Minimise the 'spinning reserve' - Fuel choice - Injection timing - Heat recovery - Power integration of multiple gas fields/oilfields	Design	Not Applicable	Not applicable to scope of project/facility operations	
Atmospheric Emissions		LCP	BAT 53	In order to prevent or reduce NOX emissions to air from the combustion of gaseous and/or liquid fuels on offshore platforms, BAT is to use one or a combination of the techniques given below. - Advanced control system - Dry low-NOX burners (DLN) - Lean-burn concept (new gas-fired engines) -Low-NOX burners (LNB) (boilers only)	Design	Not Applicable	Not applicable to scope of project/facility operations	
Atmospheric Emissions		LCP	BAT 54	In order to prevent or reduce CO emissions to air from the combustion of gaseous and/or liquid fuels in gas turbines on offshore platforms, BAT is to use one or a combination of the techniques given below. - Combustion optimisation - Oxidation catalysts (not applicable <500 h/y)	Design	Not Applicable	Not applicable to scope of project/facility operations	
Energy Efficiency	Multi-fuel Plants	LCP	BAT 55	In order to improve the general environmental performance of the combustion of process fuels from the chemical industry in boilers, BAT is to use an appropriate combination of the techniques given in LCP BAT 6 and below. - Pre-treatment of process fuel from the chemical industry	Design	Not Applicable	Not applicable to scope of project/facility operations	
Atmospheric Emissions	Multi-fuel Plants	LCP	BAT 56	In order to prevent or reduce NOX emissions to air while limiting CO emissions to air from the combustion of process fuels from the chemical industry, BAT is to use one or a combination of the techniques given below. - Low-NOX burners (LNB) -Air staging -Fuel staging -Flue-gas recirculation -Water/steam addition -Fuel choice -Advanced control system -Selective non-catalytic reduction (SNCR)] -Selective catalytic reduction (SCR) (not generally applicable to plants <100MWth)	Design	Not Applicable	Not applicable to scope of project/facility operations	
Atmospheric Emissions	Multi-fuel Plants	LCP	BAT 57	In order to reduce SOX, HCl and HF emissions to air from the combustion of process fuels from the chemical industry in boilers, BAT is to use one or a combination of the techniques given below. - Fuel choice - Boiler sorbent injection (in-furnace or in-bed - Duct sorbent injection (DSI) - Spray dry absorber (SDA) - Wet scrubbing - Wet flue-gas desulphurisation (wet FGD)	Design	Not Applicable	Not applicable to scope of project/facility operations	

Large Combustion Plant BATC					Screening			
Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status	Recommendations
Atmospheric Emissions	Multi-fuel Plants	LCP	BAT 58	In order to reduce emissions to air of dust, particulate-bound metals, and trace species from the combustion of process fuels from the chemical industry in boilers, BAT is to use one or a combination of the techniques given below. - Electrostatic precipitator (ESP) -Bag filter -Fuel choice -Dry or semi-dry FGD system -Wet flue-gas desulphurisation (wet FGD)	Design	Not Applicable	Not applicable to scope of project/facility operations	
Noise Emissions	Multi-fuel Plants	LCP	BAT 59	In order to reduce emissions to air of volatile organic compounds and polychlorinated dibenzo-dioxins and -furans from the combustion of process fuels from the chemical industry in boilers, BAT is to use one or a combination of the techniques given in LCP BAT 6 and below. -Activated carbon injection -Rapid quenching using wet scrubbing/flue-gas condenser -Selective catalytic reduction (SCR)	Design	Not Applicable	Not applicable to scope of project/facility operations	
Atmospheric Emissions	Co-incineration of waste	LCP	BAT 60	In order to improve the general environmental performance of the co-incineration of waste in combustion plants, to ensure stable combustion conditions, and to reduce emissions to air, BAT is to use technique LCP BAT 60 below and a combination of the techniques given in LCP BAT 6 and/or the other techniques below. - Waste pre-acceptance and acceptance - Waste selection/limitation - Waste mixing with the main fuel - Waste drying - Waste pre-treatment	Design	Not Applicable	Not applicable to scope of project/facility operations	
Atmospheric Emissions	Co-incineration of waste	LCP	BAT 61	In order to prevent increased emissions from the co-incineration of waste in combustion plants, BAT is to take appropriate measures to ensure that the emissions of polluting substances in the part of the flue-gases resulting from waste co-incineration are not higher than those resulting from the application of BAT conclusions for the incineration of waste.	Design	Not Applicable	Not applicable to scope of project/facility operations	
Atmospheric Emissions	Co-incineration of waste	LCP	BAT 62	In order to minimise the impact on residues recycling of the co-incineration of waste in combustion plants, BAT is to maintain a good quality of gypsum, ashes and slags as well as other residues, in line with the requirements set for their recycling when the plant is not co-incinerating waste, by using one or a combination of the techniques given in LCP BAT 60 and/or by restricting the co-incineration to waste fractions with pollutant concentrations similar to those in other combusted fuels.	Design	Not Applicable	Not applicable to scope of project/facility operations	
Energy Efficiency	Co-incineration of waste	LCP	BAT 63	In order to increase the energy efficiency of the co-incineration of waste, BAT is to use an appropriate combination of the techniques given in LCP BAT 12 and LCP BAT 19, depending on the main fuel type used and on the plant configuration.	Design	Not Applicable	Not applicable to scope of project/facility operations	
Atmospheric Emissions	Co-incineration of waste	LCP	BAT 64	In order to prevent or reduce NOX emissions to air while limiting CO and N2O emissions from the co-incineration of waste with coal and/or lignite, BAT is to use one or a combination of the techniques given in LCP BAT 20.	Design	Not Applicable	Not applicable to scope of project/facility operations	
Atmospheric Emissions	Co-incineration of waste	LCP	BAT 65	In order to prevent or reduce NOX emissions to air while limiting CO and N2O emissions from the co-incineration of waste with biomass and/or peat, BAT is to use one or a combination of the techniques given in LCP BAT 24.	Design	Not Applicable	Not applicable to scope of project/facility operations	
Atmospheric Emissions	Co-incineration of waste	LCP	BAT 66	In order to prevent or reduce SOX, HCl and HF emissions to air from the co-incineration of waste with coal and/or lignite, BAT is to use one or a combination of the techniques given in LCP BAT 21.	Design	Not Applicable	Not applicable to scope of project/facility operations	
Atmospheric Emissions	Co-incineration of waste	LCP	BAT 67	In order to prevent or reduce SOX, HCl and HF emissions to air from the co-incineration of waste with biomass and/or peat, BAT is to use one or a combination of the techniques given in LCP BAT 25.	Design	Not Applicable	Not applicable to scope of project/facility operations	
Atmospheric Emissions	Co-incineration of waste	LCP	BAT 68	In order to reduce dust and particulate-bound metal emissions to air from the co-incineration of waste with coal and/or lignite, BAT is to use one or a combination of the techniques given in LCP BAT 22.	Design	Not Applicable	Not applicable to scope of project/facility operations	
Atmospheric Emissions	Co-incineration of waste	LCP	BAT 69	In order to reduce dust and particulate-bound metal emissions to air from the co-incineration of waste with biomass and/or peat, BAT is to use one or a combination of the techniques given in LCP BAT 26.	Design	Not Applicable	Not applicable to scope of project/facility operations	
Atmospheric Emissions	Co-incineration of waste	LCP	BAT 70	n order to reduce mercury emissions to air from the co-incineration of waste with biomass, peat, coal and/or lignite, BAT is to use one or a combination of the techniques given in LCP BAT 23 and LCP BAT 27.	Design	Not Applicable	Not applicable to scope of project/facility operations	
Atmospheric Emissions	Co-incineration of waste	LCP	BAT 71	In order to reduce emissions of volatile organic compounds and polychlorinated dibenzo-dioxins and -furans to air from the co-incineration of waste with biomass, peat, coal and/or lignite, BAT is to use a combination of the techniques given in LCP BAT 6, LCP BAT 26 and below. - Activated carbon injection - Rapid quenching using wet scrubbing/flue-gas condenser - Selective Catalytic reduction (SCR).	Design	Not Applicable	Not applicable to scope of project/facility operations	
Energy Efficiency	Gasification	LCP	BAT 72	In order to increase the energy efficiency of IGCC and gasification units, BAT is to use one or a combination of the techniques given in LCP BAT 12 and below. - Heat recovery from the gasification process - Integration of gasification and combustion processes - Dry feedstock feeding system - High-temperature and -pressure gasification - Design improvements.	Design	Not Applicable	Not applicable to scope of project/facility operations	
Atmospheric Emissions	Gasification	LCP	BAT 73	In order to prevent and/or reduce NOX emissions to air while limiting CO emissions to air from IGCC plants, BAT is to use one or a combination of the techniques given below. - Combustion optimisation - Water/steam addition - Dry low-NOX burners (DLN) - Syngas dilution with waste nitrogen from the air supply unit (ASU) - Selective catalytic reduction (SCR).	Design	Not Applicable	Not applicable to scope of project/facility operations	
Atmospheric Emissions	Gasification	LCP	BAT 74	In order to reduce SOX emissions to air from IGCC plants, BAT is to use the technique given below. - Acid gas removal (applicability dependant on S content).	Design	Not Applicable	Not applicable to scope of project/facility operations	
Atmospheric Emissions	Gasification	LCP	BAT 75	In order to prevent or reduce dust, particulate-bound metal, ammonia and halogen emissions to air from IGCC plants, BAT is to use one or a combination of the techniques given below. -Syngas filtration -Syngas tars and ashes recirculation to the gasifier	Design	Not Applicable	Not applicable to scope of project/facility operations	

Waste Treatment BREF					Screening			
Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status	Further requirements
Operation/Management	Management	WT	BAT 1	In order to improve the overall environmental performance, BAT is to implement and adhere to an environmental management system (EMS)	Operation			
Energy Efficiency		WT	BAT 2	In order to improve the overall environmental performance of the plant, BAT is to use all of the techniques given below. A) Set up and implement waste characterisation and pre-acceptance procedures B) Set up and implement waste acceptance procedures C) Set up and implement a waste tracking system and inventory D) Set up and implement an output quality management system E) Ensure waste segregation F) Ensure waste compatibility prior to mixing or blending of waste G) Sort incoming solid waste	Design	Applicable		Interpretation is this BAT is for waste storage facilities, and therefore not fully applicable to the scope of this project. However, generally the plant will be required to implement appropriate waste management procedures for the temporary storage of contaminated effluents, spent containers from chemical delivery (if not immediately returned) etc. Also general (Domestic) wastes from the office blocks (paper, cardboard, plastic, food) etc.
Emissions to Water	Emissions to Water / Emissions To Air	WT	BAT 3	In order to facilitate the reduction of emissions to water and air, BAT is to establish and to maintain an inventory of waste water and waste gas streams, as part of the environmental management system (see WT BAT 1)	Operation			
Emissions to Water	Storage	WT	BAT 4	In order to reduce the environmental risk associated with the storage of waste, BAT is to use all of the techniques given below Optimised Storage Location; including techniques such as A) the storage is located as far as technically and economically possible from sensitive receptors, watercourses, etc.; B) the storage is located in such a way so as to eliminate or minimise the unnecessary handling of wastes within the plant (e.g. the same wastes are handled twice or more or the transport distances on site are unnecessarily long). Adequate Storage Capacity C) the maximum waste storage capacity is clearly established and not exceeded taking into account the characteristics of the wastes (e.g. regarding the risk of fire) and the treatment capacity; D) The quantity of waste stored is regularly monitored against the maximum allowed storage capacity; E) the maximum residence time of waste is clearly established. Safe storage operation F) equipment used for loading, unloading and storing waste is clearly documented and labelled; G) wastes known to be sensitive to heat, light, air, water, etc. are protected from such ambient conditions; H) containers and drums are fit for purpose and stored securely. Separate area for storage and handling of packaged hazardous waste	Design	Applicable	Considerations listed here are generally applicable to and will form the waste management procedures for the facility.	
Emissions to Water	Waste Handling	WT	BAT 5	In order to reduce the environmental risk associated with the handling and transfer of waste, BAT is to set up and implement handling and transfer procedures. They include the following elements: A) handling and transfer of waste are carried out by competent staff; B) handling and transfer of waste are duly documented, validated prior to execution and verified after execution; C) measures are taken to prevent, detect and mitigate spills; D) operation and design precautions are taken when mixing or blending wastes (e.g. vacuuming dusty/powdery wastes).	Operation			
Emissions to Water	Monitoring	WT	BAT 6	For relevant emissions to water as identified by the inventory of waste water streams (see WT BAT 3), BAT is to monitor key process parameters (e.g. waste water flow, pH, temperature, conductivity, BOD) at key locations (e.g. at the inlet and/or outlet of the pre-treatment, at the inlet to the final treatment, at the point where the emission leaves the installation).	Design	Not Applicable	not applicable - Project has adopted zero-liquid discharge policy. No discharged to receiving water.	
Emissions to Water	Monitoring	WT	BAT 7	BAT is to monitor emissions to water 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. SEE WASTE TREATMENT TABLE 1	Design	Not Applicable	not applicable - Project has adopted zero-liquid discharge policy. No discharged to receiving water.	
Atmospheric Emissions	Monitoring	WT	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. SEE WASTE TREATMENT TABLE 2	Operation	Applicable	Only Total Volatile Organic Compounds (TVOC) monitoring each 6 months is applicable.	
Operation/Management	Monitoring	WT	BAT 9	BAT is to monitor diffuse emissions of organic compounds to air from the regeneration of spent solvents, the decontamination of equipment containing POPs with solvents, and the physico-chemical treatment of solvents for the recovery of their calorific value, at least once per year using one or a combination of the techniques given below. A) Measurement - Sniffing methods, optical gas imaging, solar occultation flux or differential absorption. B) Emission factors - Calculation of emissions based on emissions factors, periodically validated (e.g. once every two years) by measurements. C) Mass balance - Calculation of diffuse emissions using a mass balance considering the solvent input, channelled emissions to air, emissions to water, the solvent in the process output, and process (e.g. distillation) residues.	Operation			
Operation/Management	Odour	WT	BAT 10	BAT is to periodically monitor odour emissions. Odour emissions can be monitored using A) EN standards (e.g. dynamic olfactometry according to EN 13725 in order to determine the odour concentration or EN 16841-1 or -2 in order to determine the odour exposure); B) when applying alternative methods for which no EN standards are available (e.g. estimation of odour impact), ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality. The monitoring frequency is determined in the odour management plan (see BAT 12).	Operation			
Emissions to Water		WT	BAT 11	BAT is to monitor the annual consumption of water, energy and raw materials as well as the annual generation of residues and waste water, with a frequency of at least once per year.	Operation			

Waste Treatment BREF					Screening			
Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status	Further requirements
Atmospheric Emissions	Odour	WT	BAT 12	In order to prevent or, where that is not practicable, to reduce odour emissions, BAT is to set up, implement and regularly review an odour management plan, as part of the environmental management system (see WT BAT 1), that includes all of the following elements: A) a protocol containing actions and timelines; B) a protocol for conducting odour monitoring as set out in BAT 10; C) a protocol for response to identified odour incidents, e.g. complaints; D) an odour prevention and reduction programme designed to identify the source(s); to characterise the contributions of the sources; and to implement prevention and/or reduction measures.	Operation			
Atmospheric Emissions	odour	WT	BAT 13	In order to prevent or, where that is not practicable, to reduce odour emissions, BAT is to use one or a combination of the techniques given below A) Minimising residence time (open systems only) B) Using Chemical Treatment to destroy or reduce the formation of odorous compounds C) Optimising aerobic treatment (use of pure oxygen; removal of scum in tanks; frequent maintenance of aeration system)	Design	Applicable	No significant odour emissions are anticipated from the water treatment units.	Odour assessment will be undertaken as part of the Environmental Impact assessment and feedback into design if mitigation measures are required.
Atmospheric Emissions	dust, organic compounds and odour	WT	BAT 14	In order to prevent or, where that is not practicable, to reduce diffuse emissions to air, in particular of dust, organic compounds and odour, BAT is to use an appropriate combination of the techniques given below. A) Minimising the number of potential diffuse emission sources (appropriate design of piping layout, favouring use of gravity transfer; limiting drop height of material; wind barriers etc) B) Selection and use of high-integrity equipment (High-integrity seals/gaskets; pumps/compressors with mechanical seals; magnetically driven pumps etc) C) Corrosion prevention (appropriate selection of construction materials and lining. Coating of equipment with corrosion inhibitors) D) Containment, collection and treatment of diffuse emissions (i.e., maintaining the enclosed equipment/buildings under adequate pressure; collecting and directing emissions to an abatement system) E) Dampening - (i.e., for dry material and dust) F) Maintenance (including ensuring access to potentially leaky equipment; regularly controlling protective equipment such as lamellar curtains, fast action doors) G) Cleaning of waste treatment and storage areas H) Leak Detection and Repair Programme	Design	Applicable	Not fully applicable to the scope of the project, however project design is to implement many of these techniques throughout	
Atmospheric Emissions	Flare	WT	BAT 15	BAT is to use flaring only for safety reasons or for non-routine operating conditions (e.g. start-ups, shutdowns) by using both of the techniques given below. A) Correct plant design including the provision of gas recovery system and the use of high-integrity relief valves B) Plan management (Balancing of gas system and use of advanced process control)	Design	Not Applicable	Not applicable - no flaring in design	
Atmospheric Emissions	Flare	WT	BAT 16	In order to reduce emissions to air from flares when flaring is unavoidable, BAT is to use both of the techniques given below. A) Correct design of flaring devices (Optimisation of height and pressure, assistance by steam, air or gas, type of flare tips, etc., to enable smokeless and reliable operation and to ensure the efficient combustion of excess gases.) B) Monitoring and recording as part of flare management	Design	Not Applicable	Not applicable - no flaring in design	
Noise Emissions	Noise	WT	BAT 17	In order to prevent or, where that is not practicable, to reduce noise and vibration emissions, BAT is to set up, implement and regularly review a noise and vibration management plan, as part of the environmental management system (see WT BAT 1), that includes all of the following elements: A) a protocol containing appropriate actions and timelines; B) a protocol for conducting noise and vibration monitoring; C) a protocol for response to identified noise and vibration events, e.g. complaints; D) a noise and vibration reduction programme designed to identify the source(s), to measure/estimate noise and vibration exposure, to characterise the contributions of the sources and to implement prevention and/or reduction measures.	Operation			
Noise Emissions	Noise	WT	BAT 18	In order to prevent or, where that is not practicable, to reduce noise and vibration emissions, BAT is to use one or a combination of the techniques given below. A) Appropriate location of equipment and buildings B) Operational measures (inspection/closing of doors; operated by experienced staff; avoid noisy activities at night; provisions of noise control) C) Low-Noise Equipment (Direct drive motors, compressors, pumps and flares) D) Noise and vibration control equipment (enclosures, soundproofing, acoustic dampeners etc) E) Noise Attenuation (use of walls/obstacles between sound and receiver)	Design	Applicable	Part of standard design processes and considerations to minimise noise where possible via incorporating noise level requirements in vendor quotes and appropriate site layout to avoid direct line between noisy equipment and neighbours as far as practical and possible. Action was raised in ENVID (#4) to identify sound	0
Emissions to Water	Water Usage	WT	BAT 19	In order to optimise water consumption, to reduce the volume of waste water generated and to prevent or, where that is not practicable, to reduce emissions to soil and water, BAT is to use an appropriate combination of the techniques given below. A) Water management (water-saving plans; optimising use of washing water; reducing the use of water for vacuum generation) B) Water recirculation C) Impermeable surface (to avoid contamination of soil and/or adjacent water to storage area) D) Techniques to reduce the likelihood and impact of overflows and failures from tanks and vessels (i.e., overflow detectors, overflow pipes directed to contained drainage system; secondary containment) E) Roofing of waste storage and treatment areas (avoid rainwater getting in causing overflow) F) Segregation of water streams (Each water stream (e.g. surface run-off water, process water) is collected and treated separately) G) Adequate drainage infrastructure H) Design and maintenance provisions to allow detection and repair of leaks I) Appropriate buffer storage capacity	Design	Applicable	Project is implementing design choices based on potential for water saving including B) Use of recirculating water cooling; reuse of wastewater streams (example blowdown from absorber is treated and used as BFW). Recovery of condensate. F) Segregation of effluent streams with rationalisation of treatment based on stream characteristics. Buffer storage has been included in WWT design for 6 hours of normal flow rate.	G) drainage design to be established in FEED.
Emissions to Water	Emissions to Water	WT	BAT 20	In order to reduce emissions to water, BAT is to treat waste water using an appropriate combination of the techniques given below. SEE WASTE TREATMENT TABLE 3	Design	Not Applicable	Not applicable as wastewater is not being discharged.	

Waste Treatment BREF					Screening			
Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status	Further requirements
Emissions to Water	Emissions to Water	WT	BAT 21	In order to prevent or limit the environmental consequences of accidents and incidents, BAT is to use all of the techniques given below, as part of the accident management plan (see WT BAT 1). A) Protection measures (i.e., protection of the plant against malevolent acts; fire and explosion protection system; accessibility and operability of control equipment in emergency situations) B) Management of incidental/accidental emissions (Procedures are established and technical provisions are in place to manage (in terms of possible containment) emissions from accidents and incidents such as emissions from spillages, firefighting water, or safety valves.) C) Incident/accident registration and assessment system (i.e., logging and procedures to identify, respond and lean from incidents)	Design	Applicable	The (new) stack will be subject to Continuous emission monitoring of flue gas pollutant concentrations including NOx, SO_2, CO, PM, Ammonia, Amine. Full requirements are detailed in the Environmental Basis of Design.	
Energy Efficiency	Emissions to Water	WT	BAT 22	In order to use materials efficiently, BAT is to substitute materials with waste.	Design	Not Applicable	Not applicable to the scope of the plant	
Energy Efficiency	Emissions to Water	WT	BAT 23	In order to use energy efficiently, BAT is to use both of the techniques given below. A) Energy efficiency plan (estimate energy usage, set key performance indicators, targets etch) B) Energy Balance Record (breakdown of the energy consumption and generation (including exportation))	Operation			
Energy Efficiency	Emissions to Water	WT	BAT 24	In order to reduce the quantity of waste sent for disposal, BAT is to maximise the reuse of packaging, as part of the residues management plan (see WT BAT 1).	Design	Not Applicable	Not applicable to the scope of the plant	
Atmospheric Emissions	mechanical treatment of waste	WT	BAT 25	In order to reduce emissions to air of dust, and of particulate-bound metals, PCDD/F and dioxin-like PCBs, BAT is to apply BAT 14d and to use one or a combination of the techniques given below A) Cyclone (primary separator for coarse dust) B) Fabric filter C) Wet scrubbing D) Water Injection into the shredder	Design	Not Applicable	Not applicable - medical waste is not treated	
Atmospheric Emissions	Mechanical treatment of waste in shredders	WT	BAT 26	In order to improve the overall environmental performance, and to prevent emissions due to accidents and incidents, BAT is to use WT BAT 14 (G) and all of the techniques given below: - implementation of a detailed inspection procedure for baled waste before shredding; - removal of dangerous items from the waste input stream and their safe disposal (e.g. gas cylinders, non-depolluted EoLVs, non-depolluted WEEE, items contaminated with PCBs or mercury, radioactive items); - treatment of containers only when accompanied by a declaration of cleanliness.	Design	Not Applicable	Not applicable - medical waste is not treated	
Atmospheric Emissions	Mechanical treatment of waste in shredders	WT	BAT 27	In order to prevent deflagrations and to reduce emissions when deflagrations occur, BAT is to use technique a. and one or both of the techniques b. and c. given below. A) Deflagration management plan B)Pressure relief dampers C) Pre-shredding	Design	Not Applicable	Not applicable - medical waste is not treated	
Energy Efficiency	Mechanical treatment of waste in shredders	WT	BAT 28	In order to use energy efficiently, BAT is to keep the shredder feed stable.	Design	Not Applicable	Not applicable - medical waste is not treated	
Atmospheric Emissions	Treatment of WEE	WT	BAT 29	In order to prevent or, where that is not practicable, to reduce emissions of organic compounds to air, BAT is to apply BAT 14 (D), BAT 14 (H) and to use technique A) and one or both of the techniques B). and C). given below. A) optimised removal and capture of refrigerants and oils All refrigerants and oils are removed from the WEEE containing VFCs and/or VHCs and captured by a vacuum suction system (e.g. achieving refrigerant removal of at least 90 %). Refrigerants are separated from oils and the oils are degassed. The amount of oil remaining in the compressor is reduced to a minimum (so that the compressor does not drip). B) Cryogenic condensation Waste gas containing organic compounds such as VFCs/VHCs is sent to a cryogenic condensation unit where they are liquefied. The liquefied gas is stored in pressurised vessels for further treatment. C) Absorption Waste gas containing organic compounds such as VFCs/VHCs is led into adsorption systems. The spent activated carbon is regenerated by means of heated air pumped into the filter to desorb the organic compounds. Subsequently, the regeneration waste gas is compressed and cooled in order to liquefy the organic compounds (in some cases by cryogenic condensation). The liquefied gas is then stored in pressurised vessels. The remaining waste gas from the	Design	Not Applicable	Not applicable - waste electronic equipment is not being treated in this project	
Atmospheric Emissions	Explosions	WT	BAT 30	In order to prevent emissions due to explosions when treating WEEE containing VFCs and/or VHCs, BAT is to use either of the techniques given below. A) Inert Atmosphere via injecting inert gas (N2) to reduce O_2 content B) Forced Ventilation to reduce hydrocarbon concentration	Design	Not Applicable	Not applicable - waste electronic equipment is not being treated in this project	
Atmospheric Emissions	mechanical treatment of waste with calorific value	WT	BAT 31	In order to reduce emissions to air of organic compounds, BAT is to apply BAT 14d and to use one or a combination of the techniques given below. A) Absorption B) Biofilter C) thermal oxidation D) Wet scrubbing	Design			
Atmospheric Emissions	mechanical treatment of WEEE containing mercury	WT	BAT 32	In order to reduce mercury emissions to air, BAT is to collect mercury emissions at source, to send them to abatement and to carry out adequate monitoring.	Design	Not Applicable	Not applicable - waste electronic equipment is not being treated in this project	
Atmospheric Emissions	biological treatment of waste	WT	BAT 33	In order to reduce odour emissions and to improve the overall environmental performance, BAT is to select the waste input.	Design	Not Applicable	No biological treatment of waste in scope	
Atmospheric Emissions	biological treatment of waste	WT	BAT 34	In order to reduce channelled emissions to air of dust, organic compounds and odorous compounds, including H2S and NH3, BAT is to use one or a combination of the techniques given below. A) Absorption B) Biofilter C) Fabric Filter (in the case of mechanical biological treatment of waste) D) Wet Scrubbing	Design	Not Applicable	No biological treatment of waste in scope	
Emissions to Water	biological treatment of waste	WT	BAT 35	In order to reduce the generation of waste water and to reduce water usage, BAT is to use all of the techniques given below. A) Segregation of water streams B) Water recirculation C) Minimisation of the generation of leachate (Optimising the moisture content of the waste in order to minimise the	Design	Not Applicable	No biological treatment of waste in scope	

Waste Treatment BREF					Screening			
Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status	Further requirements
Atmospheric Emissions	Aerobic treatment of waste	WT	BAT 36	In order to reduce emissions to air and to improve the overall environmental performance, BAT is to monitor and/or control the key waste and process parameters. i.e., A) waste input characteristics (e.g. C to N ratio, particle size); B) temperature and moisture content at different points in the windrow; C) aeration of the windrow (e.g. via the windrow turning frequency, O_2 and/or CO_2 concentration in the windrow, temperature of air streams in the case of forced aeration); D) windrow porosity, height and width.	Design	Not Applicable	No aerobic treatment of waste in scope	
Atmospheric Emissions	Aerobic treatment of waste	WT	BAT 37	In order to reduce diffuse emissions to air of dust, odour and bioaerosols from open-air treatment steps, BAT is to use one or both of the techniques given below. A) Use of semipermeable membrane covers B) Adaptation of operations to the meteorological conditions	Design	Not Applicable	No aerobic treatment of waste in scope	
Atmospheric Emissions	Anaerobic treatment of waste	WT	BAT 38	In order to reduce emissions to air and to improve the overall environmental performance, BAT is to monitor and/or control the key waste and process parameters. A) ensure a stable digester operation; B) minimise operational difficulties, such as foaming, which may lead to odour emissions; C) provide sufficient early warning of system failures which may lead to a loss of containment and explosions. This includes monitoring and/or control of key waste and process parameters, e.g.: i) pH and alkalinity of the digester feed; ii)digester operating temperature; iii) hydraulic and organic loading rates of the digester feed; iv) concentration of volatile fatty acids (VFA) and ammonia within the digester and digestate; i) biogas quantity, composition (e.g. H2S) and pressure; vi) liquid and foam levels in the digester.	Design	Not Applicable	No aerobic treatment of waste in scope	
Atmospheric Emissions	Mechanical biological treatment of waste	WT	BAT 39	In order to reduce emissions to air, BAT is to use both of the techniques given below. A) Segregation of the waste gas streams: Splitting of the total waste gas stream into waste gas streams with a high pollutant content and waste gas streams with a low pollutant content B) Recirculation of waste gas: Recirculation of waste gas with a low pollutant content in the biological process followed by waste gas treatment adapted to the concentration of pollutants	Design	Not Applicable	No mechanical biological treatment of waste in scope	
Energy Efficiency	PHYSICO-CHEMICAL TREATMENT OF WASTE	WT	BAT 40	In order to improve the overall environmental performance, BAT is to monitor the waste input as part of the waste pre acceptance and acceptance procedures (see WT BAT 2).	Design	Not Applicable	No mechanical biological treatment of waste in scope	
Atmospheric Emissions	PHYSICO-CHEMICAL TREATMENT OF WASTE	WT	BAT 41	In order to reduce emissions of dust, organic compounds and NH3 to air, BAT is to apply BAT 14 (D) and to use one or a combination of the techniques given below. A) Adsorption B) Biofilter C) Fabric filter D) Wet scrubbing	Design	Not Applicable	Not applicable to scope of project	
Energy Efficiency	Re-refining of waste oil	WT	BAT 42	In order to improve the overall environmental performance, BAT is to monitor the waste input as part of the waste pre acceptance and acceptance procedures (see BAT 2).	Design	Not Applicable	Not applicable to scope of project	
Energy Efficiency	Re-refining of waste oil	WT	BAT 43	In order to reduce the quantity of waste sent for disposal, BAT is to use one or both of the techniques given below A) Material recovery Using the organic residues from vacuum distillation, solvent extraction, thin film evaporators, etc. in asphalt products, etc. B) Energy Recovery Using the organic residues from vacuum distillation, solvent extraction, thin film evaporators, etc. to recover energy.	Design	Not Applicable	Not applicable to scope of project	
Atmospheric Emissions	Re-refining of waste oil	WT	BAT 44	In order to reduce emissions of organic compounds to air, BAT is to apply BAT 14d and to use one or a combination of the techniques given below. A) Adsorption B) Thermal oxidation (i.e. sent to process furnace of boiler) C) Wet Scrubbing	Design	Not Applicable	Not applicable to scope of project	
Atmospheric Emissions	Re-refining of waste oil	WT	BAT 45	In order to reduce emissions of organic compounds to air, BAT is to apply BAT 14d and to use one or a combination of the techniques given below. A) Adsorption B) Cryogenic condensation C) Thermal Oxidation D) Wet scrubbing	Design	Not Applicable	Not applicable to scope of project	
Energy Efficiency	Regeneration of spent solvents	WT	BAT 46	In order to improve the overall environmental performance of the regeneration of spent solvents, BAT is to use one or both of the techniques given below. A) Material Recovery Solvents are recovered from the distillation residues by evaporation. B) Energy Recovery The residues from distillation are used to recover energy.	Design	Not Applicable	Not applicable to scope of project	
Atmospheric Emissions	Regeneration of spent solvents	WT	BAT 47	In order to reduce emissions of organic compounds to air, BAT is to apply BAT 14(D) and to use a combination of the techniques given below. A) Recirculation of process off-gases in a steam boiler B) Adsorption C) Thermal Oxidation D) Condensation / cryogenic condensation E) Wet Scrubbing	Design	Not Applicable	Not applicable to scope of project	
Energy Efficiency	Thermal treatment of spent activated carbon, waste catalysts and excavated contaminated soil	WT	BAT 48	In order to improve the overall environmental performance of the thermal treatment of spent activated carbon, waste catalysts and excavated contaminated soil, BAT is to use all of the techniques given below. A) Heat recovery from the furnace off-gas B) Indirectly fired furnace (An indirectly fired furnace is used to avoid contact between the contents of the furnace and the flue-gases from the burner) C) Process-integrated techniques to reduce emissions to air (control of furnace temperature, choice of fuel, use of seal furnace etc)	Design	Not Applicable	Not applicable to scope of project	

Waste Treatment BREF					Screening			
Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status	Further requirements
Atmospheric Emissions	Thermal treatment of spent activated carbon, waste catalysts and excavated contaminated soil	WT	BAT 49	In order to reduce emissions of HCl, HF, dust and organic compounds to air, BAT is to apply BAT 14 (D) and to use one or a combination of the techniques given below. A) Cyclone B) Electrostatic precipitator (ESP) C) Fabric filter D) Wet scrubbing E) Adsorption F) Condensation G) Thermal oxidation.	Design	Not Applicable	Not applicable to scope of project	
Atmospheric Emissions	Thermal treatment of spent activated carbon, waste catalysts and excavated contaminated soil	WT	BAT 50	In order to reduce emissions of dust and organic compounds to air from the storage, handling, and washing steps, BAT is to apply BAT 14d and to use one or a combination of the techniques given below. A) Adsorption B) Fabric Filter C) Wet Scrubbing	Design	Not Applicable	Not applicable to scope of project	
Atmospheric Emissions	Decontamination of equipment containing PCBs	WT	BAT 51	In order to improve the overall environmental performance and to reduce channelled emissions of PCBs and organic compounds to air, BAT is to use all of the techniques given below. <u>A) Coating of the storage and treatment areas</u> i.e., Resin coating applied to the concrete floor of the whole storage and treatment area. <u>B) Implementation of staff access rules to prevent dispersion of contamination</u> <u>C) Optimised equipment cleaning and drainage</u> -- External surfaces of the contaminated equipment are cleaned with anionic detergent; -- Emptying of the equipment with a pump or under vacuum instead of gravity emptying; -- Procedures are defined and used for filling, emptying and (dis)connecting the vacuum vessel; <u>D) Control and monitoring of emissions to air</u> Including -- the air of the decontamination area is collected and treated with activated carbon filters; -- the exhaust of the vacuum pump mentioned in technique c. above is connected to an end-of-pipe abatement system (e.g. a high-temperature incinerator, thermal oxidation or adsorption on activated carbon); <u>E) Disposal of waste treatment residues</u> including -- porous, contaminated parts of the electrical transformer (wood and paper) are sent to high-temperature incineration. -- PCBs in the oils are destroyed (e.g. dechlorination, hydrogenation, solvated electron processes, high-temperature incineration).	Design	Not Applicable	Not applicable to scope of project	
Emissions to Water	TREATMENT OF WATER-BASED LIQUID WASTE	WT	BAT 52	In order to improve the overall environmental performance, BAT is to monitor the waste input as part of the waste pre-acceptance and acceptance procedures (see WT BAT 2).	Design	Applicable	Environmental Basis of Design requires that adequate monitoring of wastewater effluent flow and quality to the wastewater treatment facility be implemented to ensure proper treatment of the facility.	Metering and monitoring requirements to be matured through FEED.
Atmospheric Emissions	TREATMENT OF WATER-BASED LIQUID WASTE	WT	BAT 53	In order to reduce emissions of HCl, NH3 and organic compounds to air, BAT is to apply BAT 14d and to use one or a combination of the techniques given below. A) Adsorption B) Biofilter C) Thermal Oxidation C) Wet Scrubbing	Design	Not Applicable	Amine contaminated effluent water is removed via vacuum tanker.	

Emissions from Storage					Screening			
Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status	Further Recommendations
General	Tanks - general	Sto	BAT 1	BAT for a proper design is to take into account at least the following: A) the physico-chemical properties of the substance being stored B) how the storage is operated, what level of instrumentation is needed, how many operators are required, and what their workload will be C) how the operators are informed of deviations from normal process conditions (alarms) D) how the storage is protected against deviations from normal process conditions (safety instructions, interlock systems, pressure relief devices, leak detection and containment, etc.) E) what equipment has to be installed, largely taking account of past experiences of the product (construction materials, valve quality, etc.) F) which maintenance and inspection plan needs to be implemented and how to ease the maintenance and inspection work (access, layout, etc.) G) how to deal with emergency situations (distances to other tanks, facilities and to the boundary, fire protection, access for emergency services such as the fire brigade, etc.).	Design	Applicable	Part of inherent design of the storage tanks	
Atmospheric Emissions	General	Sto	BAT 2	BAT is to apply a tool to determine proactive maintenance plans and to develop risk-based inspection plans such as the risk and reliability based maintenance approach;	Operation			
Atmospheric Emissions	General	Sto	BAT 3	BAT is to locate a tank operating at, or close to, atmospheric pressure aboveground. However, for storing flammable liquids on a site with restricted space, underground tanks can also be considered. For liquefied gases, underground, mounded storage or spheres can be considered, depending on the storage volume.	Design	Applicable	Part of design. No high pressure storage tanks as part of design.	
Atmospheric Emissions	General	Sto	BAT 4	BAT is to apply either a tank colour with a reflectivity of thermal or light radiation of at least 70 %, or a solar shield on aboveground tanks which contain volatile substances	Design	Applicable		Design of storage tanks to be established in FEED.
Atmospheric Emissions	General	Sto	BAT 5	BAT is to abate emissions from tank storage, transfer and handling that have a significant negative environmental effect. The principle of 'emissions minimisation in tank storage' is that – within a certain time frame – all emissions from the tank storage, transfer and handling will be abated before they are emitted. This includes the following emissions arising from normal operational activities and from incidents: A) emissions to air B) emissions to soil C) emissions to water D) energy consumption E) waste.	Design	Applicable	Leak prevention will be covered by inherent proper design of the storage tanks. Hot oil tanks are be blanketed by nitrogen. Ammonia storage bullets will have nitrogen blanket and vent scrubber to reduce odour emissions.	
Atmospheric Emissions	General	Sto	BAT 6	BAT is to calculate the VOC emissions regularly with validated calculation methods, and because of uncertainties in the calculation methods, emissions from the plants should be monitored occasionally in order to quantify the emissions and to give basic data for refining calculation methods. This can be carried out by using DIAL techniques. The necessity and frequency of emission monitoring needs to be decided on a case-by-case basis	Operation			
Atmospheric Emissions	General	Sto	BAT 7	BAT is to apply dedicated systems; Dedicated systems are generally not applicable on sites where tanks are used for short to medium-term storage of different products.	Design	Applicable	Interpretation of this BAT "dedicated systems" is that tanks are regulated to single content type (i.e. store only water) to avoid potential cross contamination. In design. Dedicated tanks for each stored chemical	
Atmospheric Emissions	Open Top Tank	Sto	BAT 8	If emissions to air occur, BAT is to cover the tank by applying: A) a floating cover, B) a flexible or tent cover, or C) a rigid cover. Additionally, with an open top tank covered with a flexible, tent or a rigid cover, a vapour treatment installation can be applied to achieve an additional emission reductions.	Design	Not Applicable	Not applicable to the anticipated tank requirements	
Emissions to Water	General	Sto	BAT 9	To prevent deposition that would call for an additional cleaning step, BAT is to mix the stored substance (e.g. slurry) to prevent deposition that would call for an additional cleaning.	Design	Not Applicable		
Atmospheric Emissions	External Floating Roof Tank	Sto	BAT 10	BAT is to apply direct contact floating roofs (double deck); however, existing non-contact floating roofs (pontoon) are also BAT. Additional measures to reduce emissions are: A) applying a float in the slotted guide pole B) applying a sleeve over the slotted guide pole, and/or C) applying 'socks' over the roof legs. A dome can be BAT for adverse weather conditions, such as high winds, rain or snowfall	Design	Not Applicable	Not currently anticipated for the hot oil tanks due to nitrogen blanketing	
Atmospheric Emissions	Fixed Roof Tank	Sto	BAT 11	For the storage of volatile substances which are toxic (T), very toxic (T+), or carcinogenic, mutagenic and reproductive toxic (CMR) categories 1 and 2 in a fixed roof tank, BAT is to apply a vapour treatment installation.	Design	Not Applicable	No toxic substances are being stored in tanks	
Atmospheric Emissions	Fixed Roof Tank	Sto	BAT 12	For other substances, BAT is to apply a vapour treatment installation, or to install an internal floating roof. Direct contact floating roofs and non-contact floating roofs are BAT.	Design	Applicable	Ammonia bullets will be fitted with vent scrubbers	
Atmospheric Emissions	Fixed Roof Tank	Sto	BAT 13	For tanks < 50 m^3, BAT is to apply a pressure relief valve set at the highest possible value consistent with the tank design criteria.	Design	Applicable	PSV pressures are established as part of inherent design process	
Atmospheric Emissions	Atmospheric Horizontal Tanks	Sto	BAT 14	For the storage of volatile substances which are toxic (T), very toxic (T+), or CMR categories 1 and 2 in an atmospheric horizontal tank, BAT is to apply a vapour treatment installation	Design	Not Applicable	No toxic substances are being stored in tanks	

Emissions from Storage					Screening			
Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status	Further Recommendations
Atmospheric Emissions	Atmospheric Horizontal Tanks	Sto	BAT 15	For other substances, BAT is to do all, or a combination, of the following techniques, depending on the substances stored: A) apply pressure vacuum relief valves; B) up rate to 56 mbar; C) apply vapour balancing; D) apply a vapour holding tank, or E) apply vapour treatment.	Design	Applicable		Requirement to be established while tank design matures
Atmospheric Emissions	Lifter Roof Tanks	Sto	BAT 16	For emissions to air, BAT is to - apply a flexible diaphragm tank equipped with pressure/vacuum relief valves, or - apply a lifter roof tank equipped with pressure/vacuum relief valves and connected to a vapour treatment installation.	Design	Not Applicable	No lifter roof tanks	
Atmospheric Emissions	Underground and Mounded Tanks	Sto	BAT 17	For the storage of volatile substances which are toxic (T), very toxic (T+), or CMR categories 1 and 2 in an underground or mounded tank, BAT is to apply a vapour treatment installation	Design	Not Applicable	No underground tanks	
Atmospheric Emissions	Underground and Mounded Tanks	Sto	BAT 18	For other substances, BAT is to do all, or a combination, of the following techniques, depending on the substances stored: A) apply pressure vacuum relief valves; B) up rate to 56 mbar; C) apply vapour balancing; D) apply a vapour holding tank, or E) apply vapour treatment.	Design	Not Applicable	Part of standard design processes and considerations to minimise noise where possible via incorporating noise level requirements in vendor quotes and appropriate site layout to avoid direct line between noisy equipment and neighbours as far as practical and possible. Action was raised in ENVID (#4) to identify sound sources for facility and undertake noise assessment to determine noise levels at neighbouring sites/residential areas. (Ref ENVID report 215000-00190-000-EN-REP-00004)	
Operation/Management	General	Sto	BAT 19	To prevent incidents and accidents BAT is to implement and follow adequate organisational measures and to enable training and instruction of employees for safe and responsible operation of the installation	Operation			
Emissions to Water	General	Sto	BAT 20	Corrosion is one of the main causes of equipment failure and can occur both internally and externally on any metal surface. BAT is to prevent corrosion by: A) selecting construction material that is resistant to the product stored B) applying proper construction methods C) preventing rainwater or groundwater entering the tank and if necessary, removing water that has accumulated in the tank D) applying rainwater management to bund drainage E) applying preventive maintenance, and F) where applicable, adding corrosion inhibitors, or applying cathodic protection on the inside of the tank.	Design	Applicable	OEM for tanks will provide appropriate tank design for the contents. Note - tanks will be dedicated storage units, preventing risk of improper use	
Emissions to Water	Underground and Mounded Tanks	Sto	BAT 21	To avoid corrosion, BAT is to apply to the outside of the tank: A) a corrosion-resistant coating B) plating, and/or C) a cathodic protection system.	Design	Applicable	The (new) stack will be subject to Continuous emission monitoring of flue gas pollutant concentrations including NOx, SO_2, CO, PM, Ammonia, Amine. Full requirements are detailed in the Environmental Basis of Design.	
Emissions to Water	General	Sto	BAT 22	BAT is to prevent Stress corrosion cracking (SCC) by: A) stress relieving by post-weld heat treatment, and B) applying a risk based inspection	Design	Applicable	Part of OEM appropriate design	
Operation/Management	General	Sto	BAT 23	BAT is to implement and maintain operational procedures – e.g. by means of a management system – as described in Section 4.1.6.1.5, to ensure that: - high level or high pressure instrumentation with alarm settings and/or auto closing of valves is installed - proper operating instructions are applied to prevent overfill during a tank filling operation, and - sufficient ullage is available to receive a batch filling	Operation			
Emissions to Water	Leaks	Sto	BAT 24	BAT is to apply leak detection on storage tanks containing liquids that can potentially cause soil pollution. The applicability of the different techniques depends on the tank type. The four different basic techniques that can be used to detect leaks are: A) release prevention barrier system B) inventory checks C) acoustic emission method D) soil vapour monitoring.	Design	Applicable	Tanks with potential to leak will be situated on concreted areas with appropriate kerbing/containment/sump for tank capacity.	
Emissions to Water	Leaks	Sto	BAT 25	BAT is to achieve a 'negligible risk level' of soil pollution from bottom and bottom-wall connections of aboveground storage tanks. However, on a case-by-case basis, situations might be identified where an 'acceptable risk level' is sufficient.	Design	Applicable	See comment above	
Emissions to Water	Leaks	Sto	BAT 26	BAT for aboveground tanks containing flammable liquids or liquids that pose a risk for significant soil pollution or a significant pollution of adjacent watercourses is to provide secondary containment, such as: A) tank bunds around single wall tanks; B) double wall tanks; C) cup-tanks; s D) double wall tanks with monitored bottom discharge.	Design	Not Applicable	No underground tanks	

Emissions from Storage					Screening			
Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status	Further Recommendations
Emissions to Water	Leaks	Sto	BAT 27	For building new single walled tanks containing liquids that pose a risk for significant soil pollution or a significant pollution of adjacent watercourses, BAT is to apply a full, impervious, barrier in the bund. Impervious barriers include: A) a flexible membrane, such as HDPE B) a clay mat C) an asphalt surface D) a concrete surface.	Design	Applicable	Tanks with potential to leak will be situated on concerted areas with appropriate kerbing/containment/sump for tank capacity.	
Emissions to Water	Leaks	Sto	BAT 28	For chlorinated hydrocarbon solvents (CHC) in single walled tanks, BAT is to apply CHC proof laminates to concrete barriers (and containments), based on phenolic or furan resins.	Design	Not Applicable	No CHC stored	
Emissions to Water	Underground and mounded tanks	Sto	BAT 29	BAT for underground and mounded tanks containing products that can potentially cause soil pollution is to: A) apply a double walled tank with leak detection, or B) to apply a single walled tank with secondary containment and leak detection.	Design	Not Applicable	No underground tanks	
Atmospheric Emissions	Basins and Lagoons	Sto	BAT 30	Where emissions to air from normal operation are significant, e.g. with the storage of slurry, BAT is to cover basins and lagoons using one of the following options: A) a plastic cover; B) a floating cover;, or C) only small basins, a rigid cover; Additionally, where a rigid cover is used, a vapour treatment installation can be applied to achieve an extra emission reduction	Design	Not Applicable	no significant emissions are anticipated from the storage tanks	
Emissions to Water		Sto	BAT 31	To prevent overfilling due to rainfall in situations where the basin or lagoon is not covered, BAT is to apply a sufficient freeboard	Design	Applicable	Part of inherent design	
Emissions to Water		Sto	BAT 32	Where substances are stored in a basin or lagoon with a risk of soil contamination, BAT is to apply an impervious barrier. This can be a flexible membrane, a sufficient clay layer or concrete	Design	Applicable	Part of inherent design	
Atmospheric Emissions	General	Sto	BAT 33	BAT is to abate emissions from tank storage, transfer and handling that have a significant negative environmental effect.	Design	Applicable	Ammonia bullets will be fitted with vent scrubbers to prevent odour emissions	
Emissions to Water	Piping	Sto	BAT 34	BAT is to apply aboveground closed piping in new situations. For existing underground piping it is BAT to apply a risk and reliability based maintenance approach	Design	Applicable	Part of inherent design process	
Emissions to Water	Piping	Sto	BAT 35	BAT is to minimise the number of flanges by replacing them with welded connections, within the limitation of operational requirements for equipment maintenance or transfer system flexibility.	Design	Applicable	Part of inherent design processes	
Emissions to Water	Piping	Sto	BAT 36	BAT is to prevent corrosion by: A) selecting construction material that is resistant to the product B) applying proper construction methods C) applying preventive maintenance, and D) where applicable, applying an internal coating or adding corrosion inhibitors.	Design	Applicable	Will be part of tank OEM design - appropriate design for target substance	
Emissions to Water	Piping	Sto	BAT 37	To prevent the piping from external corrosion, BAT is to apply a one, two, or three layer coating system depending on the site-specific conditions (e.g. close to sea). Coating is normally not applied to plastic or stainless steel pipelines.	Design	Applicable	Pipeline material selection will be performed as part of FEED	
Atmospheric Emissions	VOC	Sto	BAT 38	BAT is to apply vapour balancing or treatment on significant emissions from the loading and unloading of volatile substances to (or from) trucks, barges and ships. The significance of the emission depends on the substance and the volume that is emitted, and has to be decided on a case-by-case basis.	Design	Not Applicable	not applicable to scope of project	
Atmospheric Emissions	Valves	Sto	BAT 39	BAT for valves include: A) correct selection of the packing material and construction for the process application B) with monitoring, focus on those valves most at risk (such as rising stem control valves in continual operation) C) applying rotating control valves or variable speed pumps instead of rising stem control valves D) where toxic, carcinogenic or other hazardous substances are involved, fit diaphragm, bellows, or double walled valves E) route relief valves back into the transfer or storage system or to a vapour treatment system	Design	Applicable	Valve design / choice is to be studied in FEED. BAT requirements will be covered by inherent design processes	
Atmospheric Emissions	Pumps	Sto	BAT 40	BAT is to use the correct selection of pump and seal types for the process application, preferably pumps that are technologically designed to be tight such as canned motor pumps, magnetically coupled pumps, pumps with multiple mechanical seals and a quench or buffer system, pumps with multiple mechanical seals and seals dry to the atmosphere, diaphragm pumps or bellow pumps.	Design	Applicable	Specifics on the pump design to be established in FEED. This will be included as part of inherent design/equipment choice, with advisement from vendor to ensure correct design choice for process conditions.	
Atmospheric Emissions	Compressors	Sto	BAT 41	BAT for compressors transferring non-toxic gases is to apply gas lubricated mechanical seals. BAT for compressors, transferring toxic gases is to apply double seals with a liquid or gas barrier and to purge the process side of the containment seal with an inert buffer gas. In very high pressure services, BAT is to apply a triple tandem seal system.	Design	Applicable	Specifics on the pump design to be established in FEED. This will be included as part of inherent design/equipment choice, with advisement from vendor to ensure correct design choice for process conditions.	
Atmospheric Emissions	Sampling	Sto	BAT 42	BAT, for sample points for volatile products, is to apply a ram type sampling valve or a needle valve and a block valve. Where sampling lines require purging, BAT is to apply closed-loop sampling lines	Design	Not Applicable	Not applicable to the scope of the project	
Atmospheric Emissions	Open Storage	Sto	BAT 43	BAT is to apply enclosed storage by using, for example, silos, bunkers, hoppers and containers, to eliminate the influence of wind and to prevent the formation of dust by wind as far as possible by primary measures.	Design	Not Applicable	Not applicable to the scope of the project	

Emissions from Storage					Screening			
Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status	Further Recommendations
Atmospheric Emissions	Open Storage	Sto	BAT 44	BAT for open storage is to carry out regular or continuous visual inspections to see if dust emissions occur and to check if preventive measures are in good working order. Following the weather forecast by, e.g., using meteorological instruments on site, will help to identify when the moistening of heaps is necessary and will prevent unnecessary use of resources for moistening the open storage	Design	Not Applicable	Not applicable to the scope of the project	
Atmospheric Emissions	Enclosed Storage	Sto	BAT 45	BAT is to apply enclosed storage by using, for example, silos, bunkers, hoppers and containers. Where silos are not applicable, storage in sheds can be an alternative.	Design	Not Applicable	Not applicable to the scope of the project	
Atmospheric Emissions	Enclosed Storage	Sto	BAT 46	BAT for sheds is to apply proper designed ventilation and filtering systems and to keep the doors closed.	Design	Not Applicable	Not applicable to the scope of the project	
Atmospheric Emissions	Enclosed Storage	Sto	BAT 47	BAT is to apply dust abatement and a BAT associated emission level of 1 – 10 mg/m3,depending on the nature/type of substance stored. The type of abatement technique has to be decided on a case-by-case basis.	Design	Not Applicable	Not applicable to the scope of the project	
Atmospheric Emissions	Enclosed Storage	Sto	BAT 48	For a silo containing organic solids, BAT is to apply an explosion resistant silo, equipped with a relief valve that closes rapidly after the explosion to prevent oxygen entering the silo	Design	Not Applicable	No silos in design	
Atmospheric Emissions	Roads	Sto	BAT 49	BAT for roads that are used by trucks and cars only, is applying hard surfaces to the roads of, for example, concrete or asphalt, because these can be cleaned easily to avoid dust being swirled up by vehicles. However, applying hard surfaces to the roads is not justified when the roads are used just for big shovel vehicles or when a road is temporary.	Design	Applicable	Design basis is to pave access roads to the site.	
Atmospheric Emissions	Vehicles	Sto	BAT 50	Cleaning of vehicle tyres is BAT. The frequency of cleaning and type of cleaning facility applied has to be decided on a case-by-case basis.	Operation			
Atmospheric Emissions	Loading/Unloadin g	Sto	BAT 51	For loading/unloading activities, BAT is to minimise the speed of descent and the free fall height of the product. Minimising the speed of descent can be achieved by the following techniques that are BAT: A) installing baffles inside fill pipes B) applying a loading head at the end of the pipe or tube to regulate the output speed C) applying a cascade (e.g. cascade tube or hopper) D) applying a minimum slope angle with, e.g. chutes. To minimise the free fall height of the product, the outlet of the discharger should reach down onto the bottom of the cargo space or onto the material already piled up. Loading techniques that can achieve this, and that are BAT, are: E) height adjustable fill pipes F) height adjustable fill tubes, and G) height adjustable cascade tubes.	Design	Not Applicable	Not applicable to the scope of the project	

Waste Incineration BREF					Screening		
Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status
Operation/Management	Management	WI	BAT 1	In order to improve the overall environmental performance, BAT is to elaborate and implement an environmental management system (EMS).	Operation		
Energy Efficiency		WI	BAT 2	BAT is to determine either the gross electrical efficiency, the gross energy efficiency, or the boiler efficiency of the incineration plant as a whole or of all the relevant parts of the incineration plant.	Design	Not Applicable	No incineration plant in design
Atmospheric Emissions	Monitoring	WI	BAT 3	BAT is to monitor key process parameters relevant for emissions to air and water including those given below. Continuous Monitoring of A) Flue gas - flow, O_2 content, Temperature, pressure, water vapour B) Combustion chamber - Temperature C) Waste water from wet FGC - Flow, pH, Temperature D) Waste Water from bottom ash treatment plants - Flow. pH, conductivity	Design	Applicable	A) CEMS is stipulated in design by the Environmental Basis of design B) not applicable C) not applicable D) not applicable
Atmospheric Emissions	Monitoring	WI	BAT 4	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. SEE WASTE INCINERATION TABLE 1	Design	Not Applicable	Not applicable, no incineration plant in design
Atmospheric Emissions	Monitoring	WI	BAT 5	BAT is to appropriately monitor channelled emissions to air from the incineration plant during Other Than Normal Operating Conditions (OTNOC). SEE WASTE INCINERATION TABLE 2	Design	Not Applicable	Not applicable, no incineration plant in design
Emissions to Water		WI	BAT 6	BAT is to monitor emissions to water from FGC and/or bottom ash treatment 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. SEE WASTE INCINERATION TABLE 2	Design	Not Applicable	Not applicable to project
Atmospheric Emissions	Monitoring	WI	BAT 7	BAT is to monitor the content of unburnt substances in slags and bottom ashes at the incineration plant with at least the frequency given below and in accordance with EN standards. Once every 3-months A) Loss of ignition (EN14899 and EN 15169 or EN 15935) B) Total organic carbon (EN 14899 and EN 13137 or EN 15936)	Design	Not Applicable	Not applicable to project
Atmospheric Emissions	Monitoring	WI	BAT 8	For the incineration of hazardous waste containing POPs, BAT is to determine the POP content in the output streams (e.g. slags and bottom ashes, flue-gas, waste water) after the commissioning of the incineration plant and after each change that may significantly affect the POP content in the output streams.	Design	Not Applicable	
Atmospheric Emissions	Management	WI	BAT 9	In order to improve the overall environmental performance of the incineration plant by waste stream management (see WI BAT 1), BAT is to use all of the techniques (A) to (C) given below, and, where relevant, also techniques (D), (E) and (F). A) Determination of the types of waste that can be incinerated B) Set-up and implementation of waste characterisation and pre-acceptance procedure (technical and legal suitability of treatment for each waste) C) Set-up and implementation of waste acceptance procedures (These procedures define the elements to be verified upon the delivery of the waste at the plant as well as the waste acceptance and rejection criteria.) D) Set-up and implementation of a waste tracking system and inventory E) Waste segregation F) Verification of waste compatibility prior to the mixing or blending of hazardous wastes	Design	Not Applicable	
Atmospheric Emissions	Management	WI	BAT 10	In order to improve the overall environmental performance of the bottom ash treatment plant, BAT is to include output quality management features in the EMS	Design	Not Applicable	
Operation/Management	Monitoring	WI	BAT 11	In order to improve the overall environmental performance of the incineration plant, BAT is to monitor the waste deliveries as part of the waste acceptance procedures (see WI BAT 9(C)) including, depending on the risk posed by the incoming waste, the elements given below. A) Municipal solid waste and other non-hazardous waste (Radioactivity detection; weighting; visual inspection and sampling) B) Sewage sludge (Weighing; visual inspection; periodic sampling) C) Hazardous waste other than clinical waste (Radioactivity detection; weighting; visual inspection, sampling, analysis of calorific values etc) D) Clinical Waste (Radioactivity detection; weighting; visual inspection)	Design	Not Applicable	Facility is not receiving wastes
Emissions to Water	Monitoring	WI	BAT 12	In order to reduce the environmental risks associated with the reception, handling and storage of waste, BAT is to use both of the techniques given below. A) Impermeable surfaces with an adequate drainage infrastructure B) Adequate waste storage capacity	Design	Applicable	In design - see responses to other BAT docs
Emissions to Water	Waste handling	WI	BAT 13	In order to reduce the environmental risk associated with the storage and handling of clinical waste, BAT is to use a combination of the techniques given below. A) Automated or semi-automated waste handling B) Incineration of non-reusable sealed containers, if used C) Cleaning and disinfection of reusable containers, if used	Design	Not Applicable	Not within scope

Waste Incineration BREF					Screening		
Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status
Atmospheric Emissions		WI	BAT 14	In order to improve the overall environmental performance of the incineration of waste, to reduce the content of unburnt substances in slags and bottom ashes, and to reduce emissions to air from the incineration of waste, BAT is to use an appropriate combination of the techniques given below. A) Waste blending and mixing prior to incineration (not applicable for direct furnace feeding) B) Advanced control system C) Optimisation of the incineration process	Design	Not Applicable	No incineration plant in design
Atmospheric Emissions		WI	BAT 15	In order to improve the overall environmental performance of the incineration plant and to reduce emissions to air, BAT is to set up and implement procedures for the adjustment of the plant's settings, e.g. through the advanced control system, as and when needed and practicable, based on the characterisation and control of the waste (see WI BAT 11).	Design	Not Applicable	No incineration plant in design
Atmospheric Emissions		WI	BAT 16	In order to improve the overall environmental performance of the incineration plant and to reduce emissions to air, BAT is to set up and implement operational procedures (e.g. organisation of the supply chain, continuous rather than batch operation) to limit as far as practicable shutdown and start-up operations.	Design	Not Applicable	No incineration plant in design
Atmospheric Emissions	Flue gas cooling	WI	BAT 17	In order to reduce emissions to air and, where relevant, to water from the incineration plant, BAT is to ensure that the FGC system and the waste water treatment plant are appropriately designed (e.g. considering the maximum flow rate and pollutant concentrations), operated within their design range, and maintained so as to ensure optimal availability.	Design	Not Applicable	No incineration plant in design
Atmospheric Emissions		WI	BAT 18	In order to reduce the frequency of the occurrence of OTNOC and to reduce emissions to air and, where relevant, to water from the incineration plant 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 elements: A) identification of potential OTNOC, of their root causes and of their potential consequences, and regular review and update of the list of identified OTNOC following the periodic assessment below; B) Appropriate design of critical equipment (e.g. compartmentalisation of the bag filter, techniques to heat up the flue-gas and obviate the need to bypass the bag filter during start-up and shutdown, etc.); C) set-up and implementation of a preventive maintenance plan for critical equipment D) monitoring and recording of emissions during OTNOC and associated circumstances (see WI BAT 5); E) Periodic assessment of the emissions occurring during OTNOC (e.g. frequency of events, duration, amount of pollutants emitted) and implementation of corrective actions if necessary.	Operation		Part of standard design processes and considerations to minimise noise where possible via incorporating noise level requirements in vendor quotes and appropriate site layout to avoid direct line between noisy equipment and neighbours as far as practical and possible. Action was raised in ENVID (#4) to identify sound sources for facility and undertake noise assessment to determine noise levels at neighbouring sites/residential areas. (Ref ENVID report 215000-00190-000-EN-REP-00004)
Energy Efficiency		WI	BAT 19	In order to increase the resource efficiency of the incineration plant, BAT is to use a heat recovery boiler.	Design	Not Applicable	No incineration plant in design
Energy Efficiency		WI	BAT 20	In order to increase the energy efficiency of the incineration plant, BAT is to use an appropriate combination of the techniques given below. A) Drying of sewage sludge B) Reduction of the flue-gas flow C) Minimisation of heat losses D) Optimisation of the boiler design E) Low-temperature flue-gas heat exchangers F) High steam conditions G) Cogeneration H) Flue-gas condenser I) Dry bottom ash handling	Design	Not Applicable	No incineration plant in design
Atmospheric Emissions	Fugitive	WI	BAT 21	In order to prevent or reduce diffuse emissions from the incineration plant, including odour emissions, BAT is to: A) store solid and bulk pasty wastes that are odorous and/or prone to releasing volatile substances in enclosed buildings under controlled sub atmospheric pressure and use the extracted air as combustion air for incineration or send it to another suitable abatement system in the case of a risk of explosion; B) Store liquid wastes in tanks under appropriate controlled pressure and duct the tank vents to the combustion air feed or to another suitable abatement system; C) Control the risk of odour during complete shutdown periods when no incineration capacity is available, e.g. by: D) Sending the vented or extracted air to an alternative abatement system, e.g. a wet scrubber, a fixed adsorption bed E) Minimising the amount of waste in storage, e.g. by interrupting, reducing or transferring waste deliveries, as a part of waste stream management (see WI BAT 9); F) Storing waste in properly sealed bales.	Design	Not Applicable	The (new) stack will be subject to Continuous emission monitoring of flue gas pollutant concentrations including NOx, SO_2, CO, PM, Ammonia, Amine. Full requirements are detailed in the Environmental Basis of Design.
Atmospheric Emissions	Fugitive	WI	BAT 22	In order to prevent diffuse emissions of volatile compounds from the handling of gaseous and liquid wastes that are odorous and/or prone to releasing volatile substances at incineration plants, BAT is to introduce them into the furnace by direct feeding.	Design	Not Applicable	Not applicable - no incineration plant in design
Atmospheric Emissions	Fugitive	WI	BAT 23	In order to prevent or reduce diffuse dust emissions to air from the treatment of slags and bottom ashes, BAT is to include in the environmental management system (see WI BAT 1) the following diffuse dust emissions management features: A) Identification of the most relevant diffuse dust emission sources (e.g. using EN 15445); B) Identification and implementation of appropriate actions and techniques to prevent or reduce diffuse emissions over a given time frame.	Design	Not Applicable	No treatment of slags/bottom ashes
Atmospheric Emissions	Dust, metals and metalloids	WI	BAT 24	In order to prevent or reduce diffuse dust emissions to air from the treatment of slags and bottom ashes, BAT is to use an appropriate combination of the techniques given below. A) Enclose and cover equipment; B) Limit height of discharge C) Protect stockpiles against prevailing winds D) Use water sprays E) Optimise moisture content F) Operate under sub atmospheric pressure	Design	Not Applicable	No treatment of slags/bottom ashes

Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status
Waste Incineration BREF					Screening		
Atmospheric Emissions	Dust, metals and metalloids	WI	BAT 25	In order to reduce channelled emissions to air of dust, metals and metalloids from the incineration of waste, BAT is to use one or a combination of the techniques given below. A) Bag filter B) Electrostatic precipitator C) Dry sorbent injection D) Wet scrubber E) Fixed- or moving-bed adsorption	Design	Not Applicable	No incineration of waste in design
Atmospheric Emissions	Dust, metals and metalloids	WI	BAT 26	In order to reduce channelled dust emissions to air from the enclosed treatment of slags and bottom ashes with extraction of air (see BAT 24 F), BAT is to treat the extracted air with a bag filter	Design	Not Applicable	Not treatment of slags/bottom ashes
Atmospheric Emissions	HCL, HF, SO_2	WI	BAT 27	In order to reduce channelled emissions of HCl, HF and SO_2 to air from the incineration of waste, BAT is to use one or a combination of the techniques given below. A) Wet scrubber B) Semi-wet absorber C) Dry sorbent injection D) Direct desulphurisation E) Boiler sorbent injection	Design	Not Applicable	No incineration of waste in design
Atmospheric Emissions	HCL, HF, SO3	WI	BAT 28	In order to reduce channelled peak emissions of HCl, HF and SO_2 to air from the incineration of waste while limiting the consumption of reagents and the amount of residues generated from dry sorbent injection and semi-wet absorbers, BAT is to use technique (A) or both of the techniques given below. A) Optimised and automated reagent dosage The use of continuous HCl and/or SO_2 measurements (and/or of other parameters that may prove useful for this purpose) upstream and/or downstream of the FGC system for the optimisation of the automated reagent dosage. B) Recirculation of reagents The recirculation of a proportion of the collected FGC solids to reduce the amount of unreacted reagent(s) in the residues. The technique is particularly relevant in the case of FGC techniques operating with a high stoichiometric excess.	Design	Not Applicable	No incineration of waste in design
Atmospheric Emissions	NOx	WI	BAT 29	In order to reduce channelled NOX emissions to air while limiting the emissions of CO and N2O from the incineration of waste and the emissions of NH3 from the use of SNCR and/or SCR, BAT is to use an appropriate combination of the techniques given below A) Optimisation of the incineration process B) Flue-gas recirculation C) Selective non-catalytic reduction (SNCR) D) Selective catalytic reduction (SCR) E) Catalytic filter bags F) Optimisation of the SNCR/SCR design and operation G) Wet scrubber	Design	Not Applicable	No incineration of waste in design
Atmospheric Emissions	Organic Compounds	WI	BAT 30	In order to reduce channelled emissions to air of organic compounds including PCDD/F and PCBs from the incineration of waste, BAT is to use techniques (A), (B), (C), (D), and one or a combination of techniques (E) to (I) given below. A) Optimisation of the incineration process: Optimisation of incineration parameters to promote the oxidation of organic compounds including PCDD/F and PCBs present in the waste, and to prevent their and their precursors' (re)formation B) Control of the waste feed: Knowledge and control of the combustion characteristics of the waste being fed into the furnace, to ensure optimal and, as far as possible, homogeneous and stable incineration conditions. C) On-line and off-line boiler cleaning D) Rapid flue-gas cooling: Rapid cooling of the flue-gas from temperatures above 400 °C to below 250 °C before dust abatement to prevent the de novo synthesis of PCDD/F. E) Dry sorbent injection F) Fixed- or moving-bed adsorption G) SCR H) Catalytic filter bags I) Carbon sorbent in a wet scrubber	Design	Not Applicable	No incineration of waste in design
Atmospheric Emissions	Mercury	WI	BAT 31	In order to reduce channelled mercury emissions to air (including mercury emission peaks) from the incineration of waste, BAT is to use one or a combination of the techniques given below. A) Wet scrubber (operated at low pH ~1) B) Dry sorbent injection C) Injection of special, highly reactive activated carbon D) Boiler bromine addition E) Fixed- or moving-bed adsorption	Design	Not Applicable	No incineration of waste in design
Atmospheric Emissions		WI	BAT 32	In order to prevent the contamination of uncontaminated water, to reduce emissions to water, and to increase resource efficiency, BAT is to segregate waste water streams and to treat them separately, depending on their characteristics.	Design	Applicable	Segregation of wastewater streams is in design - refer to drainage philosophy
Atmospheric Emissions	Water	WI	BAT 33	In order to reduce water usage and to prevent or reduce the generation of waste water from the incineration plant, BAT is to use one or a combination of the techniques given below. A) Waste-water-free flue gas cooling (FGC) techniques B) Injection of waste water from FGC C) Water reuse/recycling D) Dry bottom ash handling	Design	Not Applicable	No incineration of waste in design

Waste Incineration BREF					Screening		
Aspect		BAT Reference		Description	Implementation Stage	Applicability	Project Status
Atmospheric Emissions	Material	WI	BAT 34	In order to reduce emissions to water from FGC and/or from the storage and treatment of slags and bottom ashes, BAT is to use an appropriate combination of the techniques given below, and to use secondary techniques as close as possible to the source in order to avoid dilution. Primary Techniques A) Optimisation of the incineration process (see BAT 14) and/or of the FGC system (e.g. SNCR/SCR, see BAT 29(F)) Secondary Techniques B) Equalisation C) Neutralisation (target acids/alkalis) D) Physical separation, e.g. screens, sieves, grit separators, primary settlement tanks Physico-chemical treatment E) Adsorption on activated carbon (organic compounds) F) Precipitation (dissolved metals, sulphate) G) Oxidation (sulphides, sulphite, organic compounds) H) Ion exchange (dissolved metals) I) Stripping (purgeable pollutants - ammonia/ammonium) J) Reverse osmosis (ammonia/ammonium, metals. sulphate, chloride, organic compounds) Final Solids Removal (Suspended solids/particulate-bound metals) K) Coagulation and flocculation L) Sedimentation M) Filtration	Design	Not Applicable	no treatment of FGC/Bottom ashes
Energy Efficiency		WI	BAT 35	In order to increase resource efficiency, BAT is to handle and treat bottom ashes separately from FGC residues.	Design	Not Applicable	no treatment of FGC/Bottom ashes
Atmospheric Emissions		WI	BAT 36	In order to increase resource efficiency for the treatment of slags and bottom ashes, BAT is to use an appropriate combination of the techniques given below based on a risk assessment depending on the hazardous properties of the slags and bottom ashes. A) Screening and sieving (i.e., Oscillating screens, vibrating screens and rotary screen etc) B) Crushing C) Aeraulic separation (Aeraulic separation is used to sort the light, unburnt fractions commingled in the bottom ashes by blowing off light fragments, i.e., vibration tables) D) Recovery of ferrous and non-ferrous metals (i.e., magnetic separation) E) Ageing to stabilises the mineral fraction of the bottom ashes by uptake of atmospheric CO_2 (carbonation), draining of excess water and oxidation. G) Washing	Design	Not Applicable	No treatment of slags/bottom ashes
Noise Emissions		WI	BAT 37	In order to prevent or, where that is not practicable, to reduce noise emissions, BAT is to use one or a combination of the techniques given below. A) location of equipment B) Operational measures (inspection, closing doors, operation by experienced staff etc) C) low-noise equipment D) Noise attenuation E) Noise-control equipment/infrastructure	Design	Applicable	In design - see responses to other BAT docs

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