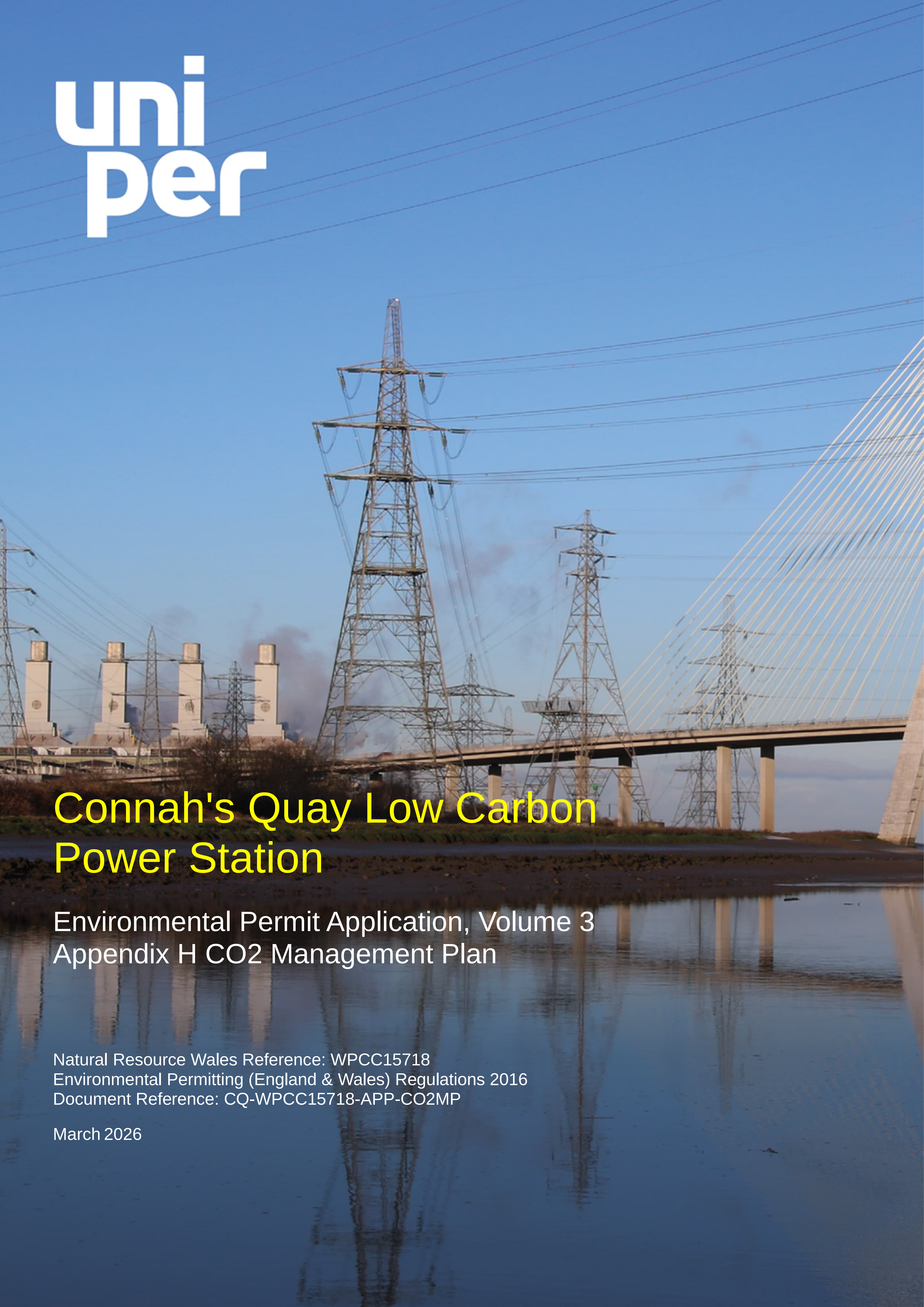


Connah's Quay Low Carbon Power Station

Environmental Permit Application, Volume 3
Appendix H CO2 Management Plan

Natural Resource Wales Reference: WPCC15718
Environmental Permitting (England & Wales) Regulations 2016
Document Reference: CQ-WPCC15718-APP-CO2MP

March 2026

Prepared for:

Uniper UK Limited

Prepared by:

AECOM Limited

Table of Contents

Figures

No table of figures entries found.

Tables

Glossary

Abbreviation	Term
CCGT	Combined Cycle Gas Turbine
CCP	Carbon Capture Plant
CEMP	Construction Environmental Management Plan
DCO	Development Consent Order
EIA	Environmental Impact Assessment
EN-1	The Overarching National Policy Statement (NPS) for Energy
EN-2	The NPS for Natural Gas Electricity Generating Infrastructure
EN-4	The NPS for Natural Gas Supply Infrastructure and Gas and Oil Pipelines
EN-5	The NPS for Electricity Networks Infrastructure
FCC	Flintshire County Council
LDP	Local Development Plan
NPS	National Policy Statement
PEIR	Preliminary Environmental Information Report
PINS	Planning Inspectorate
PPW	Planning Policy Wales
PRV	Pressure Relief Valve
SoS	Secretary of State

1. Introduction

1.1 Overview

This CO_2 Venting Management Plan has been prepared by AECOM Limited ('AECOM') on behalf of Uniper UK Limited referred to as "the Operator", in support of a new bespoke Environmental Permit application for the proposed Connah's Quay Combined Cycle Gas Turbine (CCGT) with Carbon Capture Plant (CCP) ("Proposed Installation").

The design of the Proposed Installation is subject to ongoing technical studies during Front End Engineering Design (FEED), to provide flexibility and to align with the current grid connection, but it is expected to comprise the development of up to two CCGT units achieving a net electrical output capacity of up to 1,380 megawatts (MW; referred to as MWe for electrical output) (with CCP operational) onto the national electricity transmission network.

It is expected that the Proposed Installation will make use of CO_2 transport and storage networks owned and operated by Liverpool Bay CCS Limited, currently under development as part of the HyNet Carbon Dioxide Pipeline Project (referred to as the 'HyNet CO_2 Pipeline Project'), which will transport CO_2 captured from existing and new industries in North Wales and North-West England, as well as from new hydrogen production facilities that are proposed as part of HyNet North West Project. The captured CO_2 will be stored in depleted offshore gas reservoirs in Liverpool Bay

As part of the Environmental Permit application requirements, operators of Carbon Capture Plant (CCP) are required to set out in their permit applications:

- Details of how modelling has been, or will be, used to inform process design and manage the risk of CO_2 venting, including a description of the different venting scenarios;
- Demonstrate that the design is in line with current industry best practices;
- Detail the operational methods to minimise the risks associated with CO_2 venting to atmosphere, and how venting scenarios will be limited to those considered in the permit application;
- Produce a CO_2 Venting Management Plan prior to commencement of operations.

This CO_2 Venting Management Plan has been produced to demonstrate how these requirements have been addressed, and to outline the measures in place to manage the risk to offsite sensitive receptors from the venting of CO_2, based on the scenarios considered in the Environmental Permit application.

The risks of venting CO_2 to the health and safety of workers on the Proposed Installation has been assessed during the pre-FEED stage through the Hazard Identification Process. This CO_2 Venting Management Plan does not supersede the requirements of venting to protect worker safety and should be considered in conjunction with the assessment on worker health and safety through Hazard Operability (HAZOP) Studies once FEED is completed.

The detailed FEED stage is being progressed with two Technology Licensors. This CO_2 Venting Management Plan will be updated once the FEED is completed and the Technology Licensor is selected.

1.2 Receptors

The closest receptors to the Proposed Installation are located on Kelsterton Road approximately 100m to the south of the Proposed Installation boundary. Kelsterton Road runs parallel to the site, and is bisected by the A548. Receptors are located along the length of Kelsterton Road at similar distance from the Proposed Installation though with greater distance from the Carbon Capture Plant (CCP). The receptors of relevance to this Management Plan are shown in Figure 2 as shown in Appendix A.

Table 1-1. Sensitive Receptors

Receptor ID	Description	Coordinates		Approximate Distance from Proposed Installation Boundary (m)
		X	Y	
R1	Kelsterton Road, Rockcliffe, Flint, Connah's Quay, Flintshire, Wales, CH6 5SJ	327170	371241	220
R2	Chester Road, Oakenholt, Flint, Connah's Quay, Flintshire, Wales, CH6 5SJ	327152	371210	260
R3	Chester Road, Oakenholt, Flint, Connah's Quay, CH6 5SF	326749	371070	660
R4	Kelsterton Road, Rockcliffe, Connah's Quay, Flintshire, Wales, CH6 5TH	327557	370826	490
R5	Kelsterton Road, Rockcliffe, Connah's Quay, Flintshire, Wales, CH5 4BJ	327880	370743	700
R6	Connah's Quay, CH5 4BL	327972	370700	790
R7	Deeside College, York Road, Golftyn, Connah's Quay, CH5 4YE	328024	370545	950
R8	Papermill Lane, Oakenholt, Flint, CH6 5TD	326371	371298	950
R9	Oakenholt Lane, Oakenholt, Flint, CH6 5SX	326452	370953	970

1.3 Air Quality Standards and Exposure Criteria

There are no air quality objectives, targets or Environmental Assessment Levels (EALs) (Ref 1-1) set for CO_2 to protect human health at locations where members of the public may be present. Therefore, in order to determine an appropriate assessment level to ensure the protection of human health, available workplace exposure limits have been reviewed.

CO_2 has been recognised as a potential risk in workplaces for over a century, and Workplace Exposure Limits (WELs) have been set in order to protect worker health. The Health and Safety Executive (HSE) published WELs to be used in UK workplaces in their document EH40 (Ref 1-2). This sets an 8-hour Time Weighted Average (TWA) of 5,000 ppm (or 9,150 mg/m^3), and a 15-minute Short Term Exposure Limit (STEL) of 15,000 ppm (or 27,400 mg/m^3). These values are for the protection of workers, and assume an individual that is relatively healthy and has access to areas of clean air. The values given are not considered relevant to public exposure where members of the public may be present occasionally or permanently (e.g. public rights of way or residential properties) where potentially more vulnerable individuals such as the elderly or children are likely to be present.

In addition, the HSE has published guidance on exposure to substances during major accidents (Ref 1-3, Ref 1-4), and introduce the concept of Specified Level of Toxicity (SLOT) and Significant Likelihood of Death (SLOD). These use a Dangerous Toxic Load (DTL) and a specified period of time to calculate a concentration that would represent a specific risk.

The SLOT represents the dose at which highly susceptible people would be killed (a fatality rate of 1-5%) and cause severe medical distress to a large proportion of the remaining population. The SLOD represents the dose which would result in a fatality rate of 50% within the exposed population. The SLOT and SLOD DTL's are related in the following equation:

$$C^n t = A$$

Where:

C = Concentration in ppm

t = exposure time in minutes

n = the toxic exponent of C (for CO_2, a value of 8 is used)

A = DTL, which is given as:

For SLOT, a value of 1.5 x 10^{40}

For SLOD, a value of 1.5 x 10^{41}

Given the above parameters, SLOT and SLOD concentrations for given periods of time can be derived for CO_2. These concentrations are shown in

Table 1-2 (rounded to the nearest 1,000), and indicated that significant effects, including death, can be experienced at a concentration of 6.3%.

Table 1-2. CO_2 SLOT and SLOD Concentrations

Exposure Time (minutes)	CO_2 Concentration in air			
	SLOT		SLOD	
	%	ppm	%	ppm
60	6.3%	63,000	8.4%	84,000
30	6.9%	69,000	9.2%	92,000
20	7.2%	72,000	9.6%	96,000
10	7.9%	79,000	10.5%	105,000
5	8.6%	86,000	11.5%	115,000
1	10.5%	105,000	14.0%	140,000

2. Operations on site

2.1 Carbon Capture Process

This section sets out those parts of the Proposed Installation processes where CO_2 is likely to be vented. Details of the wider Proposed Installation processes are set out in the Supporting Statement.

As describe in sections 2.2.1 to 2.1.3 below, the Proposed Installation will be designed to capture CO_2 during normal operations.

2.1.1 Absorber

The final CCP design will be provided by the selected Technology Licensor and therefore the design described below may be subject to minor amendments.

The CO_2-rich exhaust gas is fed to the bottom of the absorber, just below the packed section, consisting of a column filled with structured material designed to maximise the contact surface between gas and liquid. Lean solvent is fed to the top. As the exhaust gas flows upward and contacts the descending solvent, CO_2 is absorbed through counter-current mass transfer. The equilibrium limit for this reaction is reached at the absorber top where the leanest solvent contacts the exhaust gas with minimum CO_2 concentration, and the overall carbon capture efficiency is calculated from the difference in the exhaust gas concentrations at the absorber inlet and outlet.

The treated exhaust gas (CO_2-lean gas) then exits the top of the absorber and passes through solvent retention and air emissions mitigation stages (see Section 5.1) and is subsequently released to atmosphere via a dedicated stack.

Gas pressure throughout the absorber section is low, typically below 100 mbarg to balance the pressure drop of the absorber equipment before the atmospheric stack.

Typical operating temperatures in the absorber include a range from 30°C to 80°C, depending on the process design parameters such as the compositions of the solvent and exhaust gas, as well as the presence of any intercooling arrangement in the absorber. The final operating temperatures within the absorber will be confirmed by the Technology Licensor. Note that towards the exit point from the absorber, the exhaust gas will generally approach a temperature within 5-10°C of the lean solvent supply temperature.

2.1.2 Desorber

The CO_2-rich solvent exits the bottom of the absorber, via a lean-rich solvent interchanger (heat exchanger) and passes to the top of the stripper column (desorber) which uses hot rising vapour to break the CO2-amine bond and releases the CO_2 from the solvent at a pressure slightly above atmospheric pressure.

The hot CO_2-lean solvent enters the sump at the bottom of the desorber and is passed to the desorber-reboiler.

The desorber-reboiler boils the lean amine using saturated LP-steam heat-exchanger, and some of this is passed back to the base of the desorber column to strip the residual CO_2 from the falling lean solvent.

Lean amine from the reboiler will also be recirculated back to the absorber via the lean/rich heat exchangers, to cool the lean solvent and heat the rich solvent from the absorber. Cooled lean amine solvent may be returned to the Lean Amine Storage Tank. The CO_2 rich vapour from the top of the desorber passes through a reflux stage to maximise the solvent-CO_2 separation. As a result of the cooling process the CO_2 becomes saturated with water and is sent to the compression stage.

2.1.3 Low-Pressure Compression

The CO_2 is compressed in several stages from approximately 8 barg and reaching approximately43 barg, and then passes through conditioning plant, which will include oxygen removal using a catalyst and dehydration using a desiccant to meet the specification for CO_2 export.

Emergency CO_2 relief vents will be installed within the low-pressure compression plant to be used in the event of emergency situations.

2.1.4 Vents

Venting will be used for safety reasons or for non-routine operational conditions such as start-ups, shutdowns or depressurisation of the CO_2 pipeline for maintenance.

The location of vents will be subject to FEED but are anticipated to be:

- Venting of CO_2 during start-up or shutdown conditions when the CCP is not operating will be released via the HRSG stack.
- Pressure relief valve on the CO_2 separator to allow short term releases as safety control feature to prevent pressure build-up and tripping of the CCP due to high pressure.
- Pressure release valve for the CO_2 compression system as safety control feature to prevent pressure build-up in the compression system.

Venting will be reduced through good engineering design practice and consideration will be given to:

- Vent gas recovery systems.
- Use of high integrity relief valves.
- Sectioning of vent and isolation system pipework.

Any vent and valve will be developed in accordance with relevant industry standards (e.g. BSI, API, etc) with a focus on achieving high integrity, operational reliability and minimal fugitive emissions.

2.2 Storage and Transportation of CO_2 on site

There is no capacity for CO_2 storage on site. Following compression, the CO_2 will be exported directly to the HyNet CO_2 Pipeline Project.

2.3 Overview of CO_2 Sources

The vent arrangements will be specific to the Technology Licensor selected and the CO_2 capture solvent used, and therefore the details of each vent used to discharge CO_2 to atmosphere will be set out once detailed FEED has been completed for the Facility and the Technology Licensor selected.

2.4 Best Available Techniques

The CCP has been assessed against the BAT conclusions from the Environment Agency technical working group on Carbon Capture and Storage (CCS)[1] and the 'Post-combustion Carbon Dioxide Capture: Emerging Techniques'[2]. The BAT assessment is presented in "Assessment of Best Available Techniques for Carbon Capture and Storage" (Document Reference: WPCC15718/APP/BAT2/CCS).

2.5 Venting Scenarios

During the operation of the Proposed Installation there are likely to be events where it is required to vent CO_2 to atmosphere. These could be a regular events associated with the routine maintenance of the Proposed Installation, PRV activation for safety reasons or single large scale releases in the event of an emergency. The Proposed Installation will be designed to minimise the frequency and duration of such events.

---

[1] J.Gibbins, UKCCS (2024) Evidence Review of emerging techniques for Carbon Dioxide Capture Using Amine-Based and Hot Potassium Carbonate Technologies under the IED for the UK, Ver.4.4, March 2024. Accessed at: https://ukccsrc.ac.uk/best-available-technology-bat-information-for-ccs/ (28/05/2025)

[2] Environment Agency (2021) Guidance- Post-combustion carbon dioxide capture: emerging techniques. Updated 27 March 2024. Accessed at: https://www.gov.uk/guidance/post-combustion-carbon-dioxide-capture-best-available-techniques-bat (29/05/2025)

The venting scenarios and the associated vents will be set out once detailed FEED has been completed for the Proposed Installation.

The following scenarios have been identified where CO_2 can be released to atmosphere:

- During start-up or shutdown conditions it is envisaged that the CO_2 captured during start-up (with the excursions in oxygen and trace components) can be fed through to the CO_2 pipeline. However, in the event that the CO_2 purity is not suitable to be fed to the CO_2 pipeline, this may require short-duration venting. This would occur either via the absorber stack or a separate vent adjacent to the absorber stack. Location of venting would be finalised following technology selection and detailed design.
- During routine operation when venting takes place for safety reasons such as activation of the pressure relief valve (PRV) on the CO_2 separator to allow short term releases, preventing pressure build-up and tripping of the CCP due to high pressure.
- Emergency (e.g. unplanned plant shut down or pressure release).
- Maintenance of compressors or other CO_2 pipeline equipment when the pipeline and compression equipment need to be depressurised for maintenance and inspection.

Short term restrictions in CO_2 export during periods of time when the HyNet CO_2 transport and storage system is not available due to causes external to the operations of the Proposed Installation. During periods when the CCP is not in operation but the Proposed Installation continues to operate, then CO_2 will not be removed and the flue gas will be discharged from the HRSG stack. This scenario is not considered to be CO_2 venting for the purpose of this management plan.

3. Air Quality Management

3.1 Responsibility

The roles and associated responsibilities for each source under each release scenario are shown in Table 3-1.

Table 3-1. Responsibilities

Role	Company/Organisation	Description of responsibilities
Plant Manager	Uniper UK Limited	Overall responsibility for management of the Connah's Quay Low Carbon Power Project Plant and compliance with the Environmental Permit.
Production Manager	Uniper UK Limited	Day-to-day responsibility for the operation of the plant, ensuring operation is compliant with the permit and environmental impact is minimised including minimising CO_2 venting events.
Engineering Manager	Uniper UK Limited	Responsible for the planning, implementation and general management of maintenance activities, ensuring the plant continues to operate in accordance with its design and environmental requirements.

3.2 Sources and Control

3.2.1 Vent Design

Venting shall be reduced using good engineering design practice and in accordance with BAT. Vents will be designed in accordance with appropriate standards (e.g. API, BS or similar). Vents will be located and designed to minimise the impacts of potential CO_2 phase changes, solid effects and dense gas behaviour when venting to atmosphere.

Full vent design details and applicable standards will be provided once detailed FEED has been completed and the Technology Licensor selected.

3.2.2 Modelling

An Air Dispersion Modelling study shall be carried for CO_2 releases to atmosphere in both normal operating and emergency scenarios to demonstrate that adequate dispersion will be achieved.

As CO_2 is a dense gas, meaning that it is heavier than air and a pure release of CO_2 does not disperse in the same manner as other typical industrial releases. There is a significant risk that CO_2 releases can travel along the ground, representing a greater risk to public exposure than might otherwise be the case and therefore the choice of model needs to be able to model dense gas releases. This limits the number of commercially available models for such purposes.

At this stage of the project it is proposed that for this assessment, two models will be used – ADMS (latest version) and GASTAR (latest version), both produced by Cambridge Environmental Research Consultants (CERC).

ADMS comes with extensive verification studies for the dispersion of gas phase emissions [Ref 1-5], and is currently accepted by NRW as an appropriate model for air dispersion of typical gaseous emissions from industrial sources for regulatory purposes. ADMS allows for modelling of grounded plumes where the gas is too dense, and treats the modelled plume as passive from the point it hits the ground. For gaussian plume models, where the plume becomes passive within a relatively short distance and the inputs are known to a high degree of certainty, there is evidence that such models perform similarly to dense gas models over distances of up to 5 km from the source [Ref: 1-6]. Over greater distances (up to 25 km), gaussian plume models can predict concentrations 2 to 3 times greater than dense gas models, and can be shown to be conservative when undertaking environmental assessments. The initial release conditions for each scenario will be provided as steady-state, so as to present a conservative assessment of CO_2 emissions. Initial release conditions will be derived from the available process design data and are considered to be conservative estimates of release conditions. The use of steady-state emissions data and the proximity of receptors to the source means that ADMS can be considered to be suitable for modelling dense gas emissions in such scenarios.

- GASTAR is a consequence model optimised for process safety risk assessments under complex near field conditions, and therefore is less well suited to more typical environmental impact assessment work. For scenarios where ADMS is unable to model the movement and dispersion of the CO_2 plume due to the complex near field conditions, GASTAR will be used instead.

The modelling shall be followed by sensitivity analysis to consider the range of stack heights, flowrates, and temperatures of release to identify appropriate parameters for adequate dispersion under all anticipated venting conditions.

Detailed modelling will be undertaken once detailed FEED has been completed for the Proposed Installation and vents and release scenarios have been identified. The modelling will confirm the identified release scenarios have been reduced to acceptable levels.

As identified in Section 1.3, there are no air quality objectives, targets or EALs set for CO_2 for the protection of human health at locations where members of the public may be present. Therefore, in order to determine an appropriate assessment level to ensure the protection of human health, we propose that information published by the HSE and UK Health and Security Agency (UK HSA) such as the SLOT and SLOD shown in Table 1.2 are reviewed to identify suitable upper and lower exposure criteria for the assessment.

3.2.3 Monitoring

The Proposed Installation will include process control monitoring to ensure compliance with the operational requirements of the Environmental Permit. It is expected that this monitoring will allow for controlled releases of CO_2 to atmosphere when required during any of the permitted release scenarios.

Monitoring of CO_2 venting will include the following:

- CO_2 mass balance to confirm the total mass of CO_2 emissions (tonnes/event)
- Duration of CO_2 venting events

The total mass of emissions associated with CO_2 venting events will be calculated by a method traceable to national standards compliant with UK ETS and agreed with NRW.

References

Ref 1-1 Environment Agency, 2025, Guidance: Air emissions risk assessment for your environmental permit, url: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

Ref 1-2 Health and Safety Executive, EH40/2005 Workplace exposure limits, Fourth Edition, 2020

Ref 1-3 Health and Safety Executive, Methods of approximation and determination of human vulnerability for offshore major accident hazard assessment.

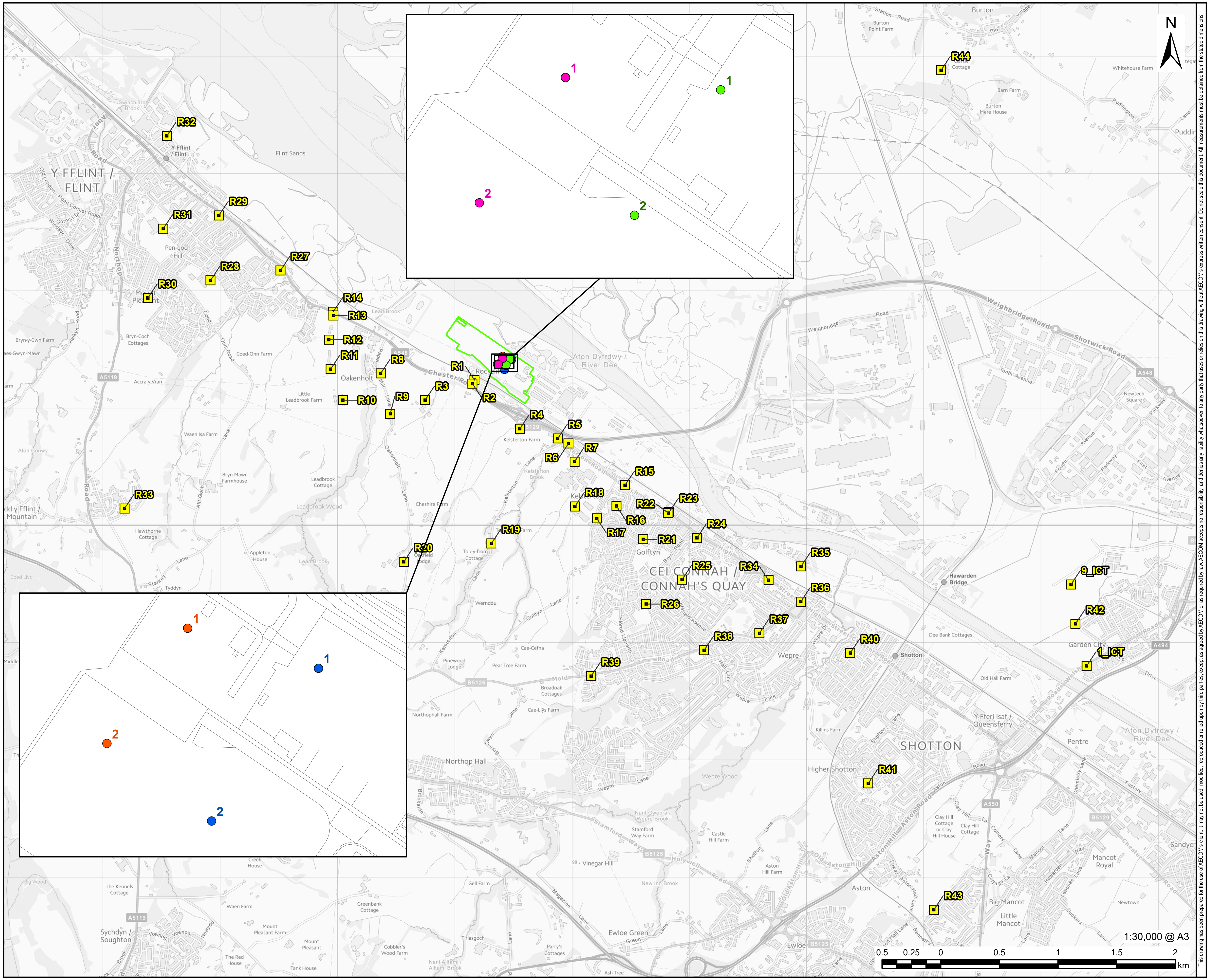
Ref 1-4 Health and Safety Executive, Assessment of the major hazard potential of carbon dioxide (CO_2), 2011

Ref 1-5 CERC, 2023, Model Validation, url: https://www.cerc.co.uk/environmental-software/model-validation.html

Ref 1-6 Health and Safety Executive, 2021, Review of dense-gas dispersion for industrial regulation and emergency preparedness and response, June 2021

Appendix A Figures

Revision: 1 Drawn: LP Checked: JG/EB Approved: EU Date: 2026-01-27



This drawing has been prepared for the use of AECOM's client. It may not be used, modified, reproduced or relied upon by third parties, except as agreed by AECOM or as required by law. AECOM accepts no responsibility, and denies any liability whatsoever, to any party that uses or relies on this drawing without AECOM's express written consent. Do not scale this document. All measurements must be obtained from the stated dimensions.

AECOM uniper

PROJECT

Connah's Quay Low Carbon Power

CONSULTANT

AECOM Limited
The Colmore Building
Colmore Circus, Queensway
Birmingham, B4 6AT
www.aecom.com

LEGEND

- Indicative Installation Boundary
- Feed 1 - Absorber Stack
- Feed 1 - Bypass Stack
- Feed 2 - Absorber Stack
- Feed 2 - Bypass Stack
- Human Health Receptor

NOTES

Air Quality Study Area(s), including for specific receptors shown, defined in Section 8.4 of Chapter 8: Air Quality (ES Volume II).

ISSUE PURPOSE

Environmental Permit Application

DATE

January 2026

PROJECT NUMBER

60756365

FIGURE TITLE

Operational Phase Assessment – Air Quality Study Area and Human Health Receptors

FIGURE NUMBER

Figure 2

Filename: C:\Users\PringL\OneDrive - AECOM\General - Uniper Connah's Quay LCDP DCO\900_CAD_GIS\920_GIS\02_Maps\Environmental Permit Application\CQ_Environmental_Permit_Application_Air_Quality_20260127.aprx aecom.com