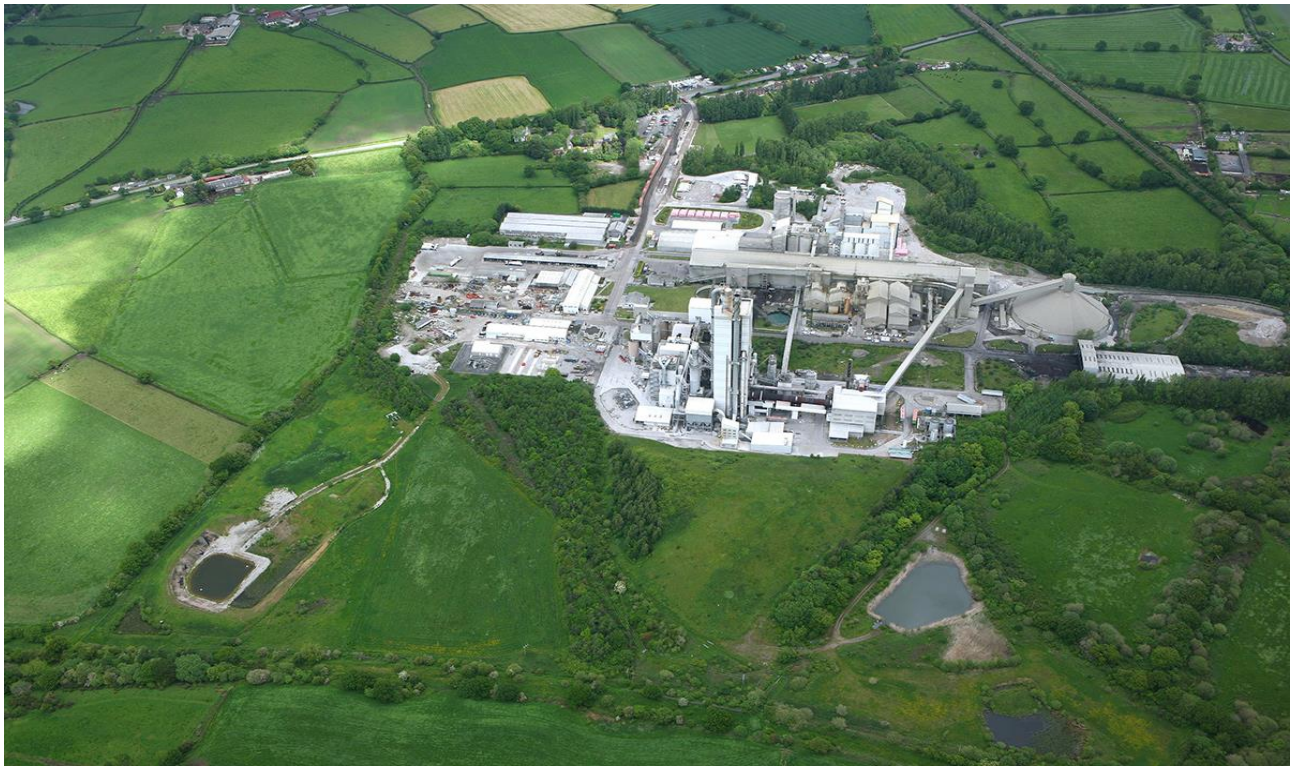
HEIDELBERG MATERIALS

Padeswood Carbon Capture Plant - FEED Phase

Environmental Management and Monitoring Plan

Document no. Rev A: 215000-00190-000-EN-PLN-00001



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PROJECT 215000-00190-000 - 215000-00190-000-EN-PLN-00001: Padeswood Carbon Capture Plant - FEED Phase - Environmental Management and Monitoring Plan							
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Revision History

Rev	Status	Section	Description of Change
A	IDC	All	Issue for Discipline Check

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1. Introduction

1.1 Project Description

The Heidelberg Materials Padeswood Cement Works CCS Project will enable post combustion 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 Plant (CCP).

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 U.

The whole project will enable the production of net zero cement for use in the UK construction industry.

The detailed process description is covered in Ref 1.

1.2 Document Purpose

This document comprises the Environmental Management and Monitoring Plan (EMMP) for the Padeswood carbon capture plant. The purpose of this document is to outlay the appropriate methods of environmental management and the particulars for monitoring all waste and discharge streams to be applied to the PROJECT. The information contained herein shall be considered as the reference framework from which all activity specific environmental management plans (EMPs) related to the PROJECT will be developed.

Adherence to this EMMP and subsequent detailed environmental management plans will ensure consistency of the Project activities and operational integrity at all stages.

This EMMP is scoped to the construction and operational phases of the PROJECT, applicable to all facilities and associated activities and covers the following aspects:

- Construction Environmental Management Plan
- Atmospheric Emissions Management
- Waste Management
- Water Management
- Noise Management
- Lighting Management
- Emergency Response Management

1.3 Abbreviations and Definitions

Abbreviation	Description
AEL	Associated Emission Limits
AGI	Above Ground Installation
BOD	Biological Oxygen Demand
CCP	Carbon Capture Plant
CCS	Carbon Capture and Storage
CEMP	Construction Environmental Management Plan
CEMS	Continuous Emission Monitoring Systems
CH_4	Methane
CHP	Combined Heat and Power
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand
CSD	Chemical Safety Data
CWMS	Continuous Water Monitoring Systems
EIA	Environmental Impact Assessment
EMMP	Environmental Management and Monitoring Plan
EMP	Environmental Management Plan
ENVID	Environmental Impact Identification
EPC	Engineering and Procurement and Construction
EPPC	Environmental Permitting and Planning Contractor
FEED	Front End Engineering Design
GHG	Greenhouse Gas
H_2S	Hydrogen Sulphide
HAZID	Hazard Impact Identification
HCN	Hydrogen Cyanide
HM	Heidelberg Materials
HSE	Health, Safety and Environment
HSE-MS	Health, Safety, and Environment Management System
MAH	Monoaromatic Hydrocarbons
MCERTS	Monitoring Certification Scheme
MHI	Mitsubishi Heavy Industries
MSDS	Material Safety Data Sheets
N_2O	Nitrous Oxide
NOx	Oxides of Nitrogen
PAH	Polyaromatic Hydrocarbons
PEP	Project Execution Plan
PM	Particulate Matter
PPE	Personnel Protection Equipment
RO	Reverse Osmosis
SOx	Oxides of Sulphur
TOC	Total organic Carbon

Abbreviation	Description
TSS	Total Suspended Solids
UF	Ultrafiltration
VOC	Volatile Organic Compounds
WMP	Waste Management Plan
ZLD	Zero Liquid Discharge

Table 1-1: Table of Abbreviations

1.4 Technical Terms

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

Table 1-2: Table of Terms

1.5 References

Ref	Document Number	Document Title
Ref 1	215000-00190-000-EN-BOD-00001	Environmental Basis of Design
Ref 2	215000-00190-000-PR-DBD-00001	Project Block Flow Diagram
Ref 3	215000-00190-000-EM-BOD-00001	Overall Engineering Basis of Design
Ref 4	215000-00190-000-EN-REP-00001	Emissions, Discharge and Waste Schedule
Ref 5	215000-00190-000-EN-PLN-00002	Waste Management Plan
Ref 6	215000-00190-000-PM-PLN-00001	Project Execution Plan
Ref 7	215000-00190-000-EN-REP-00005	BAT Review Assessment

Table 1-3: Reference

2. Background Information

The documents listed in the below sections describe the key aspects of the PROJECT and legal framework it will operate under and shall be referred to in the preparation of subsequent Environmental Management Plans.

2.1 Legislative Requirements

The relevant environmental legislation, regulations and standards underpinning the design and operation of the PROJECT are listed in the Environmental Basis of Design (Ref 1).

2.2 Process Description

A detailed description of the proposed Carbon Capture Plant design is given in the Process Description (Ref 3).

An overall Block Flow Diagram of the plant units (Ref 2) is provided in **Appendix A**.

2.3 Basis of Design

The environmental management plans shall be in compliance with the Environmental Basis of Design (Ref 1) and align with the overall engineering basis of design (Ref 3) and individual discipline basis of design documents as required.

2.4 Waste Steams

Details of the anticipated atmospheric emissions, water discharges and waste generation will be included in the Emissions, Discharge and Waste Schedule (Ref 4) which will be prepared in FEED.

2.5 Contractor Roles and Responsibilities

2.5.1 FEED Contractor

During the FEED phase of the Project, responsibilities of CONTRACTOR will include Preparation of the Environmental Management and Monitoring Plan (EMMP) (this document). The CONTRACTOR will also prepare the Waste Management Plan (WMP) (Ref 5) during FEED.

The FEED phase EMMP shall be applied as a guide in preparation of detailed environmental management plans in the subsequent phases.

2.5.2 EPC Contractor

Detailed environmental management plans shall be prepared and implemented by the Engineering, Procurement and Construction (EPC) contractor. As a minimum, the following environmental management plans (EMPs) shall be developed and implemented by the EPC contractor:

- Waste Management Plan (update on FEED version)

- Atmospheric Emission Management Plan
- Wastewater Management Plan
- Noise Management Plan
- Emergency Response Plan
- Transport Management Plan
- Construction Environmental Management Plan
- Odour Management Plan

This list is a generic list rather than exhaustive, a full list of required management plans shall be prepared upon completion of the Environmental Impact Assessment (EIA) studies by the Environmental Permitting and Planning contractor (EPPC). The final list of management plans shall address all the identified environmental and social aspect of the Project as well as actions to be taken in compliance with environmental regulatory requirements.

Ultimate responsibility for the above listed plans rests with the COMPANY Project Manager. An HSE Manager will be acting on behalf, and directly reporting to the COMPANY Project Manager. A team of Environmental Engineers will work together with the HSE Manager in order to monitor the performance and achievement of the objectives of the Plans. However, specific responsibilities for implementing the terms of any of the plans rest with EPC Contractor and subcontractors.

The list of specific responsible parties and details of their roles and responsibilities must be prepared by EPC Contractor during Detailed Design and agreed with the COMPANY Project Manager and included in the detailed Contractor Management Measures.

The EPC Contractor shall review the context of the EIA Report and Environmental Permit Requirements and provide detailed management and monitoring plans accordingly.

3. Implementation and Control Management System

This section presents the implementation and control management procedure throughout the PROJECT construction and operation phases.

3.1 Construction Phase

During the construction phase the EMPs (listed in Section 2.5.2) shall be implemented and controlled through the Project management resources, EPC Contractor, and various sub-contractors.

The integrated Health, Safety, and Environment Management System (HSE-MS) of the parties shall be used to carry out the PROJECT activities by defining roles and responsibilities, inspection and reporting arrangements, monitoring, and review, and following up on the effectiveness of the mitigation measures.

A Construction Environmental Management Plan (CEMP) (discussed in Section 4) shall be developed by the EPC contractor outlaying the site-specific environmental management procedure for the construction works, including compliance requirements and necessary response procedures at the EPC phase.

3.1.1 Monitoring in Construction Phase

Routine monitoring will provide on-going assurance to site management and other influenced parties that planned environmental activities and mitigation measures are being applied and are effective. Wherever feasible, monitoring studies should be carried out by expert third parties with the involvement of local competent authorities to increase the level of confidence that monitoring will be independent and impartial. Four types of monitoring and inspection shall be used as follows:

- **Field inspections**: these are checks that are planned and conducted on a regular basis to ensure that planned environmental activities and mitigation measures are being applied and are being properly maintained, and that specific management procedures are being followed (for example, practices on waste storage and disposal).
- **Receptor monitoring**: to confirm that the construction activities at the PROJECT sites are not resulting in an unacceptable deterioration in the quality of the habitat or infrastructure, (for example, monitoring disturbance to a nearby residential area).
- **Compliance monitoring**: including monitoring of the emissions from the construction sites and monitoring of compliance with management procedures and work instructions, to confirm that the impacts remain within the applicable standards (for example, air and water quality monitoring).
- **Auditing**: refers to the in-depth assessment of the compliance of the construction activities with both regulatory and site management system requirements (for example, of waste management procedures and systems).

The output from each of the above types of monitoring and inspections shall be reported at various levels and used in several ways, including:

- To provide 'Early warning' for site management, to adjust mitigation measures on a day-to-day basis to suit evolving conditions on the site
- To enable EPC and subcontractors to demonstrate that mitigation measures and procedures laid down in EMPs are being followed and operations are being conducted within compliance limits
- To provide formal assurance to the internal stakeholders and third parties, such as Environmental Agency and Local Borough Council, that the construction phase of the PROJECT is complying with regulations and permitted limits and that relevant mitigation and enhancement measures are being adhered to.

3.2 Operation Phase

The operations phase of the PROJECT will commence with the testing and commissioning of the process facilities and utility units.

Documented procedures shall be developed to ensure that each item within the PROJECT site will be tested in a controlled and safe manner, while having all necessary emergency response on standby to deal with any unforeseen emergencies. Commissioning procedures shall include monitoring (e.g., witnessing hydro-test water) to demonstrate compliance with the PROJECT procedures.

The Project management procedures shall regulate all activities on the PROJECT process facilities and common utility units during operation period, defining responsibilities and reporting relationships for carrying out actions, and specifying mechanisms for inspecting, monitoring, auditing, reviewing, and reporting effectiveness of the environmental mitigation measures reflected in the EMPs.

3.2.1 Monitoring in Operation Phase

As with the construction phase, the purpose of monitoring in operation phase is to demonstrate and provide ongoing assurance to site management and other stakeholders that the mitigation measures are being applied and are effective.

Some monitoring requirements will be carried forward from the construction phase (e.g., surveillance of ambient air quality), especially for social and health monitoring. Others will be specific to the commissioning or operations phases.

Suitable and sufficient sampling systems shall be provided for effective monitoring.

3.2.2 Management Review

Formal HSE-MS reviews will be undertaken and documented on a regular basis, at least annually, during the construction, commissioning, and operation of the PROJECT. These reviews will consider results of the monitoring programs, the audit program and various inspection systems to identify strengths and weaknesses of the EMPs. The review will be used as an opportunity to define continuous improvement objectives and programs to achieve environmental goals.

3.2.3 Management of Changes and Uncertainty

Management of Change is a formalised process for managing and controlling changes in the PROJECT's scope which shall be carried out in accordance with procedures stated in the Project Execution Plan (PEP) (Ref 6). The changes shall be managed per PEP during FEED phase and in compliance with the COMPANY defined change management procedure afterward.

During the operation phase of the PROJECT some changes may be required from the environmental perspective that could be one of the following types:

- Changes to the PROJECT which result in environmental and social impacts that need mitigating; and
- Changes which are necessary due to a result of monitoring of environmental impacts.

The COMPANY shall develop appropriate procedures for dealing with these two types of changes.

4. Construction Environmental Management

The Construction Environmental Management Plan (CEMP) shall be developed by COMPANY in collaboration with the EPC contractor, to reduce the impacts associated with the construction activities, specifically:

- Wastes production and management taking into the account Section 6 of this document.
- Impacts on local air quality considering Section 5 of this plan
- The generation of noise considering Section 8 of this plan
- The handling and storage of hazardous materials
- Accidental events, such as leaks and spills considering Section 10 of this plan

4.1 Design and Management

The CEMP shall particularly mitigate the impacts of uncontrolled releases of hazardous materials in conjunction with Emergency Response Measures (see Section 10).

The proposed measures shall include:

- Record keeping and on-site maintenance of Material Safety Data Sheets (MSDS)
- Segregation of potentially reactive materials
- Procedures to determine acceptability of material storage and to promote the minimisation of waste storage volumes (including relevant risk assessment to determine minimum storage volumes, the compatibility of materials, container security, vapour and venting provisions, fire and explosion risks)
- Requirements for the establishment of above ground hazardous materials storage (e.g., bonding, impermeable hard standings, secure drainage, limited access and hazard warning signage)
- The provision of spill response equipment, such as PPE, shovels, absorbent sheets, and drain covers in the storage and transfer areas
- Training of personnel in the safe use and management of hazardous materials
- Auditable documentation providing a 'Chain of Custody' for the receipt and hand over of hazardous materials
- The PROJECT shall guarantee that any person dealing with hazardous chemicals will provide and maintain Chemical Safety Data (CSD) for any substance that has been authorized in the relevant permit document

4.2 Monitoring

The physical and chemical properties of soil and ground water quality shall be assessed and monitored in accordance with COMPANY approved procedures, in order to prevent or minimize the potential for negative environmental impacts during construction phase of the PROJECT taking into consideration any impact on existing groundwater monitoring wells.

The EPC construction manager is responsible for overall implementation of construction environmental management system that shall also comply with recommendations from EIA studies applicable to soil and ground water management.

5. Atmospheric Emissions Plan

The PROJECT Shall identify, assess, avoid, or if it is not possible to avoid, mitigate operation phase emissions which have the potential to adversely affect human health or the environment.

The PROJECT is required to comply with the UK Air Quality Strategy Objectives as is presented in the Environmental Basis of Design (Ref 1). Also, air emissions from the construction site will be required to meet ambient air quality standards and managed to the ALARP.

5.1 Objectives & Scope

Atmospheric emissions management plan aims to:

- Ensure the continued compliance with all applicable regulatory and other requirements governing the atmospheric emission from stationary and mobile source which have the potential to negatively affect human health or the environment.
- Conduct a continuous air monitoring program in accordance with requirements of Environmental Permit, Environmental Basis of Design (Ref 1) and this EMMP in order to prevent adverse environmental impacts and confirm adequacy of HAZID/ENVID and EIA commitments.

The Atmospheric Emissions Plan will be scoped to cover all atmospheric emission sources from the new plant, which are understood to be

- New Combined Heat and Power (CHP) Stack
- O_2 vent from Hydrogen Generator
- H_2 Vent from Hydrogen Generator (vent to save location)
- Vents on the Ammonia Bullets
- Storage tank breathers
- Fuel gas vent
- Fugitives (minimal leaks from compressor seals, valves, pumps etc.)

Detail of the operational phase atmospheric emission streams will be given in the Emissions, Effluent and Waste Schedule (Ref 4).

Emissions from the Cement plant (i.e., existing flue stack) are regulated under existing permitting and management procedures and therefore not covered by this EMMP.

5.2 Management

The PROJECT shall adopt best engineering practice and Best Available Techniques (BAT) for pollution control in order to comply with source emissions standards and ambient air quality standards.

A BAT review assessment (Ref 6) is planned for FEED to ascertain BAT use in design and highlight further considerations.

5.3 Construction Phase Emissions

Construction phase atmospheric emissions include emissions from fuel use in construction vehicles onsite equipment and generators that shall be managed to ensure efficient use. Dust is also a potential emission, discussed in the next section.

Appropriate measures shall be employed to minimise construction phase emissions as follows:

- Vehicles shall be subject to regular inspection and maintenance by the EPC contractor, and subject to periodic audit
- The EPC contractor shall provide site supervision and training to ensure that equipment is set-up and used properly to minimise accidental or fugitive releases
- Site traffic management shall employ no idling policy.
- Operation and maintenance procedures shall contain appropriate levels of training, calibration, and monitoring.

5.4 Dust Control and Abatement

The key objective of the dust control is to reduce dust emissions from the PROJECT construction activities to the extent reasonably practicable.

The EPC contractor shall develop and implement the following dust control measures:

- Regular spraying of unmade and internal service roadways with water.
- The covering of friable materials such as aggregates and excavated materials in open trucks during transport by road
- Management of loading/unloading and stockpiling activities to reduce drop heights, to avoid double handling and to minimise the exposure of loose material to the wind
- The scattering dust generation activities shall be coordinated with the local borough council.
- Site traffic management shall employ policies to minimise atmospheric emissions including wheel washing and imposed speed limits

5.5 Monitoring

5.5.1 Requirement

In-line with the requirements of Chapter III of the Industrial Emissions Directive, the PROJECT emissions will be targeted for compliance with the applicable BAT Associated Emission Limits (AEL).

Any combustion equipment with a thermal rating exceeding 50 MW_{th}[1] and operating duration of 500 hours/year will be subject to compliance with the AELs and are required to be monitored for atmospheric emissions continuously.

The CHP Boiler falls under this requirement.

5.5.2 Methods for Stack Emissions Sampling and Analysis

Standard methods for stack emissions sampling have been provided in **Appendix B**. COMPANY shall refer to these standards for sampling and analysis of emissions of the PROJECT.

5.5.3 Continuous Emissions Monitoring System

To ensure compliance with the AELs, Continuous Emission Monitoring Systems (CEMS) shall be fitted to the CHP stack to monitor the flue gas parameters stated in the Environmental Basis of Design (Ref 1).

The PROJECT will use CEMS equipment that is certified by UK Monitoring Certification Scheme (MCERTS). MCERTS is the UK certification scheme for instruments, monitoring, and analytical services. The scheme is built on proven international standards and provides industry with a framework for choosing monitoring systems and services that meet acceptable performance specifications.

Resolution and accuracy of analysing and recording equipment must be in line with EN 14181:2004 Performance Standards and quality assurance of automated measuring systems.

5.5.3.1 Data Acquisition and Handling

As a minimum CEMS shall continuously monitor the following Greenhouse Gas (GHG) and air pollutants throughout the operating period of the PROJECT:

- Carbon Dioxide (CO_2)
- Methane (CH_4)
- Nitrous Oxide (N_2O)
- Nitrogen Oxides (NOx)
- Carbon Monoxide (CO)
- Particulate Matter (PM)

[1] Individual unit rating or the aggregated thermal output of multiple combustion units connected to a single stack

Other parameters to be monitored by CEMS are:

- Temperature
- Flue gas rate
- Moisture
- Oxygen content

Monitoring of Oxygen is a requirement for standardisation of other pollutants for reporting requirements.

5.5.3.2 Monitoring Standards

Standards associated with each CEMS monitored parameter are presented in *Table 5-1*

Parameter	Relevant ISO Standard
Oxygen	ISO12039
Velocity and Temperature	ISO 10780
Moisture	None, refer to Guidance on Monitoring stack emissions: techniques and standards for CEMS and automated batch samplers[2]
NOx	ISO 10849
CO_2	ISO 12039
CO	ISO 12039
PM_{10} / $PM_{2.5}$	ISO 23210
SO_2	ISO 7934

Table 5-1: ISOs relevant to various monitored parameters

5.5.3.3 Calibration, Performance and Certification Testing

When designing a platform for CEMs, access and facilities are required to enable:

- Calibration by periodic monitoring
- Routine maintenance and operational functional checks, such as span and zero checks to be carried out

As CEMS require calibration by periodic monitoring the access and facilities should, as a minimum, comply with the requirements of section 5.2 of BS EN 15259, which will require additional sample ports along the circumference of the stack to allow for QAL 2 sampling.

A sampling monorail may be attached above the measurement ports to enable certain designs of sampling equipment to be supported. Multiple spare ports will be required for QAL2 testing to facilitate test equipment drawing a sample from the stack.

Laboratories carrying out measurements, calibrations, and relevant equipment assessments for CEMS shall be accredited in accordance with EN ISO/IEC 17025 for the relevant analytical methods or calibration activities.

[2] Monitoring stack emissions: techniques and standards for CEMS and automated batch samplers, Environment Agency, Published 18-Dec-2019

All equipment shall be certified by MCERT. Laboratory testing shall be used to determine performance characteristics of the CEMS equipment, and such testing will require highly controlled environment and competent personnel. Competency of the personnel shall be certified by MCERT. The test laboratory shall evaluate the performance of the CEMS equipment at the lowest certifiable range of measurements possible for the intended application chosen by the manufacturer.

Calibration shall be conducted in line with BS EN 14181 (Section 6) and the manufacturers recommendations and collected data shall be audited as part of the bp audit program.

Equipment shall be tested in the field by test organisations that have EN ISO/IEC 17025 certificate which is the internationally recognised competency certification for testing laboratories. The field test duration shall be at least three uninterrupted months at the PROJECT site and be appropriate to the CEMS equipment field of application.

As a minimum PROJECT CEMS operation shall comply with performance standards presented **Appendix C**. These standards are derived from MCERTS.

5.5.3.4 Installation, Maintenance, and Repair

CEMS Equipment shall be tested before installation by accredited laboratories and test organisations that have EN ISO/IEC 17025 competency certification and meet requirements of the MCERTS scheme. Further to both the laboratory and field tests, uncertainty of the CEMS values shall be calculated to EN ISO 14956 standard. The manufacturer shall report the total combined uncertainty in relation to the maximum permissible uncertainty specified under the EU regulations No 601/2012.

5.5.3.5 Quality Assurance

Quality assurance shall be undertaken in accordance with the following standards:

- EN 14181, stationary source emissions: quality assurance of automated measuring systems.
- EN 15259, stationary source emissions: requirements for the measurement sections and sites and for the measurement objective, plan, and report.

Following activities shall be undertaken to meet these standards:

- **Quality Assurance Level (QAL) 1**: Testing whether the CEMS is meeting the specified requirements: For this purpose, EN 14956, "Air quality: evaluation of the suitability of a measurement procedure by comparison with a required uncertainty measurement" and EN 15267-3, "Air quality: certification of automated measuring systems, Part 3: Performance criteria and test procedures for automated measuring systems for monitoring emissions from stationary sources" are to be used.

- **QAL2:** Calibration and validation of the CEMS: These quality tests must be performed on suitable CEMS, i.e., instruments having passed QAL1 testing and that have been correctly installed and commissioned. QAL 2 tests shall be undertaken in accordance with EN 15259.
- **QAL3:** Ongoing quality assurance during operation: QAL3 procedure is described as ongoing quality control that shall be carried out after the acceptance (QAL1) and calibration (QAL2) of the CEMS. Objective of QAL3 is to demonstrate that the CEMS is stable and does not drift significantly, and it is therefore in control during its operation so that it continues to function within the uncertainties required by the UK MRR regulations.
- **Annual surveillance test (AST):** The AST checks the variability and the validity of the calibration function annually. Its purpose is for the measurement equipment to demonstrate that it functions correctly, and its performance remains valid that its calibration function and variability remain as previously determined.

QAL2 and AST are to be performed by accredited laboratories, QAL3 to be performed by bp. Competence of the personnel carrying out the tests must be ensured.

The typical frequency of checks and responsibilities under each QAL and AST is summarised in the table below.

Table 5-2: Overview of quality assurance levels (Quals)

Quality Levels	QAL1	QAL2	QAL3	AST
Timing	Before installation of the CEMS	Installation and calibration	During operation	Starting one year after QAL2
Frequency	Once	At least every five years	Weekly (Note 1)	Annually
Responsible Party	Operator / manufacturer	Accredited laboratory	Operator	Accredited laboratory
Applicable Standards	EN 14181, EN ISO 14956, EN 15267-3	EN 14181, EN 15259	EN 14181	EN 14181

5.5.3.6 Recording and Reporting

Data received from the CEMS shall be automatically recorded on to the data acquisition and reporting system and generate the necessary reports in compliance with UK requirements.

Records of the monitoring results shall be kept in an acceptable format and in conformity with UK requirements. The records shall be maintained for a minimum period of five years or a longer period if required by EA in the integrated environmental permit.

Requirements of EU Regulations 2018/2066 on the monitoring and reporting of GHGs emissions shall be taken into account for recording and reporting of GHG emissions.

bp shall commit to keep records of the original monitoring data from which the reported information was derived, and a description of the methodology used for data gathering for a minimum period of five (5) years. The data should include the following items:

- All direct measurements
- All performance evaluations
- Verification of calibration and maintenance checks (including full traceability of the testing body and methods used)
- Monitoring equipment manufacturers' recommended maintenance and calibrations frequencies.
- Occurrences and duration of any start-ups, shutdowns or malfunctions in the operation of the affected source or emission control device
- Periods when the continuous monitoring system is inoperative
- Type of fuel used along with specification and consumption (upon request) (unused fuel does not require reporting)
- Vendor manual with calibration details and technical specification of equipment used.
- Data collection shall be in accordance with internationally approved methodologies such as:
- CEN and ISO standards as measurement methodologies

5.5.4 Discrete Periodic Sampling

In the event of a CEMS failure, a back-up monitoring system must be available. This can be undertaken by suitably calibrated, portable analysers. Also, CEMS shall be calibrated, and quality checked by auxiliary measuring and monitoring equipment.

Periodic discrete sampling may be used for spot checking the consistency and quality of the CEMS. The sample is withdrawn from the stack (extractive sampling). An instrumental or automated technique may be used, where the sampling and analysis of the substance is fed to an on-line analyser. Alternatively, a technique may be used where a sample is extracted on site and analysed later in a laboratory. Samples may be obtained over several hours or may be so-called "spot" or "grab" samples collected over a period of seconds to several minutes.

Responsibilities of the key parties in discreet sampling are as follows:

- bp shall undertake periodic sampling from stacks in accordance with BS EN 15259 to demonstrate consistency and quality of the CEMS operating on these equipment stacks.
- EPC Contractor shall properly identify measurement positions when preparing the detailed design of the PROJECT. BS EN 15259 identifies positional requirements for measurements that shall be used for:
  - sampling particulates
  - sampling multiphase pollutants
  - sampling using wet chemistry when droplets are present
  - velocity measurements for reporting mass emission sampling gases that are distributed heterogeneously, due to effects, such as stratification determining a representative sample location for CEMS
- Calibration of CEMS shall be established by comparison with simultaneous measurements obtained using a periodic standard reference method. Further information is contained in BS EN 14181.

Other requirements:

- Wherever possible, the CEMS and periodic monitoring locations should be in close proximity. Therefore, the same location requirements apply to periodic monitoring and CEMS.
- Permanently installed CEMS sampling points or lines on the stacks must be located, so that a representative sample of the measurand is obtained. They must be positioned so as not to obstruct, or be affected by, sampling probes used to perform periodic measurements.
- Platforms must have a sufficient working area to manipulate the sampling probe and operate the measuring instruments, without equipment overhanging guardrails.
- Platforms must have a rain shield over the full sampling equipment platform gantry to enable testing scope.
- Measurement ports shall be big enough for the insertion and removal of the equipment used, and to allow the measurement points to be reached.
- Suitable arrangements to be made to enable test equipment to be lifted to the sampling gantry.
- Provision of suitable power supplies near sampling gantry to for sampling equipment.

5.6 Odour

Close monitoring of Odour sources (including the parts of the facility where amine is being used and the wastewater treatment package) is required to prevent nuisance, and shall cover operating logs, shutdown events, general process parameter monitoring and treatment excursions.

6. Waste Management

6.1 Waste Management Plan

A detailed Waste Management Plan (WMP) (Ref 5) will be developed during FEED to guide the Project staff and EPC contractor actions regarding the waste management procedures.

The WMP will be developed using the results of the HAZID, ENVID and other analysis that will be carried out during the FEED phase.

In compliance with the principles of COMPANY environmental policy, the PROJECT Waste Management plan shall be developed to:

- Prevent or minimize any irreversible negative impact on the environment
- Comply with applicable safety and environmental legislations and requirements
- Comply with requirements of the COMPANY safety and environmental procedures

These initiatives shall be sought through applying the following hierarchy which is also shown in Figure 6-1:

- Avoidance
- Reducing the amount of waste generated
- Re-use the material if possible
- Recycling the material
- Recovery of the materials from wastes
- Dispose of the waste as per Waste Control Act requirements
- Preparing plans to manage the storage, handling, transport, and disposal of waste

Figure 6-1 Waste management hierarchy

6.2 Objectives of Waste Management Plan

The waste management plan aims to:

- Where possible eliminate, otherwise limit the volume of wastes generated and provide for reusing, recycling, or disposing of wastes that cannot be avoided in a manner that reduces negative impacts to human health and the environment
- Provide for monitoring and assessment of the integrated waste management process such that compliance with regulatory requirements is achieved
- Minimise, and in some cases eliminate the environmental impacts of the proposed chemical uses through appropriate chemical selection, monitoring, and application of Best Available Technique (BAT).

6.3 Design and Management

During the construction phase, the PROJECT will control the production, storage, transfer, and disposal of construction wastes via implementing the Construction Waste Management Measures. The WMP will enforce a strict 'Duty of Care' onto the COMPANY Project Manager and the EPC contractor through the following good practices:

- Design of secure waste storage facilities in areas away from open ground
- Prohibition of uncontrolled burning or burial of waste materials
- Monitoring and auditing of working procedures (e.g., secure transport, handling, and transfer).
- Different approaches shall be applied to control the risk associated with the following specific waste streams:
- Non-hazardous solid wastes
- Hazardous solid wastes
- Liquid wastes (sanitary effluent, surface run-off and hydro-test water)

6.4 Monitoring

The Project staff and/or EPC contractor shall record all waste streams generated by the PROJECT and document recycling and disposal methods. Records of the following items shall be kept for future monitoring and evaluation of processes and procedures detailing:

- Date of waste generation
- Type of the waste
- Volume of the waste
- Method of temporary storage
- Method of transportation
- Disposal/recycling method and location

In addition to the above, the Project HSE Manager shall conduct monthly evaluations of:

- Compliance with the EMP by the Project staff, contractors, and subcontractors
- Compliance with Government approval, permit, and license obligations

- Use of waste handling procedure
- Training provided regarding waste management

All waste stream spills to the environment shall be investigated and reported to the PROJECT site environmental management as soon as possible.

The PROJECT Manager shall prepare monthly internal environmental reports that include reporting on the effectiveness of waste management measures. An annual Environmental Report, including a section on waste management and monitoring, shall be prepared for the COMPANY and external stakeholders.

7. Water Management

Water management, including both water supply and wastewater disposal, is a key element of environmental management. Water management is essential for establishing the operational integrity of the PROJECT and for minimising the adverse environmental impacts associated with the PROJECT during construction and operation phases.

The key recommendations regarding the water management include:

- An integrated approach to water use, water handling and wastewater discharges
- Prevention and control measures that aim to deliver sustainable water use, minimize associated environmental and social impact, and use of efficient water treatment techniques.

7.1 Objectives of Wastewater Management Plan

The objectives of the Wastewater Management Plan are to:

- Provide sufficient water for process, non-process, and any other project uses (e.g., hydro-testing)
- Minimise the potential for PROJECT activities resulting in pollution of surface and groundwater sources
- Ensure no discharge of untreated wastewater and process water to the receiving environment

7.2 Design and Management

7.2.1 Construction

The key wastewater streams during construction phase include sanitary effluent, hydro-test water and surface runoff which to be managed as follows:

- **Sanitary Effluent:** Sanitary effluent from the construction site shall be stored in a closed sump which will be routinely emptied by road tankers. Sanitary effluent shall be properly managed in a closed sump in order to prevent overflow from the sump.
- **Hydro-test Water:** Quality of Hydro-test water shall be maintained in compliance with the legal water criteria as are stated in the Environmental Basis of Design (Ref 1). To minimise water use, hydro-test waters shall be continuously reused and either pumped or transported by vacuum tanker between different components of the PROJECT.
- **Surface Runoff:** Temporary diversion channels shall be constructed early in construction phase to reduce soil erosion and to protect certain areas, on steep slopes or around deep excavations that could be at risk from flooding during rainstorms. These temporary drainage channels shall feed into a local settling pond and shall be allowed to infiltrate

7.2.2 Operation

As part of the COMPANY sustainability goals to reduce water use, and to reduce environmental impact, the PROJECT has committed to a Zero-Liquid Discharge (ZLD) policy. The design

incorporates wastewater reuse and condensate recovery with an ISBL wastewater treatment unit.

Table 7-1 summarises the effluent streams, treatments and routing. Effluents produced in the wastewater treatment process (i.e., sludges) are routed to the cement plant for use. Further details on the below will be provided in the Emission, Discharge and Waste schedule (Ref 4).

Effluent Stream	Treatment	Route/Disposal
Blowdown from flue gas quencher	N/a	Directed to Cement plant for use in cement production
Flue gas condensate from Quencher	Chemical coagulant added, filtering and condensing to remove particulates	Cooling Water Makeup
Cooling Tower Blowdown	Combined with raw-water treatment which includes Chemical coagulation, flocculation and setting. Ultrafiltration (UF) and Reverse osmosis (RO)	Offtake upstream of UF/RO for Firewater. Offtake downstream of UF/RO for boiler Feed Water, Demin Water and service water.
Sewage from facilities	n/a	Routed to tie-in with existing plant sewage facility
Stormwater (amine contamination)	n/a – pumped to drain drum 740-VZ-003 for testing	If contaminated found, will be removed by 3rd party waste handler in vacuum tanker.
Stormwater (no contamination)	Chemical coagulant added, filtering and condensing to remove particulates	Clean stormwater is pumped from drain drum to oily water separator and then into treatment facility for use in cooling water makeup

Table 7-1: Effluent Streams

7.3 Monitoring

7.3.1 General Requirements

Adequate monitoring shall be included in plant design to allow water balance to be recorded for the plant.

Monitoring of wastewater effluent flow and quality from the process units at inlet and outlet points of the wastewater treatment system shall be provided to ensure that proper treatment of the effluent takes place in the event of fluctuating loads.

Surface water and ground water monitoring shall be developed within the EIA as part of the integrated Environmental Permit requirements.

Data shall be recorded such that variations in treatment performance can be monitored and remedial actions implemented as necessary.

7.3.2 Monitoring Points

Sampling and Monitoring shall be undertaken at key control points as follows:

Control Points:

- Drain Drum 740-VZ-003
- Oily water Separator (740-SR-001)
- Treatment points within the wastewater treatment plant (inlet and outlet)

Sanitary Sewage Inlet Points:

- local area foul sewer connection

Parameters to be monitored as well as types and numbers of sample to be taken varies among the above monitoring and sampling points. Detailed monitoring plan for each of the monitoring points shall be prepared by COMPANY prior to commissioning of the PROJECT.

7.3.3 Continuous Water Monitoring Systems (CWMS)

Continuous Water Monitoring Systems (CWMS) include automatic measurements carried out continuously, with few if any gaps in the data produced. Measurement may be carried out in situ in the effluent flow, or a sample taken from the effluent flow automatically to a permanently sited instrument. Continuous monitoring for certain determinants will be specified in the integrated environmental permit. CWMS are often used to trigger alarms when permit limits are approached, so effluent can be diverted automatically to storage before the receiving environment becomes polluted.

An indicative list of parameters to be considered for continuous monitoring regime and online analysing at test point is as follows:

- Flow rate
- pH
- Temperature
- Total organic Carbon (TOC)
- Total Suspended Solids (TSS)
- Chemical Oxygen Demand (COD)
- Biological Oxygen Demand (BOD)
- Total Phosphorous
- Total Nitrogen
- Nitrate
- Total Monoaromatic Hydrocarbons (MAH)
- Total Polyaromatic Hydrocarbons (PAH)

Requirements for monitoring of one or more of these parameters at the control points shall be dependent on the nature and source of the stream as well as the receiving unit in the Wastewater treatment plant.

7.3.4 Location of Monitoring Equipment

Monitoring equipment sensors can be in situ, directly in the effluent flow, or remote from the effluent flow with sample pumped to it. Following criteria apply to access, facilities, and services in the monitoring location:

- Safe means of access to, and a safe place of work at the sampling position
- Provision of shelter and weatherproofing of equipment
- Space for the equipment and personnel
- Essential services, for example, electricity and lighting

Also, provision should be made for cleaning of sampling pipes and tubes where necessary.

7.3.5 Calibration and maintenance

CWMS should be installed, commissioned, and validated by their manufacturers or manufacturers' agents.

Maintenance procedures should be documented and carried out as per manufacturer's instructions and recommended frequencies. Major servicing is best carried out by manufacturers or specialist companies. Suitably trained staff can undertake interim (daily, weekly) calibration and maintenance checks.

7.3.6 Periodic Monitoring

In the context of discharges to water, periodic monitoring usually occurs by removing a discrete sample from the effluent flow and sending the sample to a laboratory for analysis. Samples can be single spot samples or composite samples collected over a period of time.

7.3.7 Standard Methods for Wastewater Sampling and Analysis

Wastewater monitoring shall be undertaken in accordance with best industry practices and internationally accepted methods for sample collection and analysis such as ISO standards and those published by the European Committee for Standardization. **Appendix D** contains the "Standard Methods for Wastewater Sampling and Analysis".

7.3.8 Quality assurance

COMPANY shall ensure the wastewater treatment plant's Operation Management System covers all aspects of self-monitoring, including:

- Sampling program design
- Sampling procedures
- Analysis and reporting procedures

- Staff training
- The process of audit and review of sampling and analysis operations
- Addressing non-conformities

Sampling should be conducted by, or under, the supervision of trained individuals. Analysis should be conducted by entities accredited MCERT or possessing valid ISO/IEC 17025:2017 certificate. Sampling procedures, sampling quality control, as well as samples storage and transportation shall be in accordance with requirements of ISO/DIS 5667-10 "Water quality Sampling Part 10: Guidance on sampling of wastewater).

Automatic sampling devices used for monitoring purposes shall be tested and certified to the MCERTS performance standard (or equivalent): "Continuous Water Monitoring Equipment Part 1: Performance standards and conformity testing procedures for automatic wastewater sampling equipment'.

For a safe access Sampling position shall be provided with:

- Safe mean of access to and safe place of work
- Provision of shelter and weatherproofing of equipment
- Space for the equipment and personnel
- Essential services, for example, electricity and lighting

8. Noise Management Plan

The PROJECT will generate noise from a number of sources during construction, commissioning and operation phases. Noise emission must be managed in compliance with the Noise at Work Regulations 2005 (UK Statutory Instruments 2005 No. 1643).

The environmental noise in the communities and ecological receptors shall comply with the Statutory Instrument 2006 No. 2238 - The Environmental Noise (England) Regulations 2006.

8.1 Objectives of Noise Management Plan

The key objective of the noise management plan is to mitigate project noise impacts on nearby communities and to effectively manage the occupational noise exposure of employees.

The noise management plan shall specifically aim to minimise adverse noise impacts on residents and workers through compliance with the regulatory noise standards.

Once issued, the Environmental permit will identify the noise level that shall be achieved by the PROJECT in nearby communities.

8.2 Design and Management

8.2.1 Construction Noise

Noise Control measures during construction phase includes:

- Regular maintenance, monitoring and, where limits are exceeded, the retrofitting of silencing equipment
- Maintenance of vehicles and equipment in accordance with manufacturers recommended standards
- Locating pumps, generators, and fixed equipment as far as practicable from any sensitive receptors
- Switching off equipment, whenever possible, during periods of inactivity
- Where possible, restrict noisy construction work activities to period of 8AM to 6PM

8.2.2 Operation Phase Noise

The following control measures shall be adopted to minimise noise emissions from the PROJECT plant operations and reduce the potential for noise impacts. General noise control measures that are likely to be adopted are as follows:

- Significant noise generating equipment and vehicles shall be regularly maintained and monitored to meet manufacturer's specifications
- Noise attenuation devices shall be regularly serviced so that they remain effective
- Pumps, generators, and fixed equipment shall be located as far as reasonably practicable from any sensitive receptors
- Noisy equipment shall be switched off whenever is possible during periods of inactivity

- Offices and residential building location shall be chosen to minimise disturbance effects

8.2.3 Occupational Workplace Noise

The FEED phase BAT studies will address the noise aspects and best available techniques will be adopted to minimize adverse impacts of the PROJECT noise on the workers. The following control measures shall be adopted to minimise noise related impacts:

- The intention shall be always to reduce noise at source, for example with the use of low noise valves rather than the application of acoustic insulation to downstream piping
- Noise sources in the workplace which contribute to high noise exposure shall be identified and, where possible, eliminated, isolated, or replaced
- The overall sound pressure level (SPL) dB(A) value for any equipment item shall be limited to 85 dB(A) at one-meter distance as is required by Environmental Basis of Design.
- Typical noise levels in rotating machinery areas are 85-95 dB(A). Other sources include large pumps, motors, and compressors These shall be enclosed in order to meet the 85 dB(A) limit at one meter

8.3 Noise Monitoring

- Initial ambient noise monitoring will be undertaken in and around the PROJECT footprint as part of the EIA studies
- Construction noise shall be monitored during the daytime, evening time, and nighttime, at the periphery of the PROJECT site and at local sensitive receptors throughout the construction phase
- Noise measurement shall be conducted at representative locations in the PROJECT site at regular intervals over the life of the PROJECT
- Need for hearing protection at any point of the PROJECT site, shall be identified through workplace noise exposure assessment in accordance with best industry practices.
- An occupational noise monitoring program shall be implemented during the construction, commissioning and operational phases which shall include:
- Workplace noise monitoring prior to commissioning to determine the principal noise sources in the work environment
- Reporting on high noise sources identified in monitoring and developing appropriate noise mitigation strategies to reduce overall noise emission.

9. Lighting Management Plan

The proposed PROJECT site is located in an industrial area where several existing projects with industrial features and structures are operating, therefore, no significant visual impact from the PROJECT is anticipated.

9.1 Visible Plume

Emission sources with high water content may generate a visible plume which can also reflect light vertically above the horizon resulting in extended light nuisance beyond the intended area of influence.

If it is suspected that the water-cooling tower may form a visible plume, plume modelling shall be undertaken to investigate frequency of occurrence and size of visible plumes relevant to the PROJECT emission sources.

9.2 General Measures for Lighting Management

Personnel safety and efficiency of operation are the preliminary factors to be considered while designing the Lighting System. The lighting system shall be designed to provide the desired quantity of light at the particular locations and in the proper visual plane, taking into account all safety requirements for the lighting and considering the following provisions:

- Artificial lighting should be angled downwards and to a degree which avoids unnecessary illumination of the sky or areas outside fence line of the facility.
- Lighting near or above the horizon is usually to be avoided to reduce glare and sky glow (the brightening of the night sky), i.e., considered use of elevated lighting
- Good design, correct installation and ongoing maintenance are essential to the optical effectiveness of lighting schemes such as fixed and/or regularly operated functional and decorative lighting elements. In combination with optical good practice aimed at limiting light pollution, efficient lamp and luminaire selection are important considerations to minimise energy use and associated carbon emissions.

10. Emergency Response Management Plan

Emergency Response Management Plan (ERMP) shall be prepared for the construction and operations phases, detailing the procedures for managing emergencies and reducing the impacts of abnormal events and accidents on the workers, asset, and the environment. The Emergency Response Plan should be aligned with the existing COMPANY Emergency Response Strategy.

The ERMP shall address PROJECT-specific accident scenarios and prescribe actions and procedures for worst case/critical events that may occur. The PROJECT shall engage with other operators in the area to provide a supporting role for the coordination of accident and emergency response management plans across the Immingham industrial area. This may include promoting existing emergency response.

10.1 Objectives of Emergency Response Management Plan

The objective of emergency response planning is to develop a strategy and corresponding response procedure(s) which will ensure emergency preparedness and provide means for mitigating the consequences of emergencies, including very low probability events, in order to protect the environment, health and safety of the general public and personnel.

The ERMP aims to establish an organisation to mitigate incidents within the boundaries of the PROJECT.

10.2 Design and Management

The major emergency scenarios to be considered include:

- Fire or explosion
- Toxic gas release
- CO_2 release
- Chemical or hydrocarbon release
- Road Traffic Accident.

The Emergency Response Plan shall include the requirements for:

- Fire Management roles, responsibilities, and coordination
- Specialist training
- Procedures and schedule for emergency drills and simulations (firefighting, emergency evacuation etc.)
- Communication (internal and external)
- Emergency response equipment operation and maintenance
- Restoration (clean up and disposal of wastes)
- Plan review and update

The ERMP shall be developed in consultation with the Project process engineers, management staff, local authorities, PROJECT and other neighboring facilities. The Plan shall be coordinated with the Waste Management Plan in possibility that an incident could produce (hazardous) waste items that requires disposal. Engagement with the local stakeholders will be an essential part of implementing the EMRP.

The Project HSE Plan shall address safety measures to minimise the impacts of abnormal events including fire and explosions, toxic gas and asphyxiant release, and chemical spillage.

10.2.1 Spill Response

It should be envisaged that a dedicated spill team to be assigned for providing a rapid response to contain and recover small-scale spillages on PROJECT site.

Training in spill response shall be given to all personnel to ensure that appropriate measures are deployed for dealing with different hazards and risk and of different magnitudes.

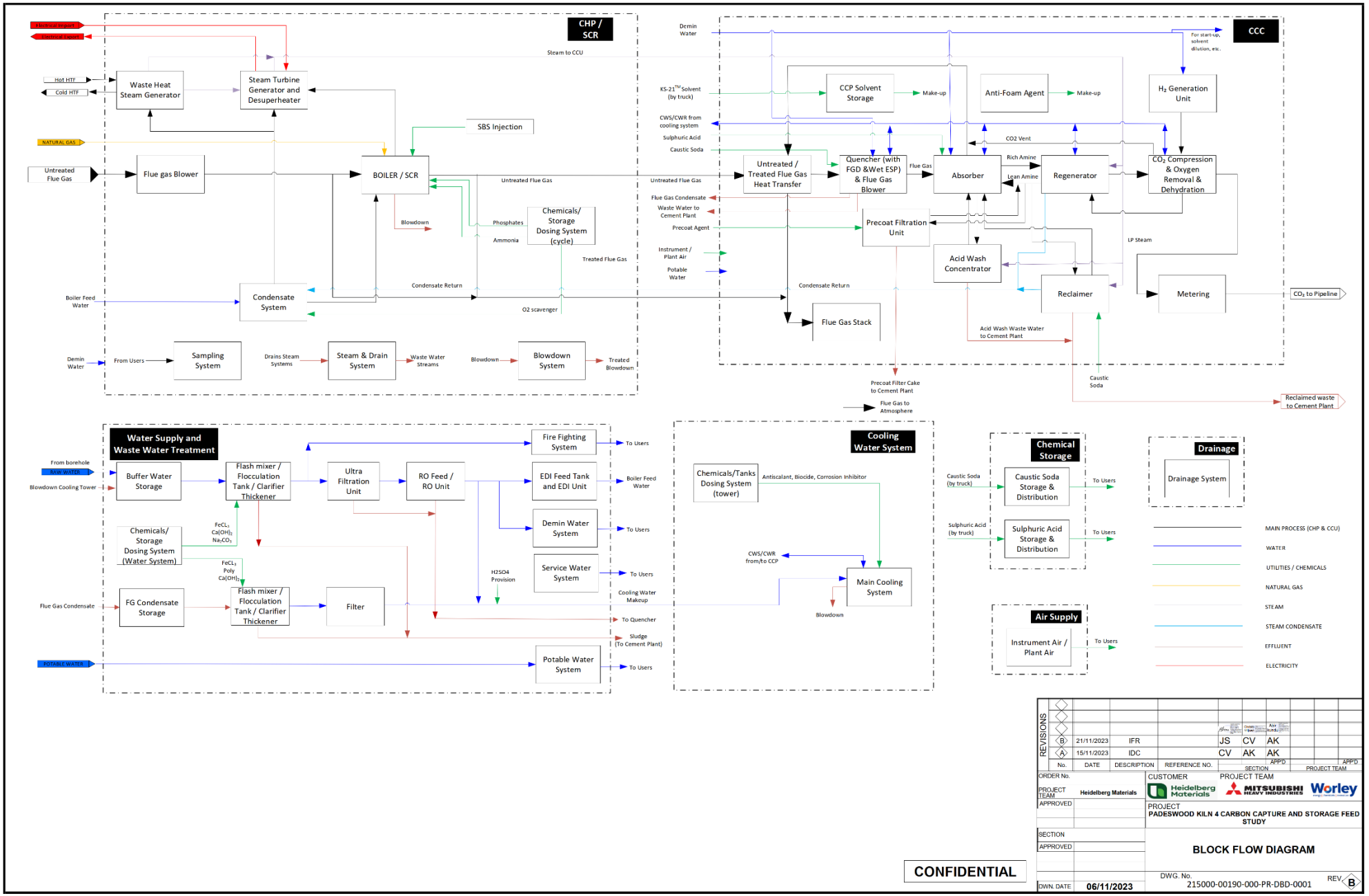
Spill control measures should include:

- Provision of hard paved surfaces
- Drainage and bunding to limit ground contamination in areas where spills are credible
- Spill response planning during the operational phase shall be based upon:
- The probable size of the spill to be estimated by realistic failure scenarios
- The resulting impact on the environment and related potential environmental damage.

Spill response plan shall detail:

- Alarm, reporting and communication
- Location of spill kits and equipment, routine operation, and the maintenance checks
- The deployment of booms, vacuum pumps and sorbent materials
- The disposal of recovered oil and chemicals as a hazardous waste

Appendix A. Overall Block Flow Diagram



REVISIONS	No.	DATE	DESCRIPTION	REFERENCE NO.	SECTION	PROJECT TEAM
	B	21/11/2023	IFR		JS	CV AK
	A	15/11/2023	IDC		CV	AK AK

ORDER No.
PROJECT TEAM Heidelberg Materials
APPROVED
SECTION
APPROVED
DWN. DATE 06/11/2023

CUSTOMER Heidelberg Materials
PROJECT TEAM MITSUBISHI HEAVY INDUSTRIES, Worley

PROJECT
PADESWOOD KILN 4 CARBON CAPTURE AND STORAGE FEED STUDY

BLOCK FLOW DIAGRAM

DWG. No. 215000-00190-000-PR-DBD-0001
REV. B

CONFIDENTIAL

Appendix B. Stack Sampling and Analysis Standards

NO	ISO Standards	Sampling Method
1	ISO 7934:1989 (Rev 2016)	Stationary source emissions -- Determination of the mass concentration of sulphur dioxide -- Hydrogen peroxide/barium perchlorate/Thorin method
2	ISO 11632:1998 (Rev 2016)	Stationary source emissions -- Determination of mass concentration of sulphur dioxide -- Ion chromatography method
3	ISO 7935:1992 (Rev 2013)	Stationary source emissions — Determination of the mass concentration of sulfur dioxide — Performance characteristics of automated measuring methods
4	ISO 11564:1998 (Rev 2016)	Stationary source emissions — Determination of the mass concentration of nitrogen oxides — Naphthylethylenediamine photometric method
5	ISO 10849:1996	Stationary source emissions -- Determination of the mass concentration of nitrogen oxides -- Performance characteristics of automated measuring systems
6	ISO 21258:2010 (Rev 2016)	Stationary source emissions -- Determination of the mass concentration of dinitrogen monoxide (N_2O) -- Reference method: Non-dispersive infrared method
7	ISO 12039: :2019	Stationary source emissions — Determination of the mass concentration of carbon monoxide, carbon dioxide and oxygen in flue gas — Performance characteristics of automated measuring systems
8	ISO 12141:2002 (Rev 2015)	Stationary source emissions — Determination of mass concentration of particulate matter (dust) at low concentrations — Manual gravimetric method
9	ISO 23210:2009 (Rev 2015)	Stationary source emissions -- Determination of PM10/PM2.5 mass concentration in flue gas -- Measurement at low concentrations by use of impactors
10	ISO 9096:2017	Stationary source emissions — Manual determination of mass concentration of particulate matter
11	ISO 9096:2017 (Rev 2016)	Stationary source emissions — Manual determination of mass concentration of particulate matter
12	ISO 10155:1995	Stationary source emissions -- Automated monitoring of mass concentrations of particles -- Performance characteristics, test methods and specifications
13	ISO 14164:1999 (Rev 2016)	Stationary source emissions — Determination of the volume flowrate of gas streams in ducts — Automated method
14	ISO 10396:2007 (Rev 2016)	Stationary source emissions — Sampling for the automated determination of gas emission concentrations for permanently-installed monitoring systems
15	ISO 10780:1994 (Rev 2016)	Stationary source emissions -- Measurement of velocity and volume flow rate of gas streams in ducts
16	ISO/TR 27912:2016	Carbon dioxide capture — Carbon dioxide capture systems, technologies and processes

Appendix C. CEMS Performance Standard

Performance characteristic	Gases other than HCl, HF and O_2 (NOTE 1)	O_2 Level
Linearity	<±2%	<±0.3% vol
Cross-sensitivity	<±4%	<±4%
Zero shift due to ambient temperature change of 1 °C (ΔT= 10 °C)	<0.3%	<±0.5% vol
Span shift due to ambient temperature change of 1 °C (ΔT= 10 °C)	<0.3%	<±0.5% vol
Response time (seconds)	<200	<200
Detection limit (% of range)	<2%	<0.2%
Detection limit (% of emissions limit) (Note 2)	<5%	–
Analysis function/integral performance	>95%/<10%	>95%/<5%
Availability	>95%	>95%
Zero drift (weekly)	<2%	<±0.2% vol
Span drift (weekly)	<4%	<±0.2% vol
Linearity	<±2%	<±0.3% vol

NOTE 1: The gases will ordinarily include SO_2, CO_2, NO, NO_2, H_2O, CO, N_2O, SF_6, CH_4, perfluorocarbons, and hydrofluorocarbons. However, other gases or vapour may be included, such as formaldehyde, mercury vapour and benzene.

NOTE 2: This is not applicable to gases where there is not a set emissions limit, for example, GHGs such as perfluorocarbons and hydrofluorocarbons.

Appendix D. Water Monitoring Standards

NO	Parameter	CEN and ISO monitoring methods	Standard Methods
1	Colour	ISO 2211:1973 and ISO 6271:1997	Method 2120
2	Temperature		Method 2120
3	Total Suspended Solids	BS EN 872 : 2005	Method 2540
4	pH	BS ISO 10523	Method 4500
5	Dissolved oxygen	ISO 5813:1983, 5814:1990	Method 4500
6	BOD	BS EN 1899-1 BS EN 1899-2 ISO 5815-1, 2	Method 5210
7	COD	BS 6068-2.34 Same as ISO 6060 BS ISO 15705	 Method 5220 Correction to be made with TOC
8	Cyanide	BS EN ISO 14403-1 BS EN ISO 14403-2 BS ISO 17690 ISO 6703-1 ISO 6703-2 ISO 6703-3	Method 4500
9	Fluoride	BS EN ISO 10304-1 ISO 10359-1 ISO 10359-2	
10	Free Chlorine	BS EN ISO 7393-3 BS EN ISO 7393-2 BS EN ISO 7393-1	
11	Chloride	ISO 15682:2000	Method 4500 Cl-
12	Phenols	BS EN ISO 14402 BS 6068-2.12 ISO 6439	 Method 6420
13	Sulphate	BS ISO 15923 – 1 ISO 22743	Method 4110B
14	Nitrate as NO3-	BS EN ISO 13395 BS EN 26777 ISO 6777 ISO 7890-3	Method 4500
15	Phosphate	BS EN ISO 18856	Method 4500
16	Orthophosphate and total Phosphorous	BS EN ISO 15681-1 BS EN ISO 15681-2 BS EN ISO 6878	Method 4500
17	Total Nitrogen	BS EN ISO 11905-1 BS EN 12260 BS ISO 29441	Method 4500
18	Ammonia as Free NH3	BS EN ISO 11732 BS 6068-2.11 ISO 7150-1	Method 4500

NO	Parameter	CEN and ISO monitoring methods	Standard Methods
		BS 6068-2.7 ISO 5664 BS 6068-2.10 ISO 6778	
19	Lead	BS EN ISO 15586 EPA 3015 BS EN ISO 11885 ISO 8288	Method 3500
20	Arsenic	BS ISO 17378 -1 BS ISO 17378 -2 BS EN 26595 ISO 6595	Method 3500
21	Copper	BS EN ISO 15586 ISO 8288 EPA 3015 BS EN ISO 11885	Method 3500
22	Nickel	BS EN ISO 15586 ISO 8288 EPA 3015 BS EN ISO 11885	Method 3500
23	Selenium	PD ISO/TS 17379-1 PD ISO/TS 17379-2	Method 3500
24	Mercury	ISO 5666 BS EN 12846 BS EN ISO 17852 EPA 3015 BS EN ISO 17852	Method 3112B
25	Cadmium	ISO 8288 BS EN ISO 5961 EPA 3015 BS EN ISO 11885	Method 3113
26	Zinc	ISO 8288 BS EN ISO 15586 EPA 3015 BS EN ISO 11885	Method 3500-Zn
27	Chromium	ISO 9174 BS EN 1233 EPA 3015 BS EN ISO 11885	Method 3500-Cr
28	Chromium - Hexavalent	BS 6068-2.47 ISO 11083 BS EN ISO 18412 BS EN ISO 23913	Method 3500-Cr

NO	Parameter	CEN and ISO monitoring methods	Standard Methods
29	Aluminium	ISO 10566: BS EN ISO 15586	
30	Barium		Method 3500-Ba
31	Cobalt	ISO 8288 BS EN ISO 15586	Method 3500-Co
32	Iron	ISO 6332	Method 3500-Fe
33	Manganese	ISO 6333	Method 3500-Mn
34	Silver	BS EN ISO 15586	Method 3500-Ag
35	Total Hydrocarbon & Derivatives	BS EN ISO 17993 BS ISO 28540	By Gas Chromatography
36	Sulphide	ISO 10530	Method 4500 – S2-
37	Organic solvents		Method 6200
38	Benzene	ISO 11423-1: 2002 BS EN ISO 6468	Method 6200
39	Chlorinated Hydrocarbons	BS ISO 18073	Method 6232
40	TOC	ISO 8245 BS EN 1484: 1997	
41	Alkalinity	ISO 9963-1 ISO 9963-2	Method 2320 B
42	Acidity		Method 2310B
43	Hardness as Calcium CaCo3		Method 2340
44	Oil and Grease	BS EN ISO 9377-2: 2002 IP426	Method 5520 B
45	Total and Faecal Coliform		Method 9222
46	Total Coliform bacteria		Method 9222 B
47	Fecal Coliform		Method 9222 D
48	polycyclic aromatic hydrocarbons (PAH)	BS EN ISO 17993 BS ISO 28540	
49	Conductivity	BS EN 27888 ISO 7888	
50	Turbidity	BS EN ISO 7027-1	
51	Dioxin-like PCBs	BS ISO 17858	
52	VOC	BS EN ISO 15680	
53	Volumetric flow	MCERTS	

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