HyNet North West

HyNet Hydrogen Production Plant
Environmental Permit Application Supporting Document

21/07/2021

HyNet North West

Non-Technical Summary

Introduction

Essar Oil (UK) Ltd (Essar) is applying to vary their existing Environmental Permit (EPR/FP3139FN/V010) to include the operation of a new Hydrogen Production Plant (HPP) on redundant land formerly used by the Alcohols Plant at Stanlow Refinery, Cheshire. Essar will be the HPP operator.

The new HPP is being developed as part of the wider HyNet Project. The aim of this project is to reduce carbon dioxide (CO_2) emissions from the combustion of gaseous fossil fuels through their substitution with hydrogen (the combustion of hydrogen does not produce CO_2). Bulk hydrogen will be produced (at the HPP) by the reforming of natural gas (NG) and refinery off-gas (ROG) using the Low Carbon Hydrogen (**LCH**™)[1] process. The CO_2 produced in the reforming and later shift reaction will be captured and routed to subsea geological sequestration via carbon capture and storage (CCS) infrastructure (the CCS infrastructure and sequestration is not within the scope of this application). The hydrogen product will be piped to industrial consumers and used as a blend into the natural gas grid.

The HPP is being developed by a consortium comprising Johnson Matthey plc, SNC-Lavalin UK Ltd, Essar and Progressive Energy Limited. The Consortium was awarded the contract to undertake Front End Engineering Design (FEED) of the HPP by the Department for Business, Energy and Industrial Strategy (BEIS).

The HPP will be developed in two phases: Phase 1 involving the construction and subsequent operation of facilities to produce 100,000 Nm^3/h of hydrogen, and Phase 2 which will increase the hydrogen production capacity by a further 200,000 Nm^3/h through the installation of further plant. The Environmental Permit variation application covers Phase 1 of the development only.

The Plant and Process Description

The HPP is designed to:

- Produce a compressed hydrogen product, of greater than 99.9% purity by volume, from a feedstock of NG/ ROG, water and oxygen; and
- Capture the CO_2 produced by the reforming process, and compress and dehydrate it suitable for routing to subsea geological sequestration via a CO_2 pipeline.

The overall process for the production of hydrogen and the separation of CO_2 is carried out in a sequence of stages, albeit on a continuous basis:

- Feed gas delivery and purification;
- Feed gas saturation;

[1] **LCH**™ Refers to the process and process plant licenced by Johnson Matthey

- Gas reforming;
- Isothermal Shift (ITS) conversion;
- CO_2 removal, compression and export; and
- Hydrogen purification, compression and export.

Feed Gas Delivery and Purification

The feed gas stream comprises either NG (on start-up and shut-down) or a mixture of up to 55% NG and 45% ROG. The NG is sourced from the UK National Transmission System (NTS), and the ROG piped from the refinery. The incoming gas stream is heated in the Feed Fired Heater and goes through a process to remove any chloride or sulphur compounds to prevent the deactivation of down-stream catalysts.

The Feed Fired Heater is fired on PSA Tailgas (or NG on start-up and shut-down) a desulphurised process off-gas, comprising mostly hydrogen, nitrogen and methane, from the hydrogen product purification process. Products of combustion are exhausted to atmosphere via a stack.

Feed Gas Saturation

The purified and heated feed gas is passed to the Saturator and is contacted with hot water and steam to saturate the gas stream (this is required to achieve the reforming process reaction). The water-saturated gas (now termed the Mixed Feed) is then heated further in the Feed Fired Heater and routed to the Gas Heated Reformer.

Steam is generated in a Steam Boiler fired on PSA Tailgas. Products of combustion are exhausted to atmosphere via a second stack.

Gas Reforming

The Mixed Feed is passed through two reformers, a Gas Heated Reformer (GHR) and an Autothermal Reformer (ATR) both of which contain proprietary nickel-based catalysts. The reformers promote the conversion of the Mixed Feed into a mixture of oxides of carbon – carbon monoxide and CO_2 – hydrogen and residual methane. The mix of carbon oxides and hydrogen is termed synthesis gas (Syngas).

Isothermal Shift (ITS) Converter

The Syngas leaving the reforming process passes to the ITS Converter, which comprises tubes containing a copper-based catalyst, surrounded by a water jacket. The catalyst promotes the reaction of carbon monoxide with water to produce hydrogen and CO_2. The heat of the water gas shift reaction is recovered for steam generation and is also used for heat exchange against other process streams (optimising the energy efficiency of the HPP). The cooled reacted gas is routed to the CO_2 Removal Unit.

CO_2 Removal and Export

The CO_2 Removal Unit uses an amine solution to adsorb CO_2 from the Syngas; the amine solution is then passed to a lower pressure stripper column where the adsorbed CO_2 is released, and the lean amine solution is then returned to absorb more CO_2 from the Syngas. The process operates continuously to produce two separate product gas streams:

- a high purity CO_2 product stream (with a CO_2 concentration in excess of 95% mol) which is then sent for compression, dehydration and export in a dedicated CO_2 pipeline for sequestration; and
- a CO_2-free syngas (with a CO_2 concentration of less than 0.1% mol) which is sent to a Pressure Swing Adsorption (PSA) unit for further purification.

Hydrogen Purification and Export

The CO_2-free syngas is passed through the PSA Separation Unit where remaining carbon monoxide, methane and nitrogen are removed from the hydrogen. The hydrogen product is then compressed and cooled. A proportion is used in the refinery as a fuel (the hydrogen is essentially a decarbonised replacement for the ROG used as HPP feedstock). The remainder is exported via the hydrogen pipeline (which will be consented separately).

The gases separated from the hydrogen product stream in the PSA Separation Unit (comprising a portion of hydrogen gas as well as carbon monoxide, methane and nitrogen) is the PSA Tailgas, used as a fuel in the Feed Fired Heater and Steam Boiler.

Utilities and Services

There are a range of utilities and services required to ensure that the HPP process operates effectively. These are described in the following sections.

Water Supply and Treatment

Water used in the plant is primarily sourced from an existing United Utilities raw water supply drawn from the River Dee. However, water usage has been optimised by augmenting this supply with re-used process water and harvested rainwater.

Raw water is clarified to remove suspended solids before storage in the Clarified Water Tank for use in the process.

Process effluent streams (from blow-down and condensate returns, sludge dewatering, and the CO_2 removal system) are collected and routed to a Membrane Bioreactor (MBR) for treatment. The treated effluent from the MBR is then routed to the Clarified Water Tank, where it joins the clarified raw water stream.

Rainwater draining from potentially contaminated areas of the plant drains to an interceptor, to remove oils, and is then mixed with the process water steam and routed to the MBR for treatment and re-use (rainwater falling on areas of the HPP at low risk of contamination is collected in the uncontaminated drains system and transferred to the existing refinery drainage system for discharge to the existing United Utilities Treatment Plant).

Water in the Clarified Water Tank is passed through a Dual Media Filtration Plant to produce filtered water. Part of this filtered water is used to meet demineralized water demand. The Demineralizer plant design is yet to be finalised, but will generate a demineralized water stream and a reject brine, which will be discharged to the existing refinery drainage system for eventual discharge at existing discharge point W3.

The water clarification, filtration and MBR process generates sludges which are dewatered and sent for off-site disposal.

Steam System

Steam is generated in the Steam Boiler (a fired boiler using PSA Tailgas as a fuel) and in the ITS Converter (using recovered process stream heat). Boiler Feed Water is demineralized water treated with a Boiler Feedwater Package.

Air Separation Unit

A single cryogenic air separation unit (ASU) supplies oxygen to the ATR and nitrogen, which will be used as a process purge gas in start-up and shut down, and for inerting.

Cooling Medium System

Cooling is provided by an air-cooled closed-circuit system using a propylene glycol/ water mix as the cooling medium.

Emergency Power Generation

The facility has a diesel engine-driven emergency power generator (2.9 MWth input) to allow safe shutdown and maintenance of the facility in the event of loss of power. Under normal circumstances, the emergency generator will only be operated for regular routine testing, amounting to fewer than 50 hours operation a year.

Flare

A flare is provided for emergency and maintenance purposes. It is sized to serve both Phase 1 and Phase 2. It comprises a single raised flare stack with a common header. The flare is designed to provide a safe disposal route for the HPP's flammable gases under start-up, shut-down, abnormal and emergency conditions.

Best Available Techniques (BAT) Assessment

The HPP design and operating techniques have been assessed against BAT requirements. This considered relevant BAT Guidance identified in pre-application discussions with the Environment Agency, including:

- Guidance for Establishing Best Available Techniques for Hydrogen Production from Methane and Refinery Fuel Gas with Carbon Capture;
- BAT Conclusions Document for the Refining of Mineral Oil and Gas; and
- BAT Conclusions Document for Common Waste Water and Waste Gas Treatment/ Management Systems in the Chemical Sector.

Techniques for Process Control

The HPP process has been compared with process requirements in the BAT Guidance covering the different elements of the process. The detail of the assessment is provided in the main body of the Application Supporting Document. However, the key finding is that the HPP process is

representative of a plant using GHR and ATR reforming technology, and aligns with the BAT requirements and key performance parameters for the hydrogen production sector.

Emissions Control

Point source emissions to air are controlled through the use of a desulphurised processed fuel (the PSA Tailgas) as well as combustion plant controls, including combustion control systems, air control and the use of low NOx burners in the Steam Boiler and Feed Fired Heater. Emissions to air achieve the indicative emissions values identified in relevant BAT Guidance documents.

Point source emission to water are controlled by the efficient re-use of water within the process, and by using a biological water treatment technology augmented by rainwater harvesting. The demineralization process generates a brine reject stream, which joins the existing refinery process drainage system, and discharges to the Manchester Ship Canal under permit limits, the majority of which are already established for the refinery discharge.

There are no anticipated emissions to groundwater from the installation. Measures are in place to prevent accidents that could lead to such emissions and to mitigate their environmental consequences if they were to occur. There are no emissions to land at the installation.

The HPP design and Essar's management arrangements, including an inspection, maintenance, leak detection and repair programme, will ensure that materials used in the process will be delivered, stored and used in a manner which ensures that they will be suitably contained, and stored liquids have appropriate secondary containment to prevent their escape in the event of a spill or accident.

The process has a low potential for odour, and the containment and management techniques to control fugitive emission to air, as well as a leak detection and repair programme, will ensure the potential for odour nuisance is minimised.

The use of compressors, pumps and other machinery at the HPP has the potential to cause noise. Measures have been identified and incorporated into the design, and BAT will be applied to the final selection of process equipment to select low noise equipment, manage their siting, and control noise through the use of acoustic enclosures. During the operation of the installation, basic good practice measures for the control of noise will be employed, including planned maintenance of any plant or equipment whose deterioration may give rise to increases in noise. A noise modelling study has been conducted to assess the potential for incremental noise arising from the operation of the HPP.

The HPP has been designed to be as energy efficient as practicable, allowing for safety and plant complexity considerations. It includes a series of energy transfers within the process to ensure energy is used efficiently and increase the efficiency of the HPP. As a result of the efficient re-use of heat energy within the process, any residual heat is of low grade (low temperature), which does not lend itself to CHP or efficient further use.

Management, Raw Materials and Waste

The existing Essar management system, certified to ISO14001, will be extended to include the operation of the HPP. This will include the identification, assessment and management of accident

hazards associated with the HPP; the application supporting document has identified the accident hazards that apply to the HPP.

Proposals for monitoring process variables and emissions are included within the application: these accord with BAT guidance and will ensure the process is operated within the authorised emissions limits.

A range of raw materials will be used at the HPP, the main ones being the feed gases (ROG and NG), catalysts and support media used in the process, as well as the amine and TEG, industrial gases, water and coolant medium. The raw materials will be stored in process containment or storage tanks, with appropriate secondary containment for liquids.

The HPP will generate wastes during operation and in outage periods. During typical operations the most significant waste streams will be water treatment sludges; these will be dewatered on site to reduce the volume to be disposed of off-site. The other main source of wastes will be catalysts, support media and adsorption solutions (amine and TEG), which will be generated periodically during routine outages at intervals of four years or more. Aside from these, other wastes will be generated from general process operation including consumables and maintenance wastes.

All waste generated at the HPP will be managed in accordance with the Essar EMS, which requires that waste is treated as high up the waste hierarchy as possible. The first priority is therefore waste minimisation, then re-use within the process should be considered, followed by methods of recycling. The last option, once the higher measures have been fully considered for technical and economic feasibility, will be offsite waste disposal. The EMS Duty of Care measures will ensure that waste is transported and treated or disposed of using carriers and at sites that are appropriately permitted.

Emissions

There are six emission points for releases to atmosphere from the HPP:

- HPP-A-1 - Feed Fired Heater;
- HPP-A-2 - Steam Boiler;
- HPP-A-3 - Flare;
- HPP-A-4 - Emergency Diesel Generator; and,
- HPP-A-5 - Firewater Pump.

There is one water discharge to the Manchester Ship Canal at existing point W3 for demineralizer reject water (the water is combined with existing refinery effluent streams) and one transfer of uncontaminated surface water via the existing refinery drainage system to Point S1, to the United Utilities treatment plant.

Relevant emission benchmarks and limits have been identified, where available, and appropriate emission limits proposed for emissions to air and water.

Impact on the Environment

An Environmental Risk Assessment (ERA) has been undertaken to identify the potential environmental impacts arising from the operation of the proposed facility.

Emissions to Air

An air quality dispersion modelling study has been undertaken to assess the environmental impact of atmospheric emissions from the key continuously-operating plant at HPP (the Feed Fired Heater and the Steam Boiler). Other plant were considered to have an insignificant contribution to atmospheric emissions due to their small scale and infrequent operation. The results showed that that there will be no significant environmental impact arising from emissions to air from the proposed installation on either human or ecological receptors.

Emissions to Water

The release of uncontaminated surface water run-off – transferred via the existing refinery drainage system to Point S1 and the United Utilities treatment plant – is not considered likely to result in adverse effects. A formal assessment of the clean uncontaminated discharge is not considered necessary.

The demineralizer reject water is to be discharged, via the existing refinery drainage system, to the Manchester Ship Canal at existing discharge point W3. Essar are currently carrying out a review of site effluents to address an existing Permit Improvement Condition, which will result in changes to the effluents, flow rates and compositions discharged via the existing permitted discharge points.

An assessment of the existing and the revised discharges (including those through W3) is being developed by Essar and is due to report in later in 2021. This assessment will need to be completed first in order to provide a basis for the assessment of HPP discharges (which will be an additional element to the revised W3 discharges). Once the refinery-wide revised discharges assessment is submitted, Essar propose adding the HPP discharges to the revised assessment model, and provide this assessment to the Environment Agency (EA).

Global Warming Potential

The HPP's Global Warming Potential (17,405 teCO_2eq/year) has been calculated following EA Guidance and is presented in the application. It should be noted that this calculation does not take into account the reduction in CO_2 emissions arising from the down-stream use of the decarbonised hydrogen product.

Noise

A noise assessment has been undertaken to predict the impact of operational noise from the HPP. Noise effects are predicted to have, at worst, a low impact (at one receptor) with noise levels at other receptors at or below background values.

The noise assessment was based on worst-case plant noise data available at the current stage of design; further information on noise levels from equipment will become available in the detailed design phase. This, coupled with the BAT management procedures and control measures that will

be used at the installation to mitigate the noise impact, will control noise generating activities so as to minimise the risk of annoyance or public nuisance.

Odour

The Hydrogen BAT Guidance does not identify odour as an issue, and the process is not inherently odorous. The feed gas is desulphurised, and potential odorous materials are contained and subject to regular maintenance checks. The HPP is therefore not considered likely to give rise to any off-site odour nuisance.

Other Emissions

There are no anticipated process emissions to land or groundwater from the installation. Fugitive emissions to air and/ or water, ground or groundwater will be controlled by suitable containment, the provision of adequate secondary containment, as well as inspection and maintenance procedures. Waste generation will be minimised though the application of the waste hierarchy and management controls. Further assessment of environmental risks is provided in the application and ERA tables.

Environmental Statement

The Environmental Statement is due to be submitted with the planning application to Cheshire West and Cheshire Council for the HPP development. A copy will be made available to the EA in electronic form.

Pre-operational Conditions

Pre-operational Conditions have been proposed.

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ABBREVIATIONS

AEL	Associated Emission Level
AEP	Annual Exceedance Probability
AMP	Accident Management Plan
AQMA	Air Quality Management Area
AQS	Air Quality Standard
ASU	Air Separation Unit
ATR	Autothermal Reformer
BAT	Best Available Techniques
BEIS	UK Government Department for Business, Energy and Industrial Strategy
BFW	Boiler Feed Water
BOD	Biochemical Oxygen Demand
BOL	Beginning of Life
CCC	Committee on Climate Change
CCS	Carbon Capture and Storage
CCUS	Carbon Capture Utilisation and Storage
CEN	Comité Européen de Normalisation (The European Committee for Standardization)
CH_4	Methane
CICS	Common Incident Classification Scheme
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand
CPI	Corrugated Plate Interceptor
CW&CC	Cheshire West and Chester Council
DAA	Directly Associated Activity
DB&B	Double Block and Bleed
EA	Environment Agency
EIA	Environmental Impact Assessment
ECU	Electronic Control Unit
EMS	Environmental Management System
EOL	End of Life
EP	Environmental Permit

EPR16	Environmental Permitting Regulations (England and Wales) 2016 (as amended)
ERA	Environmental Risk Assessment
FEED	Front End Engineering Design
FRA	Flood Risk Assessment
GHG	Greenhouse Gas
GHR	Gas Heated Reformer
GWP	Global Warming Potential
H1	Horizontal Guidance 1
H_2	Hydrogen
HCl	Hydrogen chloride
HHV	Higher Heating Value
HP	High Pressure
HPP	Hydrogen Production Plant
HSP	Hydrogen Supply Programme
IBC	Intermediate Bulk Container
IED	Industrial Emissions Directive
ITS	Isothermal Shift
kV	Kilovolt
LCH	Low Carbon Hydrogen
LDAR	Leak Detection and Repair
LHV	Lower Heating Value
LNR	Local Nature Reserve
LP	Low Pressure
LPG	Liquefied Petroleum Gas
LWS	Local Wildlife Site
MATTE	Major accident to the environment
MBR	Membrane Bioreactor
MCPD	Medium Combustion Plant Directive
MP	Medium Pressure
MWth	Megawatt (thermal)
NACE	Nomenclature of Economic Activities
NG	Natural Gas

NNR	National Nature Reserve
Nm^3/h	Normal cubic metres per hour
NO_2	Nitrogen Dioxide
NOx	Oxides of Nitrogen
NSR	Noise Sensitive Receptors
NTS	National Transmission System
OSBL	Outside Battery Limits
PM	Particulate Matter
ppmv	Parts per million by volume
PSA	Pressure Swing Adsorption
ROG	Refinery Off-Gas
SAC	Special Area of Conservation
SCR	Selective Catalytic Reduction
SIMOPS	Simultaneous Operations
SMR	Steam Methane Reforming
SNCR	Selective Non-Catalytic Reduction
SO_2	Sulphur Dioxide
SOP	Site Operating Procedure
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
SUDS	Sustainable Drainage System
TEG	Triethylene Glycol
te/h	Tonnes per hour
TSS	Total Suspended Solids
TWh/y	Terawatt hours per year
UU	United Utilities
VOC	Volatile Organic Compound
VSD	Variable Speed Drive

1.0 INTRODUCTION

1.1 General Introduction

1.1.1 This document is Essar's technical submission to support its application for a variation to the Stanlow Refinery bespoke Installation Environmental Permit (EP) EPR/FP3139FN/V010 [1]. The variation of the EP is required under the Environmental Permitting (England and Wales) Regulations 2016, as amended (hereafter EPR16), to cover the operation of a new Hydrogen Production Plant (HPP) at the former Alcohols site located within Stanlow Refinery. The application for permit variation is being submitted to the Environment Agency (EA), the body responsible for regulation of EPR16 Environmental Permits for Schedule 1 A(1) activities in England.

1.1.2 The new HPP is being developed at Stanlow Refinery under the wider HyNet Project. The development will be carried out in two phases: Phase 1 involving the construction and subsequent operation of facilities to produce 100,000 Nm^3/h of hydrogen (approximately 3 TWh/y), and Phase 2 which will increase the hydrogen production capacity by a further 200,000 Nm^3/h through the installation of further similar plant. This variation application covers Phase 1 of the development only. However, it is noted that a number of the Phase 1 utilities have been sized to accommodate the future expansion.

1.1.3 This supporting document presents information which supplements that provided in the accompanying Environmental Permit application forms. It describes the operation of the HPP and its impact on the environment, details abatement equipment that will be used to ensure compliance with regulatory requirements, and demonstrates that the design and operation of this equipment will be consistent with the principles of Best Available Techniques (BAT).

1.1.4 This document is structured as follows:

Section 1 presents general background information to the overall HyNet project, summarises the purpose of the HPP, and describes the legislative context of the development in terms of the Project's definition under EPR16 and its listed and directly associated activities (DAA). The development site and its surroundings are described. Summary Application Information, contacts details, etc are provided.

Section 2 describes the HPP, utilities, materials storage arrangements, and interfaces with Stanlow Refinery and other external services. The layout of the plant within the Alcohols site is also described.

Section 3 presents information on the techniques incorporated within the HPP's design to minimise environmental emissions, effluents and wastes. Initially a summary is provided of the plant's relevant design philosophies and Design Requirements aimed specifically at environmental protection. Thereafter, the conformance of the HPP with BAT is evaluated through comparison with regulatory guidance, in particular the recently published guidance on BAT on Hydrogen Production from Methane and Refinery Fuel Gas with Carbon Capture [2]. Reference is also made to Essar's

Environmental Management System and its proposed approach to the management of the permitted activities (essentially a continuance of on-going practices).

Section 4 provides a quantification of the HPP 's emissions, effluents, and wastes, highlighting the release points and discharge characteristics. It is this information that is used to evaluate the plant's environmental impact. Emissions and process monitoring arrangements are proposed.

Section 5 addresses the environmental impacts which are likely to arise from the operation of the HPP, and endeavours to establish their acceptability through comparison with environmental quality standards. The Environmental Risk Assessment (ERA) is supported by a range of specific studies including an air quality assessment, noise assessment, and Global Warming Potential (GWP) assessment (the study reports are contained within the document appendices). Proposed amendments to the Site Condition Report and Accident Management Plan (AMP) are also set out.

Section 6 lists the variation application's references.

The **Appendices** contain the variation application's supporting information including site plans and drawings, the specific technical assessments, plans and reports referred to above, and the minutes arising from pre-application discussions with the EA.

1.2 Background to HyNet

1.2.1 In November 2019 the **LCH** Consortium – comprising Johnson Matthey plc, SNC-Lavalin UK Ltd, Essar Oil (UK) Ltd and Progressive Energy Limited – was awarded a contract by the Department for Business, Energy and Industrial Strategy (BEIS) to undertake Front End Engineering Design (FEED) for the HPP as part of its Hydrogen Supply Programme (HSP). The proposed plant is at the core of the overall HyNet integrated Hydrogen and Carbon Capture Utilisation and Storage (CCUS) project located in the North West of the UK.

1.2.2 The HyNet Project as a whole is designed to meet the challenge of reducing carbon emissions from industry, domestic heating, and transport. This will be achieved by the production of bulk hydrogen through reforming natural gas (NG) and refinery off-gas (ROG), together with the capture and sequestration of the carbon dioxide (CO_2) produced by the reforming process. The hydrogen product will be piped to industrial consumers and used as a blend into the natural gas grid, while the CO_2 will be routed to subsea geological sequestration via CCS infrastructure. An overview of HyNet is illustrated in Figure 1.1 overleaf.

1.3 Purpose of the HPP

1.3.1 The HPP (Phase 1) is designed to produce 100,000 Nm^3/h of hydrogen by reforming a feedstock comprising NG, ROG, water, and oxygen. It is also designed to capture 97% of the CO_2 produced by the reforming process (approximately 70 to 75 te/h) for subsea geological sequestration, although it is highlighted that the downstream CO_2 sequestration does not form part of the HPP for which an Environmental Permit is being sought; it is a separate HyNet project.

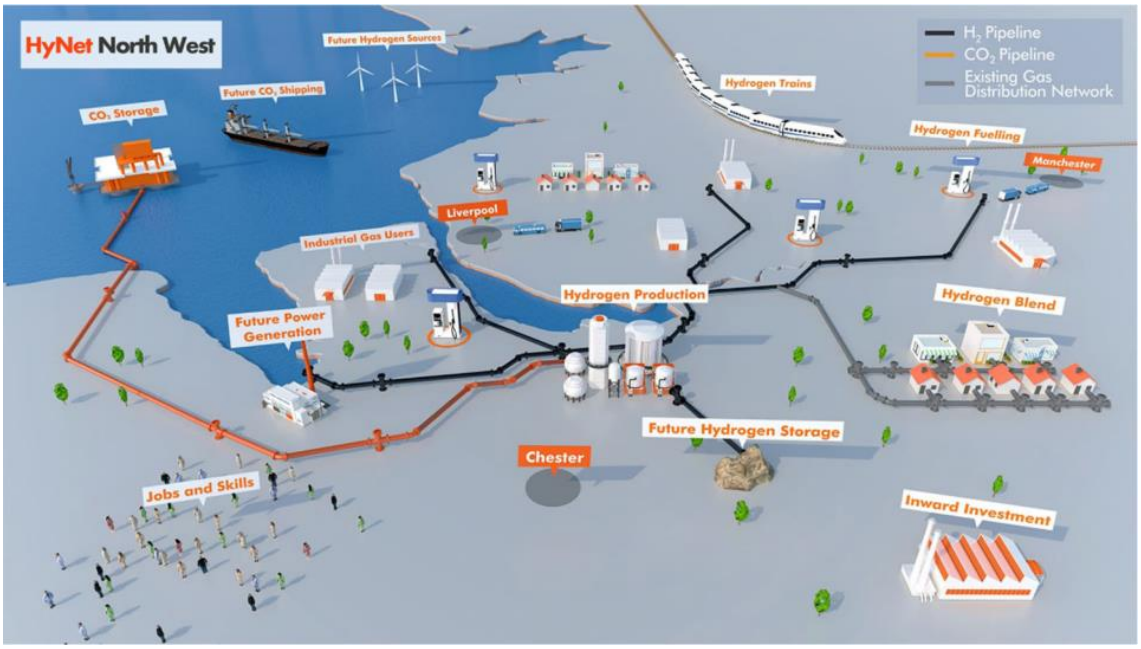


Figure 1-1 Overview of HyNet Project

1.4 Description of the Site and its Surroundings

1.4.1 The HPP will be sited in an area of Stanlow Refinery known as "Alcohols", currently a largely redundant plot of land which was, in part, the location of the previous Shell Alcohols production facility and used for tank storage of liquids. The Alcohols area is located on the south-eastern quadrant of the refinery (see location plan in Figure 1.2) and is within the existing Stanlow Oil Refinery EP boundary.

1.4.2 To the west and north the HPP site is bounded by the refinery. Immediately to the south is the A5117 beyond which are the village of Thornton-le-Moors (at a distance of approximately 325 m) and the Gowy Meadows Nature Reserve and Local Wildlife Site (approximately 520 m to the south west). Thornton-le-Moors is designated as a Conservation Area.

1.4.3 To the east of the southern section of the site is Pool Lane and beyond this is open countryside, designated as Green Belt, and the villages of Elton and Elton Green. Elton is located approximately 185 m from the site boundary. Immediately to the east of the northern part of the site lies the University of Chester's Thornton Science Park which is approximately 66 acres in area and accommodates over 40 science and technology sector companies.

1.4.4 The village of Ince is located approximately 645 m to the north east of the site. North of Elton and east of Ince is the Encirc Glass factory, and further east is the Ince Park Biomass Energy Plant and the CF Fertilisers facility.

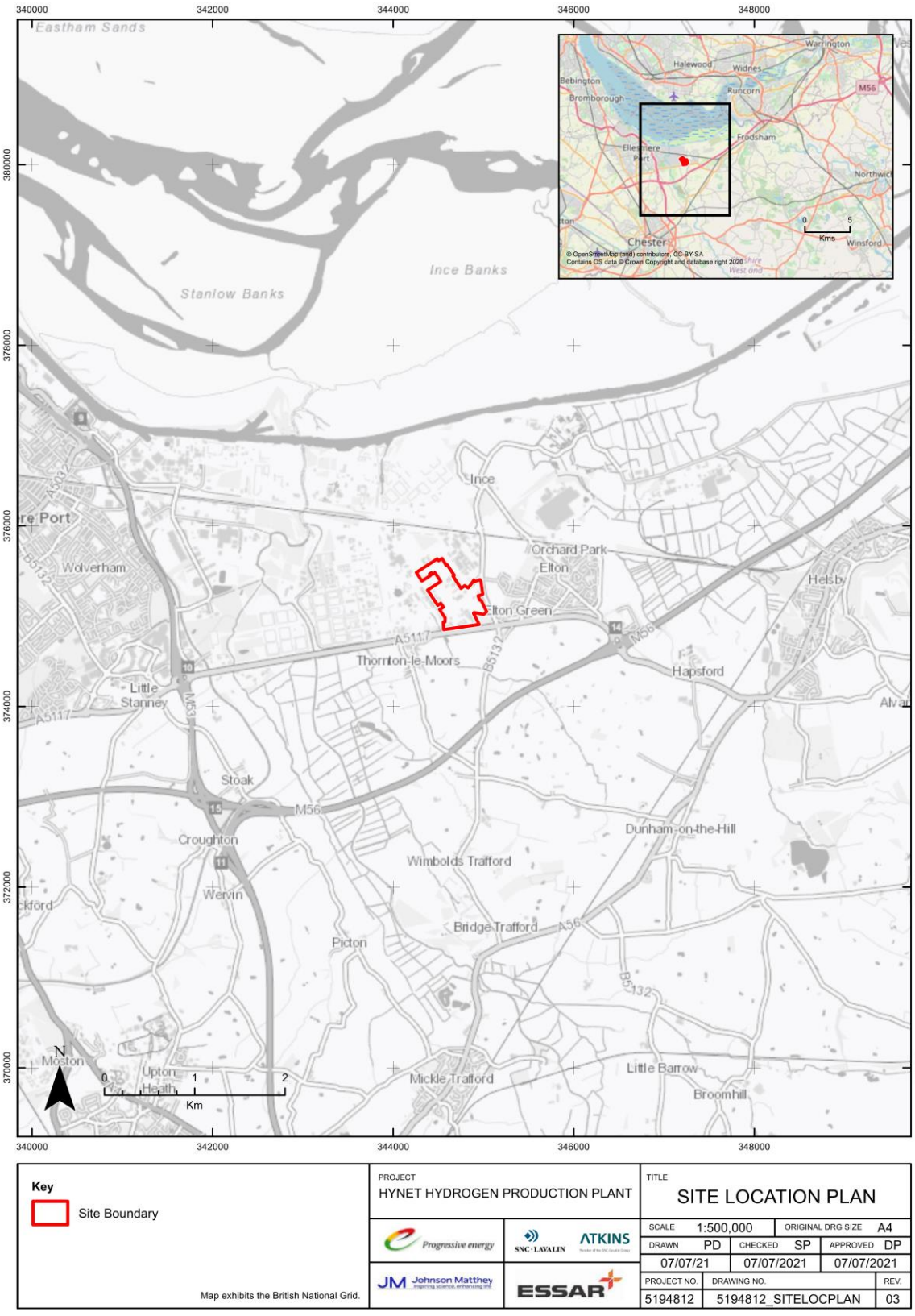


Figure 1-2 Location of HPP Site

1.4.5 The Manchester Ship Canal and the River Mersey run in an east west direction at a distance of 1.4 km and 2 km to the north of the site respectively. The Mersey Estuary is a designated Ramsar site, Site of Special Scientific Interest (SSSI) and Special Protection Area (SPA).

1.4.6 The site partially lies within Thornton le Moors Air Quality Management Area (AQMA). This area encompasses the entire village of Thornton le Moors, its surroundings and parts of the adjacent area of Stanlow. It was declared in 2016 for exceedances of the Air Quality Standard (AQS) objective for sulphur dioxide (SO_2) associated with industrial emissions. There are also AQMAs in Ellesmere Port (Whitby Road/ Station Road) and Frodsham (A56/ Fluin Lane), and Chester (city centre), which were all declared for annual mean nitrogen dioxide (NO_2) with road traffic as the main source. The nearest of these is Ellesmere Port, approximately 4.5 km to the north west.

1.4.7 The site is not located within a groundwater Source Protection Zone for a potable water supply although a number of groundwater abstraction licences are held approximately 350 m east of the site authorised since 2014 for a variety of uses including cooking, sanitary, drinking, washing, general cooling and agricultural use. Gale Brook, partially culverted during the development of the refinery, is located approximately 60 m west of the site. This watercourse has not been classified by the Environment Agency. Thornton Brook runs approximately 1.1 km to the west and converges with the River Gowy approximately 1.4 km to the north west.

1.4.8 The site is currently hard standing and predominantly located within Flood Zone 1 (low probability) indicating land having less than a 1 in 1000 annual probability of river or sea flooding (0.1% AEP – Annual Exceedance Probability). Flood Zone 2 (between a 1 in 100 and 1 in 1,000 annual probability of river flooding) and Flood Zone 3 (1 in 100 or greater annual probability of river flooding) are located within the western area of the site associated with the Gale Brook.

1.5 Applicable Environmental Permitting Regulations

1.5.1 Stanlow Refinery is already regulated under the EPR16, and Essar is now seeking to vary the existing EP [1] to include the **LCH** facilities. The new facilities will fall under EPR16 as follows:

- The HPP will fall under EPR Schedule 1, Part 2, Chapter 4, Section 4.2, Part A(1)(i) as a process for "*Producing inorganic chemicals such as gases (for example ammonia, hydrogen chloride, hydrogen fluoride, hydrogen cyanide, hydrogen sulphide, oxides of carbon, sulphur compounds, oxides of nitrogen,* ***hydrogen****, oxides of sulphur, phosgene)*". This definition reflects the plant's primary objective of hydrogen production.

- The **LCH** fired heater and boiler will fall under EPR Schedule 1, Part 2, Chapter 1, Section 1.1 Part A(1)(a) as combustion plant burning any fuel in an appliance with a rated thermal input of 50 MWth or more. As the existing permit already contains a 1.1 Part A(1) (a) activity for combustion, the additional combustion plant associated with the hydrogen production process will be regulated by that activity. The Feed Fired Heater, Steam Boiler and emergency generator have an aggregated thermal input capacity of 50.7 MWth. The plant will constitute Chapter II Industrial Emissions Directive (IED) combustion plant, but not a Chapter III plant, as each plant item over 15 MWth has its own stack, so will not aggregate to be considered a Large Combustion Plant under Chapter III of the IED.
- The **LCH** Combustion Plant will also be Medium Combustion Plant under EPR Schedule 25A, but will not be Specified Generators under EPR Schedule 25B, as they are IED Chapter II plant.
- The HPP will capture CO_2 for geological storage. It will therefore also fall under Chapter 6, Section 6.10, Part A(1)(a) as a process for the "*Capture of carbon dioxide streams from an installation for the purposes of geological storage pursuant to Directive 2009/31/EC of the European Parliament and of the Council on the geological storage of carbon dioxide*".
- The **HPP** will treat the waste water from the process together with surface water streams and due to the characterisation of the water streams and the capacity of the Waste Water Treatment plant will fall under EPR Schedule 1, Part 2, Chapter 5, Section 5.3 Part A(1) (a) (i) and (ii) as a process for the "*disposal or recovery of hazardous waste with a capacity exceeding 10 tonnes per day by (i) biological and (ii) physio-chemical treatment (sludge dewatering).*"

1.5.2 The combustion plant being added as part of this permit variation application is not considered to form part of the existing Stanlow Refinery emissions to air 'refinery bubble'.

1.5.3 The full profile of EPR listed activities and DAAs included in this application are provided in Table 1.1. Note that the list this is limited to new activities associated with the HPP and does not include activities listed on the existing EP except where they will be varied by the addition of the HPP

Table 1-1 Listed Activities and Directly Associated Activities

EPR16 Schedule 1 Activity References	Description of Specified Activity
Section 4.2 Part A(1)(i) Producing inorganic chemicals such as gases (hydrogen).	Receipt and reforming of natural gas and Refinery Off- Gas and the separation of gases from the synthesis gas (syngas) stream to produce hydrogen and capture of CO_2 for offsite sequestration.
Section 6.10, Part A(1)(a) Capture of carbon dioxide streams from an installation for the purposes of geological storage pursuant to Directive 2009/31/EC of the European Parliament and of the Council on the geological storage of carbon dioxide.	Separation and capture of CO_2 from reforming process in readiness for geological storage offsite. The activity does not include the sequestration (geological storage) under this permit. A separate permit will be sought for this in the future which will need to be noted as an 'other permit relating to this installation' in the introduction of this permit at that time.
Section 5.3 Part A(1) (a) (i) Disposal or recovery of hazardous waste with a capacity exceeding 10 tonnes per day by biological treatment.	From receipt of site drainage and process effluents, pre-treatment dosing and treatment in the Membrane Bioreactor (MBR), transfer of treated effluent to the Clarified Water Tank and then filtration in the Dual Media Filtration Plant to storage of filtered water in the Filtered Water Tank. Including separation and dewatering of sludges, re-use of supernatant and off-site disposal of sludge.
Section 5.3 Part A(1) (a) (ii) Disposal or recovery of hazardous waste with a capacity exceeding 10 tonnes per day by physio-chemical treatment.	From receipt of sludges arising from the pre-treatment of water and process effluents to dewatering of sludges.
Update existing activity Section 1.1 Combustion Activities Part A(1)(a) Burning any fuel in an appliance with a rated thermal input of 50 or more megawatts.	*Update existing description to add*: From receipt of fuel gas and its combustion to generation of heat, steam and/or electricity, serving the HPP, in combustion plant with an additional aggregated thermal input of 50.7 MWth (total for both Phase 1).
DAA	**Description of Specified Activity**
Water Demineralization Plant	From the receipt of filtered water to the production of demineralized water for use in the HPP.
Surface water drainage	Operation of systems for the collection, re-use and discharge of uncontaminated surface water.

EPR16 Schedule 1 Activity References	Description of Specified Activity
Process water drainage	Collection of condensates, discharges from amine-based CO_2 capture, mixed wastewater from process units and CO_2 Compressor wastewater, blowdown to a sealed drainage system for treatment in the MBR for re-use in the process.
Production oxygen and nitrogen	Production and storage of oxygen and nitrogen in a cryogenic Air Separation Unit (ASU).
Process cooling plant	Operation of a cooling plant to provide process cooling.
Waste management and handling	Operation of systems and facilities for the storage, management, handling and disposal of wastes.
Raw materials handling	Storage, handling, distribution and use of raw materials, water and gaseous and liquid fuel (diesel fuel for emergency generators).
Flare[2]	Operation of a flare for the safe disposal of flammable off-gases in start-up, shut-down, process upsets and emergencies.

1.5.4 The SHOP and Alcohols plants have ceased operating, therefore the following activities should be removed from Table S1.1 of permit EPR/FP3139FN:

- Section 4.1 Part A(1)(a)(i) - Producing organic chemicals such as hydrocarbons (linear or cyclic, saturated or unsaturated, aliphatic or aromatic) (Shell Higher Olefins Process (SHOP)).

  LCP 143: Higher Olefins SHOP

  Production capacity 395 kt/a (kilotonnes per annum)

  From receipt of raw materials to the manufacture, storage and despatch of finished product. Including the cleaning of the process plant, operation of abatement systems and the storage and handling of waste arising from the process and including process heaters:

  F9460 1.5 MWth

  F9401 1.5 MWth

  F9801 64 MWth

- Section 4.1 Part A(1)(a)(ii) - Producing organic chemicals such as organic compounds containing oxygen (Alcohols (Neodol and Linevol) and production of syngas and epoxy resins).

  Alcohols (Neodol and Linevol) including Syngas production. Production capacity: Neodol: 93 kt/a and Linevol: 48 kt/a

[2] The flare is excluded from the s1.1 A(1) Activity as it is for abatement rather than combustion of a fuel (See RGN2, Appendix 2).

From receipt of raw materials to the manufacture, storage and despatch of finished product. Including the cleaning of the process plant, operation of abatement systems and the storage and handling of waste arising from the process and including process heaters:

F2102	26 MWth
F2101 A,B	2.3 MWth
F3901	5.2 MWth
F4701	5.2 MWth

1.6 Application Information

Table 1-2 Application Information

Type of Application	Bespoke Installation Permit variation to include ERP16 activities: • Sch.1, s 4.2 A(1) inorganic chemical production of hydrogen gas activity • Sch1, s.6.10 A(1) carbon dioxide capture and storage activity • Sch.1, s 1.1 A(1) combustion activity • Sch.1, s.5.3 A(1) (a) (i) hazardous waste water treatment activity • Sch.1, s.5.3 A(1) (a) (ii) hazardous waste sludge treatment activity • Schedule 25A medium combustion plant activity.
Installation Name	Stanlow Manufacturing Complex
Installation Address	PO Box 3, Ellesmere Port, Cheshire, CH65 4HB
NACE Code	C19.2 - Manufacture of refined petroleum products
Company Registration Number	07071400
Registered Address	The Administration Building, Fifth Floor, Stanlow Manufacturing Complex, PO Box 3, Ellesmere Port, Cheshire, CH65 4HB
Installation Grid Reference	SJ440755
Pre-Application Discussion	Pre-application meetings were held by telecon on: 1 June 2020 23 February 2021 Minutes of these meetings are included in this application in Appendix A5.0

Legal Status of Operator	Essar Oil (UK) Limited is a limited company. Company certificates have been provided in this application in Appendix A6.0
Application Contact	[redacted] Senior Environmental Specialist [redacted] [redacted]
Operational Contact	[redacted] Environmental Manager [redacted] [redacted] [redacted]

1.7 Application Fees

The application fees of £65,914 were calculated using the fee calculation sheet provided in EA Pre-application advice (see Appendix A5.0 Pre-app letter dated 16/06/2021, section 16 and 17). The change for noise and vibration assessment has not been included as the noise assessment results indicated that noise levels at the receptors are substantially unchanged (see Appendix A3.0).

2.0 PROCESS DESCRIPTION

2.1.1 This section presents a description of the proposed **LCH** facility. Initially an overview of the process is given, outlining the scheme's operating cases, feedstocks and products. Thereafter descriptions are provided firstly of the gas processing operations, and secondly of the utilities and services which will support these operations. Information is then set out on the usage of hazardous materials in the plant – catalysts, chemicals, and fuels – and their proposed storage arrangements. Finally, the physical layout of the HPP is described.

2.1.2 It should be noted that the Project is currently at the FEED stage and final selection of equipment will not be made until vendors have been appointed. Consequently, certain assumptions have been made in the preparation of this EP Variation Application. These are identified throughout this document.

2.1 Process Overview

2.1.1 The HPP is designed to:

- Produce a compressed hydrogen product, of greater than 99.9% purity by volume, from a feedstock of natural gas/ ROG, water, and oxygen. Downstream, the hydrogen will be piped for fuel-switching and blending into the gas distribution system; and
- Capture the CO_2 produced by the Low Carbon Hydrogen (**LCH**) process, and compress and dehydrate it suitable for routing to subsea geological sequestration via a CO_2 pipeline (the pipeline is not within the scope of this application).

2.1.2 The NG will be sourced from the UK National Transmission System (NTS), and the ROG will be piped from the refinery. The compositions of these gas streams (used for the performance evaluation of the HPP) are shown in Table 2.1. The NG will not be odourised.

2.1.3 Water used in the plant will be obtained predominantly from a United Utilities raw water supply (the water is sourced from the River Dee). However, surface (rain) water falling within the HPP process area will be harvested and used to supplement the supply. The plant's water demand has been minimised through process water recycling. The HPP has been designed to be self-sufficient in steam. Oxygen (99.5% by volume) will be generated on site in a dedicated ASU which forms part of the HPP's utilities.

2.1.4 Four operating cases have been defined for the plant:

- Natural Gas Case - Beginning of Life[3] (BOL);
- Natural Gas + ROG Case – BOL;

[3] "Life" is defined as the operational life of the principal catalysts between catalyst change (i.e. 4 years)

- Natural Gas Case – End of Life (EOL); and
- Natural Gas + ROG Case – EOL.

2.1.5 The materials flows associated with these operating cases are shown in Table 2.2. The plant will be operated on natural gas only in start-up and shut-down, moving to a mixture of natural gas and ROG in routine operation.

Table 2-1 Gas Feedstock Composition

Component	Composition (mol% unless otherwise stated)	
	Natural Gas	ROG
Methane (CH_4)	89.00	39.06
Ethylene (C_2H_4)	0.00	0.39
Ethane (C_2H_6)	7.00	18.06
Propane (C_3H_8)	1.00	0.00
Butane (C_4H_{10})	0.10	0.00
Pentane (C_5H_{12})+	0.01	0.00
Carbon dioxide (CO_2)	2.00	0.00
Carbon monoxide (CO)	0.00	1.46
Nitrogen (N_2)	0.89	10.01
Hydrogen (H_2)	0.00	31.02
Total sulphur	<15.1 mg/Nm^3	
Hydrogen sulphide (H_2S)	<5.0 mg/Nm^3	13.60 ppmv
Chlorides	-	0.2 ppmv as HCl/RCl
Mercury	-	10 g/Nm^3

Table 2-2 HPP Feedstock and Product Flows

Operating Case	Feedstock Flows		Product Flows	
	Natural Gas (te/h)	ROG (te/h)	H_2 to Export (Nm^3/h)	CO_2 to Storage (te/h)
Natural Gas – BOL	29.1	-	100,000	75.1
Natural Gas + ROG – BOL	17.7	12.5	100,000	72.0
Natural Gas – EOL	29.0	-	100,000	74.8
Natural Gas + ROG – EOL	17.6	12.5	100,000	71.9

2.2 Low Carbon Hydrogen Process

2.2.1 The overall process for the production of hydrogen and the separation of CO_2 is carried out in a sequence of stages, albeit on a continuous basis:

- Feed gas delivery and purification;
- Feed gas saturation;
- Gas reforming;
- Isothermal Shift (ITS) conversion;
- CO_2 removal, compression and export; and
- Hydrogen purification, compresion and export.

2.2.2 A block flow diagram illustrating the processing scheme is presented in Figure 2.1.

Feed Gas Delivery and Purification

2.2.3 The feed gas stream to the HPP comprises either NG or a mixture of NG and ROG. As can be seen from Table 2.1, ROG has the potential to contain mercury which if uncontrolled can corrode equipment and poison catalysts. The up-stream ROG Compressor will therefore be provided with a Mercury Guard Bed consisting of a fixed bed reactor with an adsorbent. The guard bed removes any traces of mercury before the ROG is transferred to the HPP.

2.2.4 The incoming feed gas stream is mixed with a hydrogen recycle stream (the hydrogen enables the downstream reaction)[4], heated in the Feed Fired Heater, and routed to the Hydrodesulphurisation Vessel. Here any complex chloride or sulphur compounds present in the gas (also potential poisons of downstream catalysts) are converted to hydrogen chloride (HCl) and hydrogen sulphide (H_2S) by reaction with hydrogen on a nickel/ molybdenum catalyst bed.

2.2.5 The HCl and H_2S are subsequently removed in the two Desulphurisation Vessels by absorption onto sodium oxide and zinc oxide absorbent beds. The two vessels operate in a 'lead/ lag' arrangement to maximise absorption and enable the change-out of the saturated absorbent in each vessel without the need for shutting down the plant.

2.2.6 As a final purification stage, the gas is routed to the Ultrapurification Vessel where an ultra-purification metal/ zinc oxide absorbent is used to reduce the sulphur content of the feed gas to very low concentrations. This protect the catalysts in downstream units, specifically the Gas Heated Reformer (GHR) and ITS Converter.

[4] If the feed gas contains ROG, there is no need to add hydrogen as the ROG contains sufficient to enable the reaction.

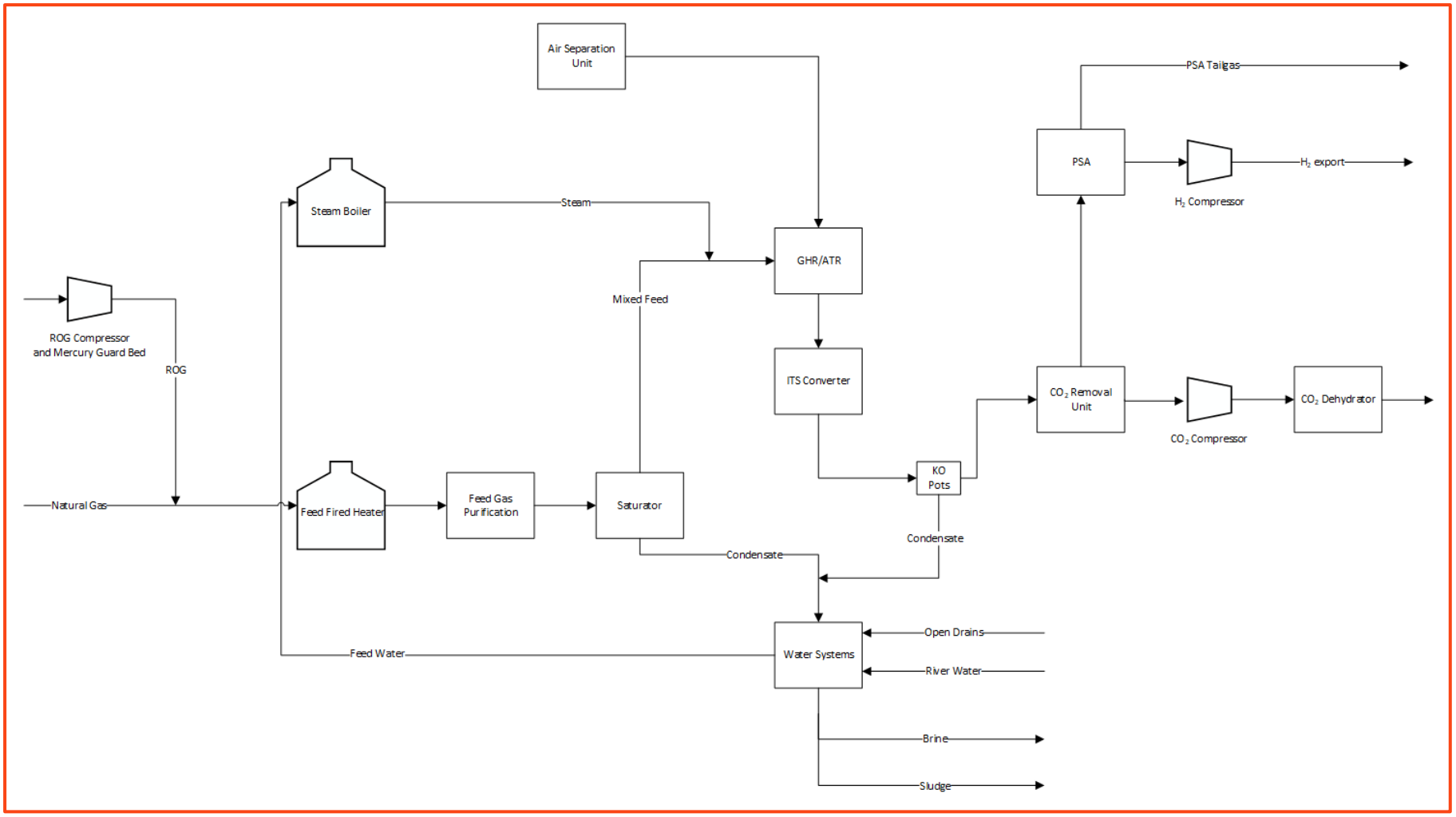


Figure 2-1 Process Block Flow Diagram

Feed Fired Heater

2.2.7 The Feed Fired Heater is used to heat the HPP's feed gas stream and the Mixed Feed sent to the GHR. The heater is fired on Pressure Swing Absorption (PSA) tail gas (see Hydrogen Purification and Export below) during normal plant operation, and natural gas on start-up and shut down. PSA tail gas is a desulphurised gas comprising predominantly hydrogen along with nitrogen and small amounts of methane. The gas specification is given in Section 3. The Feed Fired Heater has a net thermal input of 20.2 MWth. Products of combustion are exhausted to atmosphere via a dedicated stack.

Feed Gas Saturation

2.2.8 In order to facilitate the reforming process it is necessary to add steam to the feed gas. The purified gas is thus passed over packing in the Saturator where it is contacted with hot water in a packed bed. This ensures that the gas becomes water-saturated. Steam is also directly added to the gas to ensure the correct steam to carbon ratio. The gas (now termed Mixed Feed) is then heated further, in the Feed Fired Heater, and routed to the reformers.

2.2.9 To prevent the build-up of dissolved organics in the Saturator circuit a small blowdown stream is removed, cooled, mixed with other condensate streams and sent for treatment.

Gas Reforming

2.2.10 The HPP has two reformers, a GHR and an Autothermal Reformer (ATR) both of which contain proprietary nickel-based catalyst. These promote the conversion of the Mixed Feed into a mixture of oxides of carbon – carbon monoxide (CO) and CO_2 – hydrogen and residual methane (CH_4). The reforming reaction is performed in two stages.

2.2.11 Initially the Mixed Feed is reformed in the tube side of the GHR. The GHR is a refractory lined vessel which contains vertical tubes filled with the nickel catalyst. As the heated gas flows down through the tubes (tube-side) an endothermic reforming reaction occurs resulting in a partially reformed gas.

2.2.12 The partially reformed gas leaving the GHR is then fed to the ATR where it is mixed with oxygen and steam, passed through the nickel catalyst bed, and the reforming process driven to completion (the oxygen is supplied from the dedicated ASU). The resulting mix of carbon oxides and hydrogen is referred to as synthesis gas (syngas).

2.2.13 The hot syngas leaving the ATR is fed back to the shell-side of the GHR to provide the heat required for the reforming reaction on the tube side. The syngas leaving the GHR shell-side is cooled (recovering heat for use in the Saturator circuit) and is routed to the ITS Converter. Boiler feed water (BFW) is supplied to the water jackets on the GHR and ATR, where it is used to provide cooling for the refractory lined vessels.

Isothermal Shift Conversion

2.2.14 The ITS Converter comprises tubes, containing a copper-based catalyst, surrounded by a water jacket. The catalyst promotes the water gas shift reaction in the incoming syngas, reacting carbon monoxide with water to produce, and maximise the yield of hydrogen and CO_2. The heat of the water gas shift reaction is transferred to the shell-side of the ITS Converter and is used to generate steam.

2.2.15 The gas exiting the ITS Converter is cooled against other process streams, and water is removed in two knock-out pots. The water drains to the Condensate Drum from where it is recycled as make-up water to the Saturator. Any excess condensate is cooled and sent to effluent treatment. The cooled gas leaving the second of the knock-out pots is routed to the CO_2 Removal Unit.

CO_2 Removal and Export

2.2.16 The CO_2 Removal unit is based on the OASE® Process licensed from BASF. It is designed to remove the majority of the CO_2 from the cooled syngas, and produce two separate product gas streams:

- a high purity CO_2 product stream (with a CO_2 concentration in excess of 95% mol) which is then sent for compression and dehydration; and
- a CO_2-free syngas (with a CO_2 concentration of less than 0.1% mol) which is sent to the PSA unit for further purification.

2.2.17 The CO_2 is removed from the syngas by contacting it with a "lean" solution of proprietary amine solvent. The solvent adsorbs the CO_2 resulting in a "rich" amine solution. This is then routed to a stripper column where it is flashed at conditions of elevated temperature and reduced pressure, so releasing the CO_2. The once again lean amine is then cooled and recirculated. The process is continuous. The heat required by the CO_2 Removal Unit is provided by the syngas cooling train, with the heat recovered from the ITS Converter used in the Syngas CO_2 Regeneration Reboiler. There is a small purge from the stripping and recovery cycle which is sent as amine-containing waste water to the Waste Water Treatment System.

2.2.18 The CO_2 product stream separated in the CO_2 Removal Unit is mixed with a recycle stream from the CO_2 Dehydration Package and then compressed, in the electric motor-driven CO_2 Compressor, to CO_2 pipeline pressure. The compression is carried out in multiple stages with interstage cooling. Any process condensate removed in interstage knockout pots will be sent to the HPP's Waste Water Treatment Plant for effluent treatment.

2.2.19 The compressed CO_2 product stream will be dehydrated in the CO_2 Dehydration Package. Operation of the package is, in principle, similar to that of the CO_2 Separation Unit except that the dehydration is achieved by means of a recirculating solution of triethylene glycol (TEG). Downstream of the package the dehydrated CO_2 is routed for export in the new CO_2 pipeline. The pipeline is not part of the HPP project. Water removed by the lean TEG is flashed off in the TEG Regeneration skid through the application of heat, and vented to atmosphere.

Hydrogen Purification and Export

2.2.20 The CO_2-free syngas from the CO_2 Removal Unit is passed through a PSA Separation Unit where remaining carbon monoxide, methane and nitrogen are removed from the hydrogen. The PSA unit comprises a number of vessels each of which contains a solid adsorbent material. The separation is achieved by selective adsorption of the syngas components onto this material as the gas is passed through a vessel under pressure: hydrogen is not adsorbed and passes out of a vessel as product, while the other gases present in the syngas are retained on the solid adsorbent. These other gases are periodically recovered by taking an individual vessel off-line and reducing its pressure; this is carried out in a semi-continuous process to provide a stream of residual gas (termed PSA tail gas). The PSA tail gas is used as fuel in the Feed Fired Heater and Steam Boiler (see Steam System).

2.2.21 Hydrogen product from the PSA is compressed in the Hydrogen Compressor. A small flow of compressed hydrogen gas is recycled to the front end of the plant and used as a reactant in the Hydrodesulphurisation Vessel. The remaining hydrogen product is cooled in the Product Hydrogen Cooler, with some sent to the Stanlow Refinery for use as a fuel, and the remainder sent for export off the refinery site by pipeline. The hydrogen pipeline will be consented separately.

2.3 Services and Utilities

2.3.1 The HPP will be provided with the services and utilities listed in Table 2.3 and 2.4, where services are those items provided from Outside Battery Limits (OSBL) and Utilities are those provided from within the battery limits. Further detail is provided in the sections below. It should be noted that service connections have been sized for Phases 1 and 2 combined in order that the Phase 1 plant does not require shutting down for the installation of Phase 2.

Table 2-3 HPP Services

Services
Electrical power The site will be supplied with electrical power at 11 kV. The supply will be reinforced via a 132 kV/33 kV substation which will be provided by Scottish Power & Energy.
Natural gas Natural gas will be sourced from the NTS system. The gas will be unodourised.
Refinery off-gas (ROG) The HPP is designed to take natural gas from the NTS. However, for commercial and GHG benefits the plant has been designed to accommodate a level of ROG as supplied from the refinery.
Raw water United Utilities (UU) will supply raw water from the River Dee. It will be used as make-up for demineralised water.

Table 2-4 HPP Utilities

Utilities
Wastewater Treatment with Recycle Includes storm water and demineralization plant waste stream. It is designed to minimise the need for off-site treatment in order to comply with environmental sustainability requirements and reduce OPEX associated with water import.
Demineralised water The HPP will generate demineralized water in a demineralizer plant to supply process water.
Steam The HPP will be self-sufficient in steam.
Oxygen Oxygen (99.5% purity) will be generated in a dedicated ASU. It is noted in passing that for safety reasons there will be no integration between the ASU and the wider HPP.
Nitrogen Nitrogen will be generated in the ASU as a by-product of oxygen production; it will be used as an inerting and purge gas.
Compressed Air (plant and instrument air) Plant air will be required both for utility stations, and for oxidation of catalyst with the HPP during start-up. Instrument air will be required to power instrument actuators and other instrumentation. Plant and instrument air will be provided from the ASU and will include a small back-up supply.

Utilities
Cooling Medium Cooling will be required for the process, and the duty will be met via an air-cooled closed-circuit system using a glycol/ water mix as the cooling medium.
Drains A drains and water treatment system will be provided for the HPP site comprising: • Closed drains; • Open drains; • Chemical drains; • Foul water; and, • Effluent treatment.
Flare A flare will be provided for emergency and maintenance purposes, and sized to serve both Phase 1 and Phase 2. It will comprise a single raised flare stack with a common header serving two risers - a wet/warm riser and a cold/dry riser.
Emergency Power The facility will have a diesel-driven emergency power generation system to permit safe shutdown and maintenance of the facility in the event of loss of power.

HPP Water Systems

2.3.2 The HPP has a demand for water as it is essential for the reforming process. The demand will be met by means of the raw water supply from UU, surface (rain) water harvested from the process area via the open drains system, and recycled treated effluent from the process. The use of recycled water and harvested rain water will minimise the plant's demand for raw water.

2.3.3 Treatment of the process effluent and the incoming water supply will be carried out in the HPP Water Systems in the following sequence of stages:

- Raw water import and clarification;
- Open drains collection and pre-treatment;
- Process effluent collection;
- Dual media filtration;
- Demin water treatment and supply; and
- Sludge dewatering and export.

A flow schematic for the treatment process is presented in Figure 2.2. Descriptions of the processing stages are presented below.

Raw Water Import and Clarification

2.3.4 The purpose of this treatment stage will be to clarify the incoming river water. The water will initially be metered, and then routed to the Raw Water Balance Tank which will be sized to provide a residence time of 20 minutes for the combined Phase 1 and Phase 2 supply. The tank will also receive backwash supernatant from the downstream Backwash Settlement Tanks (see Dual Media Filtration).

2.3.5 The water will be pumped from the tank, dosed with aluminium bisulphite and sulphuric acid (to promote clarification), and routed to the Clarification Plant. There it will be further dosed with a flocculant to produce clarified water and a sludge. The clarified water will drain to the Clarified Water Tank where it will be mixed with the treated rain water and recycled process water streams, prior to further treatment downstream. The sludge will be sent for blending, dewatering and, ultimately, off-site disposal (see Sludge Dewatering and Export).

Open Drains Collection and Pre-treatment

2.3.6 There will be two surface water drainage networks forming the Open Drainage System:

- Clean System - collecting clean uncontaminated rainfall from areas that are unlikely to contain any contamination, including roads, building roofs, the old tank farm area and the unpaved southern area of the site for collection in four sumps. From there the water enters the existing Essar site drainage system to discharge to the United Utilities water treatment plant at S1;
- Potentially Contaminated System – collecting runoff from hardstanding in process areas (process, ASU and Utilities areas) which drain to individual sumps in each area (four in total) before being routed to treatment and re-use in the HPP process.

2.3.7 Rain water collected in the Potentially Contaminated System will drain to a Corrugated Plate Interceptor (CPI) where any recovered oil will be skimmed and taken away by tanker. The de-oiled water will then be fed via gravity to the Open Drains Sump. Any sludge collecting in the CPI will be sent for blending, dewatering and, ultimately, off-site disposal (see Sludge Dewatering and Export). The CPI will be sized to take rainfall of normal flow 5 m^3/hr, with design max of 10 m^3/hr. Storm surge will not be accommodated by the CPI, and an upstream diversion will be installed to avoid this.

2.3.8 De-oiled water will be pumped from the Open Drains Sump, mixed with the recycled process water stream (see Process Effluent Collection), dosed with phosphoric acid, nitrogen supplement, and micronutrient, and routed to the MBR. The MBR reduces the concentration of Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), and levels of ammonia, methanol, methane, amine and CO_2 in the incoming water. Inlet and outlet conditions are summarised in Table 2.5. The treated MBR effluent will be sent to the Clarified Water Tank, while the sludge resulting from the MBR treatment process will be sent for blending, dewatering and, ultimately, off-site disposal (see Sludge Dewatering and Export).

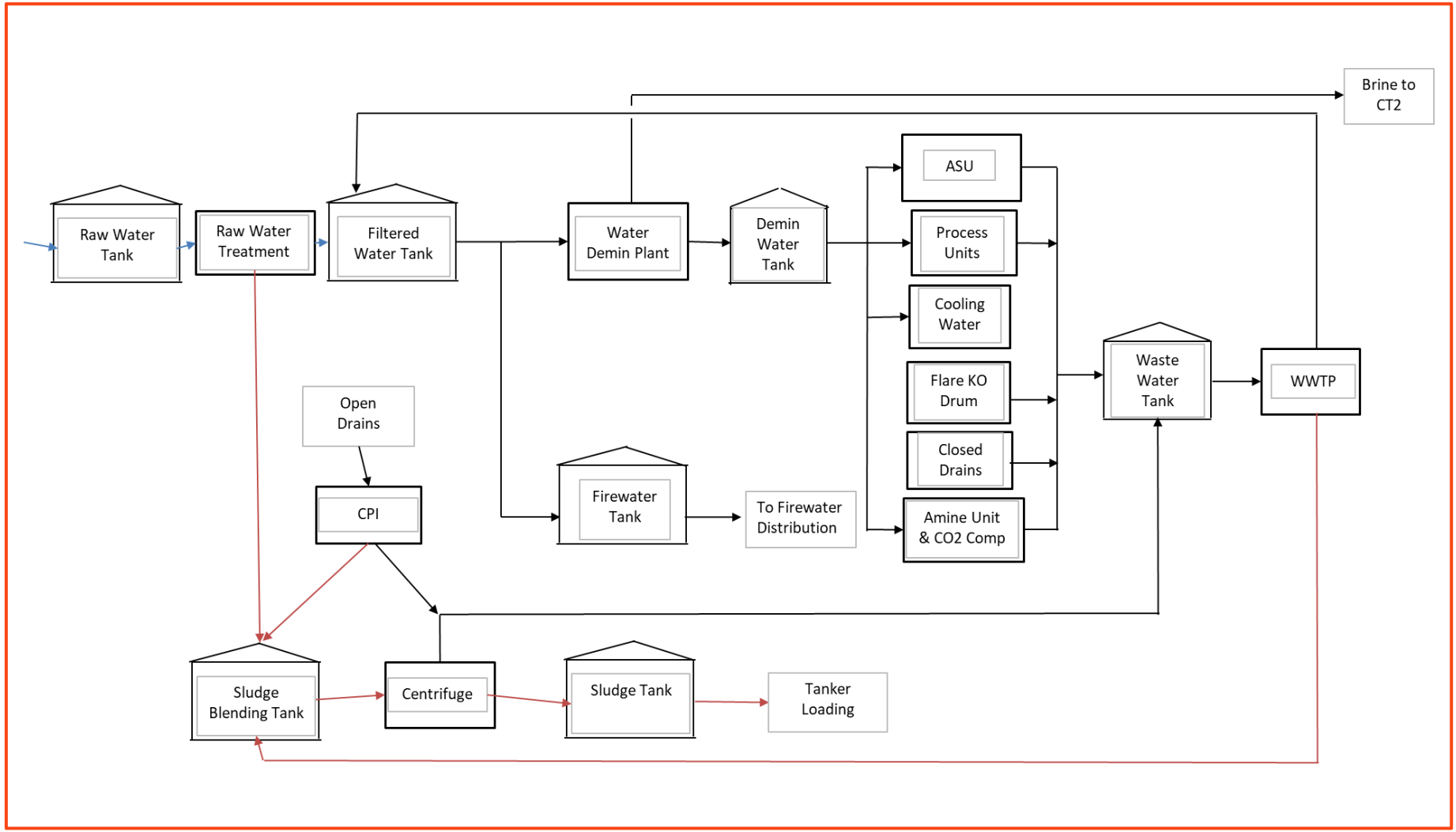


Figure 2-2 HPP Water Systems

Table 2-5 MBR Influent and Treated Effluent Stream Compositions

Component	Composition (mg/l)	
	MBR Feed	MBR Treated Effluent
Total Suspended Solids (TSS)	241.7	0.0
COD	5,155.3	33.5
BOD	4,055.3	25.0
Ammonia	182.9	0.0
Methane	6.5	0.0
CO_2	1,114.2	0.0
Nitrogen	13.3	0.0
Methanol	3,308.7	0.0
Amine	18.7	0.0

Process Effluent Collection

2.3.9 The following process water streams will be recovered and recycled via the Closed Drains System:

- Blowdown from the Saturator, ITS Steam Drum, and MP Steam Drum;
- Blowdown from the GHR and ATR water jackets;
- Condensate from the Reformed Gas Cooling Train, i.e. downstream of ITS Converter;
- Condensate from CO_2 Compressor; and
- Blowdown from the ASU.

These effluent streams, some of which are intermittent, will drain to the Closed Drains Drum from where they will be pumped to the Waste Water Blending Tank. Gases released in the Closed Drains Drum will be routed to flare.

2.3.10 The following process water streams will be piped direct to the Waste Water Blending Tank:

- Liquor from sludge dewatering (see Sludge Dewatering and Export);
- Waste water from the LP Flash Column Reflux Drum (part of the CO_2 Removal Unit); and
- Blowdown from the Cooling Medium system.

2.3.11 The resulting combined water stream will be pumped from the Waste Water Blending Tank, mixed with the de-oiled water from the Open Drains Sump, and routed for treatment in the MBR.

Dual Media Filtration

2.3.12 The purpose of this treatment stage will be to further clarify the treated, combined process water recycle stream in preparation for its demineralisation. The water will be pumped from the Clarified Water Tank, dosed with sodium hypochlorite, and routed to the Dual Media Filtration Plant. This plant will produce a filtered water stream which will be forwarded to the Filtered Water Tank, and a dirty water stream which will drain to Backwash Settlement Tanks. The details of the Dual Media Filtration Plant will be confirmed at the next phase of engineering.

2.3.13 Approximately one third of the filtered water will be pumped from the Filtered Water Tank for use in the ASU and the **LCH** dosing systems. This water will not be subject to further treatment. The remainder of the filtered water will be sent for demineralization and return to the process.

2.3.14 The Backwash Settlement Tanks will produce two effluent streams: a sludge which will be sent for blending, dewatering and, ultimately, off-site disposal (see Sludge Dewatering and Export), and a backwash supernatant, essentially the liquid drained from above the settled sludge. This water will be pumped back to the up-stream Raw Water Balance Tank (see Raw Water Import and Clarification).

Demin Water Treatment and Supply

2.3.15 The purpose of the final water treatment stage will be to demineralize the filtered water stream – to provide a final polish – to ensure its suitability for use in the reforming process. The water will be pumped from the Filtered Water Tank, dosed with sodium bisulphite and sodium hydroxide, and routed to the Water Demineralization Plant. This plant, details of which will be confirmed at the next phase of engineering, will demineralize the filtered water (probably by a process of reverse osmosis and electrodeionisation) to produce a demineralized water stream and a saline effluent stream.

2.3.16 The demineralized water will drain to the Demin Water Storage Tank from where it will be pumped back to the process (for use in the Steam System, CO_2 Removal Unit, the Cooling Medium System, and plant dosing systems). The saline effluent stream will be routed to the wider refinery drainage system for discharge. The composition of this effluent is given in Table 2.6.

Table 2-6 Demin Plant Saline Effluent

Parameter	Value
Temperature (°C)	24.2
pH	7.6
Actual volume flow (m^3/h)	14.1
Design volume flow (m^3/h)	17.0
TSS (mg/l)	0.00
COD (mg/l)	8.030
BOD (mg/l)	5.996

Sludge Dewatering and Export

2.3.17 The HPP water treatment process will produce a number of sludge streams:

- Sludge from the CPI (arising from the open drains system);
- Settled sludge from the Backwash Settlement Tanks (arising from the Dual Media Filtration process);
- Sludge from the (river water) Clarification Plant; and
- Excess sludge from the MBR.

2.3.18 These sludges will be collected in the Sludge Blending Tank which will have a working volume equivalent to one hour of the sludge production rate for HPP Phase 1 and Phase 2. The tank will be provided with a mixing pump to aggitate the solids and thereby develop a homogeneous sludge mix.

2.3.19 The sludge mix will be pumped from the Sludge Blending Tank to the Dewatering Centrifuge Plant where it will be thickened by the removal of excess water. The water removed by centrifugation will be pumped back to the Waste Water Blending Tank and mixed with the process effluents under recycle (see Process Effluent Collection). The thickened sludge will be pumped to the Dewatered Sludge Holding Tank from where it will be removed by tanker for off-site disposal.

Steam System

2.3.20 The HPP will raise steam from the demineralized Boiler Feed Water (BFW) produced by the above described Plant Water Systems. The steam will be raised in the following plant items:

- Steam Boiler;
- Saturator; and
- ITS Converter.

2.3.21 The Steam Boiler raises MP steam using heat produced by combustion of PSA tail gas during normal plant operation, and natural gas on start-up and shut down. Steam is also raised by recovering process heat in the Saturator and ITS Converter/I TS Steam Drum (the ITS reaction [$CO + H_2O <=> H_2 + CO_2$] is exothermic).

2.3.22 Steam will predominantly be used in the reforming process and will be added to the feed gases downstream of the Saturator and upstream of the GHR/ ATR. However, some will be sent to the Oxygen Pre-Heater to pre-heat the ATR oxygen, a small amount will be used as a steam purge in the hot oxygen stream, and a small flow will be provided to the Deaerator.

2.3.23 To minimise fouling and corrosion the BFW will be chemically dosed by the BFW Dosing Package. This package will supply oxygen scavenger to the Deaerator, amine to the suction of the MP Boiler Feed Water Pump, and phosphate to the MP Steam Drum and ITS Steam Drum.

2.3.24 The Steam Boiler will comprise MP Steam Boiler, MP Steam Superheater, and BFW Pre-heater sections. Like the Feed Fired Heater, it will be fired on PSA tail gas during normal plant operation, and natural gas on start-up and shut down. It will have a net thermal input of 27.6 MWth. It will exhaust products of combustion to atmosphere via a dedicated stack.

Air Separation Unit (Oxygen and Nitrogen)

2.3.25 A single dedicated cryogenic ASU will be provided to supply oxygen (99.5 mol%), nitrogen (99.9 mol%), and plant and instrument air to the HPP. Oxygen will be used within the ATR (for the partial oxidation of methane) while nitrogen will be used as a purge gas on start-up and shut down, as well as for inerting and process supply to plant operations.

2.3.26 The ASU will operate through the compression of air to multiple pressure levels and the drying and purification of the resulting component gases using temperature swing absorption. Back-up liquid oxygen and nitrogen storage will be provided. The back-up storage facilities will include a package to vaporize liquid oxygen and liquid nitrogen in the event of an ASU trip.

2.3.27 The ASU will be sized against the total Phase 1 flow of oxygen. Associated nitrogen production, above the HPP requirement, will be vented to atmosphere at safe location. Condensate will be generated by the ASU from the separation of water vapour in the incoming air. This condensate steam will be sent to the HPP Water Systems for treatment.

Cooling Medium System

2.3.28 The HPP will be provided with a closed loop Cooling Medium System to supply cooling for:

- Syngas, upstream of the CO_2 Removal Unit;
- Steam blowdown, upstream of the closed drains header;

- Blowdown from the Saturator, upstream of the closed drains header;
- Process condensate, upstream of the CO_2 Removal Unit;
- ROG Compressor;
- CO_2 Compressor; and
- H_2 Compressor

2.3.29 The cooling medium will be a 66%/33% demineralized water/ propylene glycol mix distributed from a Cooling Medium Storage Tank. Propylene glycol has been selected in order to reduce the toxicity of the medium when compared with ethylene glycol. Cooling will be achieved through a Cooling Medium Air Cooler driven by a Variable Speed Drive (VSD). This will reduce the temperature of the incoming "warm" cooling medium from 45°C to 35°C.

Emergency Power Generation

2.3.30 The HPP will be provided with a diesel-powered Emergency Generator Package to permit safe shutdown for the facility in the event of power failure. The generator will be rated at approximately 1 MWe output (2.9 MWth input).

2.3.31 Under normal circumstances, the Emergency Generator will only be operated for regular routine testing, in accordance with typical manufacturer's recommendations. It is anticipated that this would correspond with approximately one hour's operation per month, and will be below 50 hours operation a year.

Flare

2.3.32 The HPP will be provided with a Flare Package comprising a flare knock-out drum, elevated flare stack, flare tip, and a flare ignition package. The flare is designed to provide a safe disposal route for the HPP's flammable gases under start-up, shut-down, abnormal and emergency conditions. It has been sized to relieve the inventory of both the Phase 1 and Phase 2 development and thus has a design relief capacity of 280 te/h.

2.3.33 The flare will be purged with nitrogen, and will be fitted with a primary automatic ignition system, and a secondary manually-activated flame front generator. The ignition package will also include a flare snuffing system. Liquefied petroleum gas (LPG) bottles will be provided as back-up to the primary fuel source. The flare tip will be designed for smokeless operation. The flare will be 60 m in height.

2.3.34 The composition of the gas sent to flare under the worst case flaring scenario is given in Table 2.7. The case corresponds to blowdown from all blowdown valves due to an emergency event.

Table 2-7 HPP Worst Case Flaring

Parameter	Value	
	Ph 1	Ph 1 & 2
Mass Flow (kg/h)	85,957	257,872
Molar Flow (kmol/h)	5,532	16,597
Composition (mol%)		
Methane	41.48	
Ethane	2.62	
Propane	0.20	
n-Butane	0.02	
n-Pentane	0.00	
Water	32.87	
Hydrogen	18.68	
Carbon monoxide	0.58	
Carbon dioxide	3.36	
Nitrogen	0.19	

2.3.35 It should be noted that any gas routed to flare from downstream of the Desulphurisation Vessels and Ultrapurification Vessel (see Feed Gas Delivery and Purification) will essentially be sulphur free.

2.3.36 The concentration of sulphur compounds in the feed gas at the inlet to the reforming plant, i.e. upstream of these vessels, will be as per the gas specs given in Table 2.1. The specification of the NG taken from the NTS will not vary to any significant extent over time. The sulphur content of this gas can therefore be taken as a constant.

2.3.37 The sulphur content of the ROG can periodically be elevated above the level given in Table 2.1, for example during start-up or upsets of up-stream refinery units. However, elevated sulphur levels in the feed gas are undesirable due to the consequential increase in the consumption of HPP adsorbents, and in such circumstances, therefore, importation of the ROG would cease. Nevertheless, detection of an issue would take a little time, and it would probably be necessary to relieve the inventory of higher sulphur gas. Periodic short-term flaring of gas with an elevated sulphur content is therefore conceivable.

2.4 Catalysts, Chemicals and Fuel

Materials Usage

2.4.1 The speciality chemicals and catalysts used in the HPP are listed in Table 2-8. The list excludes general oils, lubricants, anti-freezes, etc. The list also excludes the inert alumino-silicate ceramic balls used to support the catalysts and absorbents.

Table 2-8 HPP Materials Usage

Material	Usage	Comment
Mercury Guard Bed Catalyst (PURASPEC™ 1173)	Mercury Guard Bed Catalyst	Charge volume: 3.5 m3 Expected Life: TBD
Hydrodesulphurisation Catalyst (PURASPEC 2571)	Hydrodesulphurisation Vessel	Charge volume: 10.4 m^3 Expected life: 4 years
Chloride removal Absorbent (KATALCO™ 59-4)	Desulphurisation Vessels	Charge volume: 8.0 m^3 per vessel Expected life: 2 years
Desulphurisation Absorbent (KATALCO 32-4)	Desulphurisation Vessels	Charge volume: 33.3 m^3 per vessel Expected life: 2 years
Ultrapurification Catalyst (PURASPEC 2084)	Ultrapurification Vessel	Charge volume: 6.6 m^3 Expected life: 4 years
GHR Catalyst (KATALCO 23-4HQR / 23-4HQ)	GHR	Charge volume: 11.1 m^3/ 11.1 m^3 Expected life: 4 years
ATR Catalyst (KATALCO 28-4Q)	ATR	Charge volume: 16.8 m^3 Expected life: 4 years
ITS Catalyst (KATALCO 83-5)	ITS Converter	Charge volume: 53.7 m^3 Expected life: 4 years
Oxygen Scavenger	Steam System	
Phosphate	Steam System	
Amine	Steam System	
Amine	CO_2 Removal Unit	
Anti-foam	CO_2 Removal Unit – Anti-foam Injection Package	
TEG	CO_2 Dehydration	
PSA Adsorbent	PSA	
Alumina/ silica desiccant	ASU/instrument air drying	
Sodium bisulphite solution	Water Demineralization Plant	
Sodium hydroxide solution	Water Demineralization Plant	

Material	Usage	Comment
N Supplement and micro-nutrient	MBR Plant	
Phosphoric acid solution	MBR Plant	
Aluminium sulphate solution	Clarification plant	
Sulphuric acid solution	Clarification plant	
Sodium hypochlorite solution	Dual Media Filtration Plant	
Flocculant polymer	Dewatering centrifuge plant	
Liquid oxygen	Back-up for the ASU	
Liquid nitrogen	Back-up for the ASU	
Diesel	Emergency Generator Package	

Storage Arrangements

2.4.2 The HPP liquid storage arrangements are set out in Table 2-9. It is noted that small quantities of chemicals that are required for continuous injection or batch mixing will be delivered to site in suitable intermediate bulk containers (IBCs). These containers will be delivered to the chemical injection packages which will have bunding.

Table 2-9 HPP Liquid Storage Arrangements

Equipment Name	Duty / Capacity (m^3)	Type of Fluid	Type of Containment
Amine Storage Tank	1043	Amine solution (70% w/w)	Bund
TEG storage tank	72		Bund
Filtered Water Tank		Water	Not required
Aluminium Sulphate Storage Tank	6	Aluminium Sulphate solution (8% w/w)	Bund
Sulphuric Acid Storage Tank	0.8	Sulphuric Acid solution (33% w/w)	Bund
Clarified Water Tank		Water	Not required
Raw Water Balance Tank		Water	Not required
Backwash Settlement Tank		Water and Sludge	Not required
Sodium Hypochlorite Storage Tank	6	Sodium Hypochlorite solution (10% w/w)	Bund
Demin Water Storage Tank		Water	Not required
Sodium Hydroxide Storage Tank	6	Sodium Hydroxide solution (32% w/w)	Bund

Equipment Name	Duty / Capacity (m^3)	Type of Fluid	Type of Containment
Sodium Bisulphite Storage Tank	2	Sodium Bisulphite solution (20% w/w)	Bund
Fire Water Storage Tank	4000	Water	Not required
Waste Water Blending Tank		Waste	Not required
Sludge Blending Tank		Sludge	Not required
Thickened Sludge Holding Tank		Sludge	Not required
Phosphoric Acid Storage Tank	5	Phosphoric Acid solution (various conc)	Bund
N Supplement & Micro-Nutrient Storage Tank	30		Not required
Cooling Medium Storage Tank	4200	Propylene glycol solution (33% w/w)	Bund
11-33kV Transformer		Oil	Bund
Liquid Oxygen tank	670		Not required
Liquid Nitrogen tank	300		Not required
Emergency Generator Diesel Tank	8.5	Diesel	Double Skin

2.5 HPP Site Layout

2.5.1 The HPP site is laid out to provide a safety distance between the new HPP and the public road to the south, and to the Thornton Science Park to the east. The dedicated flare is located in the north west corner of the site. Pipelines will approach from the south under the A5117 with Above Ground Installations (AGI) located within the southern part of the process area. The plant utilities are located to the south east of the plot and include water treatment and electrical power distribution. The HPP will be operated from the existing refinery central control room such that there will be no permanently manned buildings on the site. The layout of the **LCH** site is shown in Figure 2.3, and as a three-dimensional view in Figure 2.4.

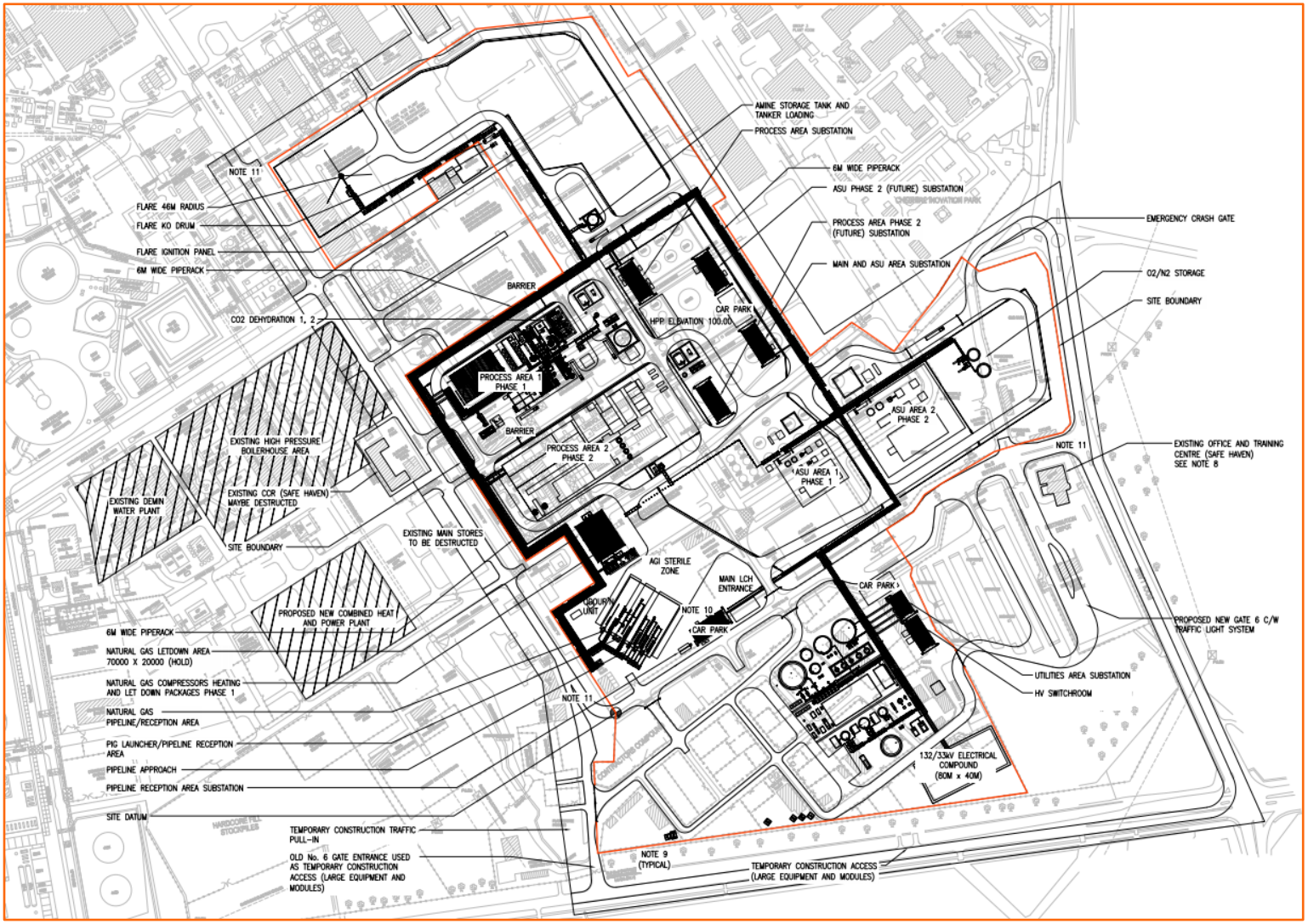


Figure 2-3 HPP Site Layout

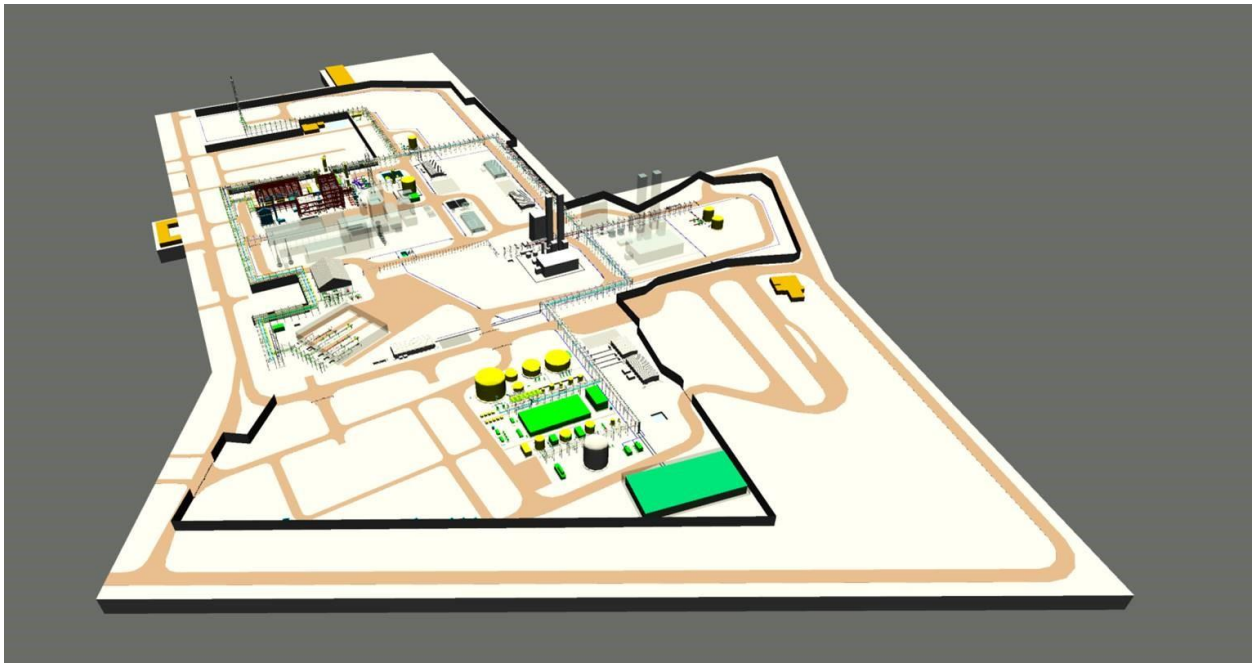


Figure 2-4 Three Dimensional View of HPP Site Layout

3.0 BEST AVAILABLE TECHNIQUES (BAT) ASSESSMENT

3.1.1 This section presents information on the techniques incorporated within the **LCH** plant's design to minimise environmental emissions, effluents and wastes. Initially a summary is provided of the plant's relevant design philosophies and Design Requirements aimed specifically at environmental protection. Thereafter, an evaluation is presented of the HPP's conformance with BAT. This is made through comparison with a range of technical guidance. Reference is made to Essar's Environmental Management System and its proposed approach to the management of the permitted activities.

3.1 HPP Design Philosophies

Basis of Design

3.1.1 The Project Basis of Design specifies philosophies which are relevant to energy usage and efficiency. These are given in Table 3-1.

Table 3-1 HPP Philosophies for Plant Design

Energy Usage Area	Philosophy
Heat integration	Heat integration within the **LCH** flowsheet and carbon capture is to be maximised in order to improve the energy efficiency of the process. In order not to over-complicate the plant other heat integration (eg. with the ASUs) will not be pursued
Cooling	The process is cooled using an air cooling system in order to minimise water make up for the plant.
Power Integration	There is no power integration within the project because there is no surplus heat or fuel for power generation.
Driver Selection	Driver selection is electric motor as there is no surplus steam and heat sufficient to meet the driver loads. Electric motors also simplify the plant operation compared to steam and fuel integration. Where drivers are required in emergency, even with site wide power failure, diesel powered drivers shall be used.

Environmental Design Requirements

3.1.2 The Project Environmental Design Philosophy also specifies design requirements specific to Basic Energy Efficiency Measures and Carbon Management.

Table 3-2 Environmental Design Requirements

Area	Requirement
Basic Energy Efficiency Measures	The HPP shall be designed to be energy efficient using the techniques listed in section 3 of the Reference Document on Best Available Techniques for Energy Efficiency [3]. A record of the techniques employed in the design shall be maintained for inclusion in the Environmental Permit application. The HPP shall be operated and maintained within an energy management system such as ISO 50001 [4] or using the techniques in section 2 of the Reference Document on Best Available Techniques for Energy Efficiency [3] (parts 2.1 to 2.8, 2.9 (maintenance) and 2.10 to 2.17).
Carbon Management	A carbon budget for the HPP shall be maintained to demonstrate the project's CO_2 emissions per MWh of energy supplied. The budget shall include direct and indirect CO_2 emissions (i.e. those arising from the operation of the HPP and its utility systems, and those arising from the overhead supply of electricity). The global warming potential (GWP) of the Project's greenhouse gas emissions shall be calculated as tCO_2eq/year [5].

3.2 Technology Selection

3.2.1 The HPP technology offers lower cost, higher CO_2 capture rate, and scalability advantages over the alternative technology, Steam Methane Reforming (SMR) coupled with CCS. Early hydrogen infrastructure assessments relating to the conversion of natural gas to hydrogen assumed that this would be delivered by an SMR which is the established technique for hydrogen production internationally today. However, whilst the SMR approach is suited to a proportion of CO_2 capture, it has a CO_2-containing stream which is at low partial pressure. Achieving acceptable levels of capture is thus expensive and energy-intensive. By contrast, the HPP technology, comprising a GHR coupled with an oxygen blown ATR, has a single process stream with a high partial pressure of CO_2. This makes it more cost-effective and efficient to deliver a high CO_2 capture rate (of around 97%) [6]. The combination of a GHR and ATR offers increased gas process efficiency compared to SMR, and the production of hydrogen at pressure results in reduced compression costs.

3.2.2 The HPP technology is inherently more efficient than the counterfactual (SMR/ CCS), as the heat required for the reforming reactions is not provided by external heat, as is the case in an SMR, and does not generate as much CO_2 for the same hydrogen production rate, as shown in the table below. As much less CO_2 is emitted, HPP is better technology than SMR in moving toward a net zero target in line with the recommendations by the Committee on Climate Change (CCC).

3.2.3 The location of the HPP has been selected to minimise both the cost of connection to a CO_2 transport network, which utilises in part repurposed existing gas pipelines, and the distance from the large industrial gas users to be converted to hydrogen. The availability of the hydrogen pipeline distribution system also facilitates the creation of hydrogen refuelling stations to support the use of hydrogen as a fuel in the road and rail transport sectors [7].

Table 3-3 Comparison of LCH with SMR

Parameter	Units	SMR	LCH
Product Flow Rate	MWth (LHV) / (HHV)	300 / 355	300 / 355
	kNm^3/h	100	100
Hydrogen Purity	%	99.9	99.9
Efficiency (LHV & HHV basis)	%	67.2 / 71.7	79.7 / 84.7
CO_2 Capture Rate	%	90.1	97.2
CO_2 Outlet Steam Purity	%	96	99.7
CO_2 Generated	kt/h	82.03	77.49
CO_2 Captured	kt/h	73.91	75.27
CO_2 Emitted	kt/h	8.12	2.22
	kg/kNm^3	81.2	22.2

3.3 Key Performance Parameters

Table 3-4 HPP Key Process, Energy Emissions and Carbon Capture Performance Parameters

Parameter	Description	Unit	Hydrogen Production BAT Value for GHR+ ATR+PSA	HyNet for NG EOL Case
Process /Energy Efficiency				
Feed Gas Energy Conversion	$\frac{Energy\ content\ of\ H2\ product\ (LHV)}{Energy\ content\ of\ Feed\ Gas\ (LHV)}$	%	80.6	**80.1**
Electrical Power Consumption	Net power import after electrical power generation	MJ/kgH_2	8.8	**12**
Overall Energy Conversion	$\frac{Energy\ content\ of\ H2\ product\ (LHV)}{Energy\ content\ of\ Feed\ Gas\ (LHV) + power\ import}$	%	76.1	**74.1**
Water Consumption (process)		kgH_2O/kgH_2	-	**8.4**
Auxiliary Heating Duty	Thermal input if not covered in the above	MJ/kgH_2	-	
Cooling Duty	Heat rejected to cooling medium or air	MJ/kgH_2	-	**21**

Emissions				
CO_2 emissions to air	CO_2 not captured	$kgCO_2/kgH_2$	0.3 – 0.4	**0.22**
NOx emissions to air		kg/kgH_2	-	**3.27×10^{-4}**
SO_2 emissions to air		kg/kgH_2	-	**Nominally zero**
CO emissions to air		kg/kgH_2	-	**4.08×10^{-4}**
Emissions to water - methanol	To effluent treatment	kg/kgH_2	-	
Emissions to water - ammonia	To effluent treatment	kg/kgH_2	-	
Emissions to water – CO_2	To effluent treatment	kg/kgH_2	-	
Waste production	Expressed over lifecycle, annually or per unit of hydrogen produced, as appropriate	kg		
Carbon Capture				
CO_2 Capture Pre-Combustion		$kgCO_2/kgH_2$	8.4	**8.29**
CO_2 Capture Post-Combustion		$kgCO_2/kgH_2$	0	**Nil**
Total CO_2 Capture	Overall Pre- and Post-Combustion	$kgCO_2/kgH_2$	8.4	**8.29**
Total CO_2 Capture Efficiency	$\frac{Carbon\ captured}{Carbon\ in\ Feed\ Gas}$	%	95 – 97	**97**
Total CO_2 Capture Heat Requirement	Net Heat Input to CO_2 Capture Process	$MJ/kgCO_2$	-	
Total CO_2 Capture Power Requirement	Net Heat Power to CO_2 Capture Process	$MJ/kgCO_2$	-	
CO_2 Compression Duty Requirement	For delivery to pipeline	$MJ/kgCO_2$	-	

3.4 BAT Guidance

3.4.1 The following documents have been used as sources of BAT guidance for the design and proposed operation of the HPP. Versions used are those prevalent at the time the application was drafted:

- Guidance for Establishing Best Available Techniques for Hydrogen Production from Methane and Refinery Fuel Gas with Carbon Capture [2];
- BAT Conclusions Document for the Refining of Mineral Oil and Gas [9]; and
- BAT Conclusions Document for Common Waste Water and Waste Gas Treatment / Management Systems in the Chemical Sector [8].

3.4.2 It is noted that the Hydrogen Production BAT is still in draft. However, it is the newest and most directly relevant of the guidance documents, and is therefore the one around which the evaluation of BAT for the HPP has largely been based. The evaluation is presented in the sections below.

3.4.3 Nevertheless, consideration was given to guidance presented in the Mineral Oil and Gas, and Common Waste BAT Conclusions documents. The documents, which have an intentionally wide coverage, were thus reviewed to identify the specific conclusions which will be applicable to the HPP development. These BAT conclusions are listed in Table 3.5 along with the sections of the application document where they are addressed.

Table 3-5 BAT Guidance Applicable to the HPP derived from the BAT Conclusions Documents for Refineries, and Common Waste Water and Waste Gas Treatment

BAT Conclusion	Summary	Permit Application Section where Addressed
Refining of Mineral Oil and Gas		
3	Solid materials storage and handling In order to prevent or, where that is not practicable, to reduce dust emissions from the storage and handling of dusty materials, BAT is to use one or a combination of the following techniques: i) store bulk powder materials in enclosed silos equipped with a dust abatement system (e.g. fabric filter), ii) store fine materials in enclosed containers or sealed bags, iii) keep stockpiles of coarse dusty material wetted, stabilise the surface with crusting agents, or store under cover in stockpiles, and iv) use road cleaning vehicles.	Raw Materials and Wastes
4	Monitoring of emissions to air and key process parameters BAT is to monitor emissions to air by using the monitoring techniques with at least the minimum frequency given [in the BAT Conclusions table] 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.	Emissions Monitoring

BAT Conclusion	Summary	Permit Application Section where Addressed
5	Monitoring of emissions to air and key process parameters BAT is to monitor the relevant process parameters linked to pollutant emissions, at catalytic cracking and combustion units by using appropriate techniques and with at least the following frequency: Monitoring of parameters linked to pollutant emissions, e.g. O_2 content in flue-gas, N and S content in fuel or feed – Continuous for O_2 content. For N and S content, periodic at a frequency based on significant fuel/feed changes (N and S monitoring in fuel or feed may not be necessary when continuous emission measurements of NO_X and SO_2 are carried out at the stack).	Emissions Monitoring
6	Monitoring of emissions to air and key process parameters BAT is to monitor diffuse VOC emissions to air from the entire site by using all of the following techniques: i) sniffing methods associated with correlation curves for key equipment, ii) optical gas imaging techniques, iii) calculations of chronic emissions based on emissions factors periodically (e.g. once every two years) validated by measurements. The screening and quantification of site emissions 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.	Emissions Monitoring
11	Emissions to water In order to reduce water consumption and the volume of contaminated water, BAT is to use all of the following techniques: i) Water stream integration, ii) Water and drainage system for segregation of contaminated water streams, iii) Segregation of non-contaminated water streams (e.g. once-through cooling, rain water), and iv) Prevention of spillages and leaks.	Waste Water Treatment and Water Reuse
12	Emissions to water In order to reduce the emission load of pollutants in the waste water discharge to the receiving water body, BAT is to remove insoluble and soluble polluting substances by using all of the following techniques: i) Removal of insoluble substances by recovering oil, ii) Removal of insoluble substances by recovering suspended solids and dispersed oil, and iii) Removal of soluble substances including biological treatment and clarification.	Waste Water Treatment and Water Reuse
13	Emissions to water When further removal of organic substances or nitrogen is needed, BAT is to use an additional treatment step: i) Removal of insoluble substances by recovering oil, ii) Removal of insoluble substances by recovering suspended solid and dispersed oil, iii) Removal of soluble substances including biological treatment and clarification, and iv) Additional treatment step.	Waste Water Treatment and Water Reuse
14	Waste generation and management In order to prevent or, where that is not practicable, to reduce waste generation, BAT is to adopt and implement a waste management plan that, in order of priority, ensures that waste is prepared for reuse, recycling, recovery or disposal.	Avoidance, Recovery and Disposal of Wastes
15	Waste generation and management In order to reduce the amount of sludge to be treated or disposed of, BAT is to use one or a combination of the following techniques: i) Sludge pre-treatment, and ii) Reuse of sludge in process units.	Avoidance, Recovery and Disposal of Wastes
16	Waste generation and management In order to reduce the generation of spent solid catalyst waste, BAT is to use one or a combination of the following techniques: i) Spent solid catalyst management, and ii) Removal of catalyst from slurry decant oil.	Avoidance, Recovery and Disposal of Wastes

BAT Conclusion	Summary	Permit Application Section where Addressed
17	Noise In order to prevent or reduce noise, BAT is to use one or a combination of the following techniques: i) make an environmental noise assessment and formulate a noise management plan as appropriate to the local environment, ii) enclose noisy equipment/ operation in a separate structure/ unit, iii) use embankments to screen the source of noise, and iv) use noise protection walls.	Noise and Vibration
18	BAT conclusions for integrated refinery management In order to prevent or reduce diffuse VOC emissions, BAT is to apply the following techniques: i) limiting the number of potential emission sources, ii) maximising inherent process containment features, iii) selecting high integrity equipment, iv) facilitating monitoring and maintenance activities by ensuring access to potentially leaking components, v) well-defined procedures for construction and assembly, vi) robust commissioning and hand-over procedures to ensure that the plant is installed in line with the design requirements, and vii) Use of a risk-based leak detection and repair (LDAR) programme in order to identify leaking components, and to repair these leaks.	Control of Fugitive and Other Emissions
34	BAT conclusions for the combustion units In order to prevent or reduce NOX emissions to air from the combustion units, BAT is to use one or a combination of the following techniques: a) Use of gas to replace liquid fuel, b) Use of low nitrogen refinery fuel oil (RFO), c) Staged combustion, d) Optimisation of combustion, e) Flue-gas recirculation, f) Diluent injection, g) Use of low-NOX burners (LNB), h) Selective catalytic reduction (SCR), i) Selective non-catalytic reduction (SNCR), j) Low temperature oxidation, and k) SNO_x combined technique.	Combustion
55	Flares In order to prevent emissions to air from flares, BAT is to use flaring only for safety reasons or for non-routine operational conditions (e.g. start-ups, shutdown).	Flaring
56	Flares In order to reduce emissions to air from flares when flaring is unavoidable, BAT is to use the following techniques: i) Correct plant design, ii) Plant management, iii) Correct flaring devices design, and iv) Monitoring and reporting.	Flaring
Common Waste Water and Waste Gas Treatment/ Management Systems in the Chemical Sector		
2	Environmental management systems 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 that incorporates all of the following features: i) information about the chemical production processes, ii) information, as comprehensive as is reasonably possible, about the characteristics of the waste water streams, and iii) information, as comprehensive as is reasonably possible, about the characteristics of the waste gas streams.	Waste Water Treatment and Water Reuse
3	Monitoring For relevant emissions to water as identified by the inventory of waste water streams, 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).	Waste Water Treatment and Water Reuse
4	Monitoring BAT is to monitor emissions to water in accordance with EN standards with at least the minimum frequency given [in the BAT Conclusions table]. 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.	Waste Water Treatment and Water Reuse

BAT Conclusion	Summary	Permit Application Section where Addressed
7	Water usage and waste water generation 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.	Waste Water Treatment and Water Reuse
8	Waste water collection and segregation 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.	Waste Water Treatment and Water Reuse
9	Waste water collection and segregation 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).	Waste Water Treatment and Water Reuse
10	Waste water treatment 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: a) Process-integrated techniques, b) Recovery of pollutants at source, c) Waste water pre-treatment, and d) Final waste water treatment.	Waste Water Treatment and Water Reuse
11	Waste water treatment 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 Treatment and Water Reuse
12	Waste water treatment In order to reduce emissions to water, BAT is to use an appropriate combination of final waste water treatment techniques.	Waste Water Treatment and Water Reuse

3.5 Evaluation of HPP Against BAT Guidance

3.5.1 Comparison of the HPP's design with BAT guidance is made below in a sequence of tables. As noted above, these are largely based upon the topics set out in section 5 of the Hydrogen Production BAT guidance document [2]. To avoid cross referencing, the guidance has been reproduced. In each table, the relevant design characteristics of the HPP are listed in demonstration of conformance with the guidance. Comment is also provided, where relevant, on the outcomes of design studies aimed at optimising energetic and environmental performance.

3.5.2 It is highlighted that, with respect to the Hydrogen Production BAT guidance, two technical areas are not relevant to the HPP, namely:

- "CO_2 Capture Strategies Specific to Steam Methane Reforming" – the HPP design is based upon a series combination of a GHR and an ATR, not on SMR technology; and

- "Post-combustion CO_2 Capture from SMR Furnace Flue Gas" – there is no post-combustion capture of CO_2 employed on the HPP. This is because the Feed Fired Heater and Steam Boiler will burn PSA off-gas. This gas will comprise predominantly hydrogen with very low concentrations of methane, oxides of carbon, and other hydrocarbons. Post combustion, the concentration of CO_2 in the flue gases sent to atmosphere will thus be of the order of 2% (by volume), rendering the capture of CO_2 from the flue gases neither economically practicable nor environmentally significant.

3.5.3 The following plant characteristics are also relevant to the assessment of BAT presented in the sections below in that they foreclose on the need to undertake specific options analysis in a number of areas:

- There will be no process emissions to sewer from the HPP;
- There will be no planned discharges to groundwater from the HPP. Measures will be developed to prevent accidents that could lead to such emissions and to mitigate their environmental consequences if they were to occur; and
- There will be no direct releases of solid and liquid wastes from the HPP to land within the installation boundary. Wastes will be sent off site for treatment and re-use/recycling, recovery or disposal.

3.6 Hydrogen Production Process

Feed Gas Supply

Table 3-6 HPP Comparison Against Hydrogen Production BAT Guidance – Feed Gas Supply

Considerations & Guidance	
The range of [Feed Gas] *composition is important for example in order to specify the desulphurisation and pre-reforming stages. The full compositional range should be specified, particularly in the case of refinery fuel gases which can typically be from several sources.* *Sulphur (SO_2) emission sources to air (through combustion of fuel gas) should be limited through the use of a low sulphur feed gas or by pre-treating the feed gas to remove sulphur-containing species.*	
HPP Status	
• The HPP is designed to process a gas stream comprising NG taken from the NTS and ROG imported from Stanlow refinery. The gases have the compositions shown in Table 2-1. Depending upon the operating case the feed gas can compromise 100% NG to a 55/45% mol NG/ ROG mix. • For all practical purposes the composition of the NG is constant. • On the refinery there are a number of sources of ROG of varying qualities and consistency. Only the best quality and most reliable of these streams will sent for reforming in the HPP. • The ROG has a design H_2S concentration of 13.6 ppmv. The HPP has been designed to handle impurities in the gas of up to 20 ppmv total sulphur (and 3.5 ppmw chlorides and 5 ppmv organo-sulphur). If the impurities exceed these levels for any appreciable time, the ROG will not be imported. • The two principal sources of combustion gases on the HPP are the Feed Fired Heater and the Steam Boiler which together have a combined net thermal input of 47.8 MW. Other than during start-up and shutdown (when NG is used as the fuel), the units will be fired on PSA tail gas. This is a desulphurised gas stream the combustion of which will not result in atmospheric emissions of SO_2.	
Conformance with BAT:	✓

Feed Gas Desulphurisation and Pre-reforming

Table 3-7 HPP Comparison Against Hydrogen Production BAT Guidance – Feed Gas Desulphurisation and Pre-reforming

Considerations & Guidance	
Where possible, the removal of sulphur components from the feed gas to the hydrogen production process should be maximised in upstream facilities to avoid excessive use of adsorbent catalyst, requiring disposal / recycle. *Catalyst selection should be made considering environmental performance, accounting for:* • *Any required pre-treatment to avoid poisoning, to minimise waste and associated treatment.* • *Prevention of any dust emissions, where applicable.* • *Ability to recover/ recycle the solids/ metals from the spent catalyst waste.* • *Handling of spent catalyst for environmentally safe recovery/ recycling/ disposal.* *Incorporation of a pre-reforming step – in which ethane and heavier hydrocarbons are broken down at a relatively low operating temperature, to avoid production of carbon residues in the methane reforming step, are also specific to the feed gas source and composition. In the adiabatic pre- reformer, endothermic reforming reactions convert heavier hydrocarbons and some of the methane to CO and hydrogen, while exothermic water gas shift and methanation reactions will also reach equilibrium, giving a mixture of methane, CO2, CO and hydrogen to the downstream reformer. Incorporation of a pre-reforming step should be considered to optimise the overall environmental performance, for example to optimise energy efficiency and to minimise NOx emissions to air.*	
HPP Status	
• There will be pre-treatment of the ROG to remove mercury which can poison HPP catalysts. The up-stream ROG Compressor will therefore be provided with a mercury guard bed to remove any traces of mercury before the ROG is transferred to the HPP. • The HPP will be provided with desulphurisaton catalyst/ adsorbent inventories with a design life of 4 years for single vessels (consistent with the major maintenance turnaround for the HPP) and 2 years where twin vessels are used. • The metals employed in the reformer catalysts can be recovered and recycled, and that is the expectation of the HPP project: "*The expectation, in the current and likely economic climate, is that the spent catalysts will be reclaimed/recycled and so not go to landfill*". The arrangements for the management of spent catalysts will be formalized at the project EPC stage through the development of a "Catalyst Care Program" (see section 8, Pre-Operational Conditions – POC8). • The ROG delivered to the HPP has an ethane content of 18% mol. However, a pre-reforming step is not necessary, and one has not been provided in the HPP design. This is because the GHR (which operates at a temperature of around 700^{o}C) is effective at breaking down the heavier hydrocarbons. The second stage reforming of the resulting gas mix is then carried out in the ATR at a higher temperature (of around 1,020^{o}C).	
Conformance with BAT:	✓

Reforming and CO Shift

Table 3-8 HPP Comparison Against Hydrogen Production BAT Guidance – Reforming and CO Shift

Considerations & Guidance
In the reforming and CO shift sections, methane conversion to hydrogen, CO and CO_2, and the CO conversion to CO_2 should be optimised considering the overall CO_2 capture target, and the impact on downstream processing to meet the hydrogen product specification. *In the case of oxidation reactions in the process, equipment design, and operating parameters should be optimised to minimise risk of soot formation. In the case of autothermal reforming, the potential to destroy any identified soot precursors in the catalyst bed to avoid soot formation should be considered. The need for soot removal, e.g. in the case of non-catalytic partial oxidation with high operating temperatures, to protect downstream systems is to be considered, along with disposal requirements.* *CO shift technology selection should consider the environmental performance:* • *To maximise energy efficiency, particularly through best heat integration with the overall hydrogen production and CO_2 capture processes.* • *To minimise the duration of start-up operations and associated emissions to air from flaring.* • *To minimise production of wastes.* *A single step CO shift process may be considered in place of a more conventional high temperature/ low temperature shift process, with isothermal conditions achieved through reactor cooling with recovery of heat. A key driver for this is in overall heat integration and efficient use of recovered heat. This also avoids use of chromium catalyst needed for high temperature shift, minimising waste and as Fisher-Tropsch reactions (e.g. producing methanol which would condense with the water downstream), which can occur in high temperature shift processes if the steam to carbon ratio is too low.* *As high steam to carbon ratios will be employed in any case, to maximise CO_2 conversion and capture rates, risk of over-reduction of catalyst is low, and the benefits of the isothermal reactor will be weighed up by the designer against the requirement for a more complex multi-tube boiling water cooled reactor.* *Methods for environmentally safe disposal and recycle/ recovery of catalyst materials, should be addressed.*
HPP Status
• The risk of soot formation within the LCH technology is eliminated by the selection of a low inlet temperature of the purification stage of the plant and for the ATR the high level of hydrogen (produced in the GHR), the reaction of higher hydrocarbons and the high steam to carbon ratio.. It can be readily detected through the presence of soot particles in process condensate (i.e. through water analysis) It is highlighted that soot formation, were it to occur in the HPP, would not be an issue left in abeyance, as it would have an impact upon the performance of the plant. • The HPP is configured to maximise the heat recovery from the ITS process. The heat of reaction from the water gas shift reaction is transferred to ITS Steam Drum to generate steam. Heat from the resulting syngas (H_2/CO_2/water mix) is transferred to process fluids (see Heat Integration and Process Cooling below). • The ITS catalyst – KATALCO 83-5 – is a copper zinc alumina product, not a chromium catalyst. • For catalyst disposal, see Feed Gas Desulphurisation and Pre-reforming above.
Conformance with BAT: ✓

Process CO_2 Capture from Hydrogen Product

Table 3-9 HPP Comparison Against Hydrogen Production BAT Guidance – Process CO_2 Capture from Hydrogen Product

Considerations & Guidance
The solvent [used to capture CO_2 from the hydrogen product stream] *should be selected, and parameters optimised within CO_2 removal system, to maximise energy efficiency and capture performance:* • *Lean solvent conditions and absorber system design for high degree of CO_2 capture to meet overall carbon capture objectives and reduce load on downstream hydrogen purification.* • *Operation of regeneration system to deliver CO_2 at as high a pressure as practical (with pressure limited by operating temperature considerations to avoid excessive degradation of solvent), and avoidance of excessive pressure loss in CO_2 product system, to reduce CO_2 compression power requirements.* • *Optimisation of lean/ rich solvent heat exchange to reduce reboil heat requirements for solvent regeneration.* *Consider technologies which reduce heat requirements for solvent regeneration, such as producing a semi-lean solvent stream for bulk removal in the bottom section of the absorber. Such techniques increase overall solvent circulation and pumping requirements, but reduce heat requirements for full thermal regeneration of the solvent.* *Consider technology which allows recovery of CO_2 at higher pressure, e.g. solvent systems with flash regeneration of a portion of CO_2 at intermediate pressure, the benefits of which are dependent on the operating pressure of the reforming process and CO2 absorber.* *Absorber design should minimise carry-over of solvent, e.g. through water wash and/ or demisting, to minimise impact on the downstream hydrogen purification process and associated product and off-gas streams.* *The overhead condenser/ reflux system and section above the feed on the solvent regeneration column will minimise potential for solvent to reach the CO_2 product. Requirements for continuous purge from the reflux system to avoid build-up of components such as methanol which may be co-produced in the hydrogen production process should be considered, such that this can be managed within effluent treatment facilities.* *Consider low temperature bulk separation of CO_2, with condensation and separation of a portion of CO_2 for delivery at elevated pressure. This has potential to reduce load on the downstream solvent based system, and its associated heat requirements, and also reduce CO_2 compression requirements. Pre-treatment of feed gas to a low temperature separation will be required to remove water which would otherwise freeze in the process.* *Requirements for CO_2 venting when downstream systems are not available should be considered, including requirements for an elevated local vent stack designed to optimise dispersion. Potential for atmospheric emission of solvent or associated substances should be low in such circumstances, but measures taken to mitigate this, such as ensuring continued operation of the regenerator overhead condenser and reflux system, should be identified.* *Continuous CO_2 venting should not be planned as a normal operating mode, but when required in transient operation for control and to avoid wider disruption of the process, or when required temporarily in emergency operation. Where venting is required from high pressure CO_2 systems, where there is a significant cooling effect on pressure reduction, the measures taken to ensure adequate atmospheric dispersion should be identified.*
HPP Status
• The CO_2 Removal unit technology is based on the OASE® Process licensed from BASF. • The objective of the unit is to remove CO_2 from the syngas downstream of the ITS Converter such that concentration of CO_2 in the treated gas sent to the PSA will be less than 0.1% mol, and the concentration of the CO_2 in the gas sent to the CO_2 Compression Unit is greater than 95% molar. This will be achieved by an absorber using a solution of lean OASE® (Amine). The unit performance requirements are reflected in the HPP mass balance tables for each of the plant operating cases. Cont'd

Considerations & Guidance	
• The CO_2 Removal unit has a number of features aimed at optimising environmental performance: - The CO_2 Absorber has been provided with a down-stream Treated Gas Knock-out Drum to reduce losses of amine to the PSA unit. A downstream charcoal filter has also been recommended to further reduce amine carry-over. The benefits conferred by such a filter will be evaluated at the Project's EPC stage. Preventing losses not only reduces the chemical's consumption, but also prevents its transfer to the Feed Fired Heater and Steam Boiler (via the PSA Unit and its tail gas production), and thus limits NOx production through amine combustion. - Heat used in the amine reboiler is recovered from the syngas (see Heat Integration and Process Cooling below) whereas steam is usually used for this heating duty. This represents beneficial heat transfer between two technology packages (the reformer and the CO_2 removal system) implemented by the project. - The Project has adopted a smaller driving temperature in the heat exchangers (5ºC compared with 10ºC). This smaller "pinch point" has maximised heat recovery albeit at the expense of the physical size of the heat exchangers. - High pressure amine flashing (in the HP Flash Column) has been incorporated to maximise H_2 recovery.	
Conformance with BAT:	✓

CO_2 Capture Rate

Table 3-10 HPP Comparison Against Hydrogen Production BAT Guidance – Hydrogen Product Purification

Considerations & Guidance	
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 SMR hydrogen production with post-combustion capture, this is consistent with expectation for CO_2 capture using amine-based technologies for power and CHP plants.* • *For ATR or POX hydrogen production, the 95% or greater CO_2 capture rate is dependent on high conversion of the methane to CO2 through the reforming and CO shift sections, and near full removal of CO_2 from the hydrogen product, both of which are considered feasible.* *If a design CO_2 capture rate of less than 95% is proposed, justification will need to be provided by the applicant.* *In operation, the actual CO_2 capture rate may vary, depending on the operating regime.*	
HPP Status	
The HPP design CO_2 capture rate is 97%.	
Conformance with BAT:	✓

Hydrogen Product Purification

Table 3-11 HPP Comparison Against Hydrogen Production BAT Guidance – Hydrogen Product Purification

Considerations & Guidance
[Regarding hydrogen purification] *It will be necessary to consider:* • *Nitrogen and Argon – present in feed gas or oxygen supply.* • *Methane – which is not converted to CO in the reforming section.* • *CO – which is not converted to CO_2 in the reforming or CO shift sections.* • *CO_2 – which is not removed in the CO_2 capture section.* • *Water – with the hydrogen stream saturated with water following CO_2 capture.* *Where gas specification allows, consider methanation (conversion of CO to CH_4) as an alternative to separation of contaminants. In this case, it is likely there will remain a requirement for dehydration to meet moisture specification, with methanation reaction introducing additional water.* *Shutdown procedures for methanation reactors to prevent formation of toxic nickel carbonyl from reaction of CO with the nickel catalyst at lower temperatures will need to be employed in line with operating experience and established procedures.* *Where hydrogen is produced with the intention of blending externally with natural gas, the impact of blending on the overall specification should be considered, with dilution of contaminants, and ability to relax hydrogen purity to enhance energy efficiency and eliminate production of low pressure/ low calorific value off-gas streams.*
HPP Status
• The PSA has been designed to remove the impurities from the product hydrogen stream and bring it to export specification for a range of operating cases. The feed gas stream composition for the maximum normal flow case is as follows (all figures are mol %): Methane: 0.27 N_2: 1.75 Hydrogen: 97.03 Water: 0.34 CO: 0.59 Methanol: 0.00 CO_2: 0.01 Ammonia: 0.01 The feed gas for the other operating cases – Normal operation and hydrogen recovery, Minimum flow and minimum hydrogen recovery, and Maximum inlet nitrogen concentration – have similar compositions. Consideration has therefore been given to the gases mentioned. • The concentration of CO in the gas from the CO_2 removal process is too low to make methanation a practical consideration, putting aside any energy efficiency benefits or disbenefits. • The down-stream blending of hydrogen is not within the scope of the HPP project. • The hydrogen purity can be relaxed to approximately 98%, depending on operating case. However, the resulting impurities present within treated gas stream (e.g. CO) can render the hydrogen unsuitable for a number of end-uses such as transportation fuel.
Conformance with BAT: ✓

Off-gas Production from Hydrogen Purification

Table 3-12 HPP Comparison Against Hydrogen Production BAT Guidance – Off-gas Production from Hydrogen Purification

Considerations & Guidance	
Off-gas produced from hydrogen purification will be rich in hydrogen (from depressurisation and purge of the adsorber vessels) and will contain nitrogen from feed gas, argon from oxygen supply, and any methane, CO, and CO_2 that is not converted/ removed upstream. The off-gas is normally used as fuel gas. *In the case of processes with ATR or POX (partial oxidation) reactions, which do not employ post-combustion capture, slip of methane or CO from the reforming and CO shift stages removed in hydrogen purification will end in the off-gas used as fuel and hence will represent uncaptured CO_2. Conversion rates in the process should be optimised to meet CO_2 capture objectives balanced with other environmental performance factors, such as overall energy use.*	
HPP Status	
• The PSA unit will produce a tail gas which will be used as an essentially decarbonized fuel in the Feed Fired Heater and Steam Boiler. • The gas will comprise predominantly H_2 (89.2 mol%) together with CO (4.16 mol%), methane (2.20 mol%), N_2 (1.86 mol%) and water (2.47 mol%). Nominal amounts of CO_2 (0.06 mol%), methanol (0.02 mol%) and ammonia (0.03 mol%) will also be present. The figures given are for the NG BOL case. The gas composition for the NG EOL case will be almost identical. The addition of ROG to the HPP feed will increase the N_2 content of the PSA tail gas by approximately 10% points and reduce the H_2 content by a similar amount. • The total mass of CO_2 arising from the combustion of the PSA tail gas in the Feed Fired Heater and Steam Boiler is 1,986 te/h (NG BOL case). This equates to 2.54% of the total CO_2 equivalent delivered to the plant as NG (78,162 $kgCO_2eq$).	
Conformance with BAT:	✓

Heat Integration and Process Cooling

Table 3-13 HPP Comparison Against Hydrogen Production BAT Guidance – Heat Integration and Process Cooling

Considerations & Guidance
Within the hydrogen production process, heat integration will typically be through gas/ gas exchange, including in gas heated reformer where used; or through heat recovery for steam generation and superheating, including demineralized and boiler feed water heating. *Heat recovered through process cooling downstream of the reforming section, to condition the temperature for CO shift reaction, is at high grade and can be used for both direct heat integration within the process and producing steam at higher pressure levels for use in the process.* *Heat recovered in condensation of water downstream of the CO shift reactor will be at lower grade, but at suitable temperature for use in CO_2 capture process using amine solvents. Recovery should be optimised through a suitable medium such as low pressure steam, or through direct transfer with syngas, to suit the CO_2 capture process, this providing an opportunity for improved overall thermal efficiency.* *There will ultimately be a need to cool further against ambient air or cooling water, but opportunities should be maximised to use the heat, for example in heating demineralized and boiler feed water.* *Selection of ambient cooling medium – e.g. air cooling, indirect sea water cooling, open (evaporative), closed or hybrid cooling circuits – should account for any impact of cooling temperature on process performance or energy efficiency, such as intercooling temperature on power requirements for compression.* *Where the hydrogen production process has potential to produce excess high pressure steam, consideration should be given to how this is used most efficiently to generate electrical power or drive mechanical equipment such as compressors within the process. Heat integration to make best use of lower grade heat, as described above, may provide additional opportunities for more optimal use of high pressure steam.*
HPP Status
Cont'd overleaf

Considerations & Guidance

- The HPP has a range of plant and heat exchangers aimed at heat integration:

Unit	Purpose
Steam Boiler (Tail Gas-Fired)	• Pre-heating boiler feed water (BFW) (via BFW Pre-heater) • Producing MP steam from the BFW (via the MP Steam Boiler) • Superheating saturated steam from the MP Steam Drum (via MP Steam Superheater)
Feed Fired Heater (Tail Gas-Fired)	• Pre-heating **LCH** Plant feed gas (via Purification Pre-heater) • Heating the mixed feed (water/ methane mix) from the Saturator (via Mixed Feed Pre-heater)
GHR/ ATR	Heat exchange between hot reformed gas leaving the ATR to the mixed feed in the GHR.
Oxygen Pre-heater	Pre-heating the 99.5% oxygen supplied from the ASU. Heat exchange against saturated steam from the MP Steam Drum.
Saturator Water Heater No.2	Heating water from Saturator Water Heater No.1. Heat exchange against hot reformed gas from the GHR.
ITS Converter	Generating steam in the ITS Steam Drum from the heat of reaction from the water gas shift reaction.
Saturator Water Heater No.1	Heating the water circulating from the Saturator. Heat exchange against hot syngas exiting the ITS Converter.
Process Condensate Pre-Heater	Heating the water condensate removed from upstream of the CO_2 Removal Unit prior to its return to the Saturator. Heat exchange against hot syngas downstream of Saturator Water Heater No.1.

Unit	Purpose
Syngas CO_2 Regeneration Reboiler	Heating the reboiler liquids circulated from the CO_2 Removal Unit. Heat exchange against hot syngas downstream of Process Condensate Pre-Heater.
Demin Water Heater	Heating the demin water prior to its discharge to the Deaerator and entry into the Steam System. Heat exchange against hot syngas downstream of Syngas CO_2 Regeneration Reboiler.

Cont'd

Considerations & Guidance

- The HPP will be provided with a closed-circuit air-cooled Cooling Medium System to meet residual plant cooling requirements post-heat transfer between process fluids. The system will provide cooling to the following:

Unit	Purpose
Final Syngas Cooler	Cooling of syngas upstream of the Second Knock-out Pot, prior to the CO_2 Removal Unit.
Product Hydrogen Cooler	Cooling of H_2 product prior to delivery to the H_2 Export Pipeline.
Blowdown Cooler	Cooling of (steam) blowdown from the MP and ITS steam drums before routing to treatment (see Process Effluent Collection).
Saturator Blowdown Cooler	Cooling of (steam) blowdown from the Saturator before routing to treatment.
CO_2 and ROG Compressor Coolers	Cooing of CO_2 and ROG Compressors.
Condensate Cooler	Cooling of condensate (water) removed upstream of the CO_2 Removal Unit before routing to treatment.

- The HPP will be managed such that it will produce sufficient steam for its requirements. It will not produce excess HP steam, and consideration of steam usage for electrical power generation, etc does not therefore arise.

Conformance with BAT:	✓

Combustion

Table 3-14 HPP Comparison Against Hydrogen Production BAT Guidance – Combustion

Considerations & Guidance
Requirements for fired equipment to provide heat to the process and generate steam is dependent on the reforming process. It can present a practical means of disposal of low pressure off-gas stream from hydrogen purification, for example using tail gas from a pressure swing adsorption process as fuel and balancing overall process heat requirements. It introduces a source of atmospheric emissions. *In the case of autothermal reforming, where the majority of heat is provided by reaction with oxygen within the process, there is a lesser requirement for heat from auxiliary furnaces or boilers and it is most likely that this can be satisfied by combustion of hydrogen rich off-gas streams or hydrogen product.* *Hydrogen combustion produces higher flame temperatures than methane combustion and has potential for higher thermal NOx formation from reaction of nitrogen and oxygen.* *Where hydrogen or hydrogen enriched fuel gases are combusted, techniques to control flame characteristics and reduce NOx formation should be considered. This may include specially designed burners, flue gas recirculation or heat exchange with fuel/ air.* *Variation of fuel gas composition, particularly hydrogen content, needs to be considered, including any requirements to switch between fuel gas sources. Start up and shut down operations should be considered, as PSA tail gas will not be available for example when the plant is ramping up to minimum flow, and any fuel will be taken from methane feed.* *Other established techniques such as Selective Catalytic Reduction (SCR) or Selective Non-catalytic Reduction (SNCR) may need to be considered if NOx formation in combustion gases cannot be reduced to acceptable levels, considering environmental risk to air quality and any prescribed emissions limits.* *The emission levels for the combustion equipment in the scope of the hydrogen production and CCS plant will need to be identified from the existing sources of statutorily applicable emission limits, including the following:* • *Medium Combustion Plant Directive* • *Industrial Emissions Directive, Annex V* • *BAT Conclusions and BRef for the Refining of Mineral Oil and Gas* • *BAT Conclusions and BRef for Large Combustion Plant* • *BRef for Large Volume Inorganic Chemicals (Ammonia and Fertilisers)* *This in accordance with the type of combustion equipment, fuels proposed to be combusted, net rated thermal inputs, Best Available Techniques for control of emissions, and the conclusions of an environmental risk assessment, considering the dispersion of pollutants into air and the sensitivity of the relevant receptors.* *Given that supply of oxygen is required for some hydrogen production processes, additional oxygen production to support oxy-combustion may be considered. Removing the source of nitrogen from combustion air would avoid NOx formation, but experience in design and operation of such combustion systems is limited, particularly for combustion of streams rich in hydrogen. Any nitrogen present in the PSA tail gas would also need to be considered, as fuel NOx would then still be formed, and this route may not be effective. Also the impacts of increasing the size of the ASU to supply additional oxygen would need to be considered.*
HPP Status
• The **LCH** Plant is based around GHR/ ATR technology. The plant will have two principal combustion units, the Feed Fired Heater and the Steam Boiler, both of which will be fired on (sulphur-free) PSA tail gas under normal operating conditions (and NG during start-up and shutdown). Both combustion units have been designed to meet a NOx emissions limit of 80 mg/Nm3 without the need for De-NOx systems (either Selective Catalytic Reduction [SCR] or Selective Non-catalytic Reduction [SNCR]). • Low NOx burners are specified for both the Feed Fired Heater and Steam Boiler. Flue gas recirculation is not considered appropriate, due to the additional complexity this adds to designs which already provide good NOx control. Cont'd

- PSA tail gas composition varies slightly across plant life and also according to the primary feed gas, with a 10% higher H_2 content during NG feed (although this will only occur for a small proportion of the life of the plant (approximately 18 hours in a 4 year cycle). NOx emissions will remain within 80mg/Nm^3 during this operating regime.
- Emission levels are considered in the context of applicable legislation and BAT requirements in section 6.2.
- Air dispersion modelling presented in Appendix A2.0 of this application document has demonstrated that the combustion gas emissions from the Feed Fired Heater and Steam Boiler will not present a significant risk to air quality.
- As air impacts do not present a significant impact, and as emissions are within BAT AELs (see section 6.0), there is no need to install secondary NOx control measures (SCR or SNCR), particularly as these measures have the potential disadvantages of:
  - increasing process complexity;
  - increasing space requirements, CAPEX and OPEX;
  - increasing the risks associated with raw materials storage and potential spills/ release of ammonia or urea; and
  - presenting a risk of ammonia slip in air emissions.
- In the context of the low significance of the HPP's atmospheric emissions, and the limited operational experience, options around oxy-combustion have not been considered.
- A third source of combustion gas emissions is the emergency generator. However, it is not considered to be a significant source on the basis of its capacity and infrequent operation. Low-sulphur diesel fuel will be selected as this provides a diverse and self-contained fuel source for emergency operation in the event of a loss of electrical power to the plant. The selected engine will be a new, modern diesel generator unit with equipped with an Electronic Control Unit (ECU). This primary technique for combustion control is regarded as BAT for emergency diesel generators.

Conformance with BAT:	✓

Table 3-15 HPP Comparison Against Refining of Mineral Oil and Gas BAT Conclusions – Combustion

BAT 34 Conclusions	HPP Status
NOx - Primary Measures	
Fuel selection	The PSA tail gas is a low-carbon fuel, and the beneficial use of a process co-product improves process efficiency. The fuel is a clean gaseous fuel which has low particulate and impurity levels and is essentially sulphur-free. Any amine carry-over from the CO_2 Removal Unit is removed through the use of a knock-out pot at the top of the CO_2 stripper, followed by a carbon filter (proposed). Together with combustion control measures and other primary measures identified below, this ensures that NOx and other emissions of combustion products are well controlled, are within BAT AELs and do not give rise to any significant environmental impacts.
Combustion control	Process controls will include monitoring and management of combustion process parameters to ensure efficient combustion.
Air control - primary and secondary	The burners specified for both the Feed Fired Heater and Steam Boiler are modern units which provide combustion air mixing and staging.
Flue gas recirculation	Flue gas recirculation is not considered appropriate, due to the additional complexity this adds to designs which will provide good NOx control.
Low-NOx burners	Low NOx burners are specified for both the Feed Fired Heater and Steam Boiler.
NO_x - Secondary measures	
SCR/SNCR	Not required or considered appropriate- see Table 3-14.
SOx	
The use of low-sulphur fuel	The feed gas is treated to remove sulphur compounds (see s. 2.2), meaning the PSA tail gas is essentially sulphur-free. Un-odorised NG has very low levels of sulphur.
Secondary measures to abate SOx emissions	Primary measures to control the sulphur content of the fuel are regarded as BAT, no further measures are required.
Particulates	
Use of gaseous fuel	PSA tail gas is a processed, clean gaseous fuel; particulate emissions are inherently controlled by the nature of the fuel.
Combustion controls	Combustion controls will ensure efficient combustion and control particulate emissions.
Secondary measures to abate particulates	Primary measures to control the nature of the gaseous fuel and combustion controls are considered BAT, no further measures are required for gas-fired plant. Cont'd

Carbon Oxides and VOCs	
Oxides of Carbon	Emissions of CO_2 will be reduced through the use of a low-carbon fuel (PSA tail gas) and managed by energy efficiency techniques which reflect BAT. CO emissions will be minimised through the use of combustion control measures to ensure efficient combustion.
Volatile Organic Compounds (VOCs)	The combustion control system will ensure efficient control of these pollutants the emissions of which would, in any case, be limited by the specification of the PSA tail gas and the composition of NG.
Conformance with BAT:	✓

Oxygen Production

Table 3-16 HPP Comparison Against Hydrogen Production BAT Guidance – Oxygen Production

Considerations & Guidance
Oxygen purity should be optimised, considering both the impact on the specific power required for oxygen production and the impact on the requirements for removal of argon/ nitrogen in purification of the product hydrogen. High purity of 99.5 mol% oxygen is typically achievable economically in large scale cryogenic air separation, the balance then being argon. *Co-production of nitrogen and argon should be considered where there is local demand, where this reduces overall energy requirements. Nitrogen may also be required routinely on site (e.g. for blanketing following a trip, continuous purging, or purging following maintenance).* *Energy consumption in the ASU should be optimised through flowsheet selection and efficient machinery selection. It is typical for oxygen to be pumped to required delivery pressure, avoiding an oxygen compressor, with air being compressed and fed to the unit at multiple pressure levels. The ASU and associated air compressor design should be optimised around the oxygen purity and supply pressure requirements of the hydrogen production process.* *Heat requirements for regeneration of adsorbers used for drying and purification of compressed air should be optimised, including the best technique for chilling the air to condense and separate water upstream.* *Use of dry waste gas to produce chilled cooling water though absorption cooling should be considered where can be used advantageously in the process.* *Opportunities for recovery and use of heat from the air compression system should be considered if this can be matched with demand within the process. and if this is practical from a technical and commercial perspective, given that the oxygen may typically be supplied from a stand-alone plant by a third party.* *The form of heat integration should be selected to avoid additional hazards (e.g. through combining oxygen production and hydrocarbon streams).* *Reduction of the number of compressor cooling stages to increase the compressor discharge temperature and grade of heat available is an option but will also increase compressor driver power requirements.* *High availability of oxygen supply should be targeted, for example by having parallel equipment or a back up supply, recognising that interruption of oxygen supply will impact the hydrogen production process, with any commercial and environmental consequences associated with restart following shutdown such as venting or flaring. The capacity of liquid oxygen production, storage and vaporisation should be optimised to provide back-up to gaseous oxygen production accordingly.*
HPP Status
• The HPP (Phase 1) will be provided with a single dedicated cryogenic ASU capable of providing oxygen at a purity of 99.5 mol%. The unit will also supply nitrogen (99.9 mol% purity), and plant and instrument air. • Vendor quotations for the supply of the ASU state electrical power demands of between 13.1 MW and 15.7 MW, with an average of 14.4 MW, with in one case a small additional demand for steam. All had comparable demands for cooling water. • For safety reasons (to eliminate the potential for the mixture of flammable gases) the ASU will not be integrated with the wider HPP, and will occupy a geographically separate area from the main process plant. This safety requirement takes priority over any opportunities for the recovery and use of heat from the air compression system. • The ASU will be provided with a back-up liquid oxygen and nitrogen supply.
Conformance with BAT: ✓

Waste Water Treatment and Water Reuse

Table 3-17 HPP Comparison Against Hydrogen Production BAT Guidance – Waste Water Treatment and Reuse

Considerations & Guidance
Water/ steam is both consumed in the hydrogen production process and used as a medium for recovery and transfer of heat. Water is therefore condensed both from the steam being used as a utility and from cooling of streams within the process. *By-products of the hydrogen production process, such as methanol and ammonia, which are expected to be present in condensed water from the process should be identified and quantified.* *A large proportion of water condensed in the process can be re-used, but there is a need to release some water to effluent to avoid build-up of dissolved solids or other contaminants.* *For condensed water that is to be reused following treatment, any processing requirements for contaminant removal to allow reuse need to be identified, and any effluents and emissions from the proposed processes defined.* *Requirements to remove dissolved gases, including CO_2, from the boiler feed water to reduce corrosion should be identified together with associated emissions to atmosphere associated with this deaeration.* *For condensed water directed to effluent, contaminants need to be identified to allow an appropriate strategy to effluent treatment to be developed, together with any other effluents from within the facilities.* *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.* *Water consumption and volume of contaminated water should be minimised by through design of the hydrogen production process, optimisation of water management through segregation of contaminated water streams (from water wash, condensate) and of non-contaminated water streams (once through cooling, rain water).* *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.*
HPP Status
• The bulk process effluent recycled via the Closed Drains Drum – i.e upstream of the Membrane Biological Reactor (MBR) – has been characterised. Ammonia, methanol and amine are shown as constituents of the effluent at concentrations of 183 mg/l, 3308 mg/l and 10.7 mg/l respectively (see Table 2-5). • The HPP condensed process waters, together with rain water harvested via the open drains system, will be: i) treated in the MBR, ii) mixed with clarified river water (a United Utilities supply) and clarified in the Dual Media Filtration Plant, and iii) demineralized in the Water Demineralization Plant (a proportion of the water bypasses this final stage and is routed to process uses). The only loss from the HPP Water Systems will be the reject water from the Water Demineralization Plant the composition of which is shown in Table 2-6. This water will flow to the wider Essar Refinery site via the CT2 open sump, N38 interceptor and out through the existing W3 outfall. The effluent stream will meet the ELVs as listed in the Essar Refinery Permit (EPR/FP3139FN/V010) [1] which are derived from the BAT Conclusions for Refining of Mineral Oil and Gas [9]. • Contaminants present in the recycled process waters will be removed in the MBR. The composition these waters – i.e. the MBR feed – and the resulting treated effluent are shown in Table 2-5. The MBR will produce a sludge that will be forwarded for thickening (centrifugation) and disposal off site. At the at the present time the MBR sludge is uncharacterised. The disposal route has also to be confirmed. • The suspended growth biological treatment and membrane filtration employed in the MBR are both techniques referred to as BAT in BAT 12 of the CWW BREF [8]. • The HPP's water consumption has been minimised through recycle of the process condensate streams and the harvesting of rain water falling within the process area (recovered via the open drains system). • The conformance of the HPP with the Common Waste Water and Waste Gas Treatment/Management System and Refining of Mineral Oil and Gas BAT Conclusions documents in relation to waste water is set out in Tables 3-18 and 3-19.
Conformance with BAT: ✓

3.6.1 The BAT for Hydrogen Production [2] states that water treatment should follow the existing BAT Conclusions for Common Waste Water and Waste Gas Treatment [8] (see Considerations & Guidance in the table above). Conformance with this latter guidance is addressed in Table 3-18.

Table 3-18 HPP Comparison with the Common Waste Water and Waste Gas Treatment/Management System BAT Conclusions Document

BAT Conclusion	Techniques	Justification
BAT 2	Environmental management systems 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 that incorporates all of the following features: i) information about the chemical production processes, ii) information, as comprehensive as is reasonably possible, about the characteristics of the waste water streams, and iii) information, as comprehensive as is reasonably possible, about the characteristics of the waste gas streams.	The influent water streams processed by the HPP – process water streams recovered and recycled via the Closed Drains System, harvested rain water, and raw (river) water supplied by UU – are described above under "HPP Water Systems". For each stream the temperature, pH, flow rate and composition (with respect to TSS, COD, BOD, ammonia, methane, CO_2, N_2, methanol and amine, where relevant) are listed in the Water Balance. Some TSS is introduced into the HPP Water Systems via river water, and the harvested rain water introduces additional TSS and COD (although the bulk of the COD is removed from the rain water by de-oiling in the CPI). However, the preponderance of the pollutants treated in the water systems arises from the H_2 production and CO_2 removal processes as described in Section 2.
BAT 3	Monitoring For relevant emissions to water as identified by the inventory of waste water streams, 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).	The HPP Water Systems will produce a single liquid effluent, the demin plant saline effluent, the composition of which is shown in Table 2-6. This stream will not be discharged directly to water, but will be transferred to the refinery from where it will ultimately be released to the Manchester Ship Canal via permitted emission point W3 [1]. Periodic process monitoring of the transfer stream will be carried out to record its flow rate, temperature, pH, TSS and COD (i.e. those parameters covered by the refinery's existing Environmental Permit).
BAT 4	Monitoring BAT is to monitor emissions to water in accordance with EN standards with at least the minimum frequency given [in the BAT Conclusions table]. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.	The monitoring of the demin plant saline effluent process stream referred to above will follow the methods and frequency referenced under Emission Point W3 in Table S3.2(a) of Essar's existing Environmental Permit [1]. The frequency of monitoring is to be determined.

BAT Conclusion	Techniques	Justification
BAT 7	Water usage and waste water generation 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.	The usage of raw water and the generation of waste water have both been reduced through the recovery and recycling of process water streams, and the harvesting of rain water. The influent water flows for Phase 1 comprise; i) river water – 73.8 m^3/h, ii) recycled process waters – 36.2 m^3/h, and harvested rain water – 1.7 m^3/h (on average). The process recycle and rain water streams thus comprise slightly over 33% of the influent. It is noted in passing that there is no in-principle requirement to recycle the process streams; the HPP could function perfectly on 100% raw water.
BAT 8	Waste water collection and segregation 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.	The issue of segregating uncontaminated waste water streams is not relevant to the HPP. However, it is noted that water treatment is specific to each influent stream. For example, it is only the harvested rainwater that requires de-oiling (in the CPI), and the raw (river) water, given its relatively unpolluted nature, does not require treatment in the MBR; it is mixed with the combined process recycle and rain waters only after that unit. Furthermore, not all of the treated water requires demineralization: filtered but undemineralized water is used in the ASU, in the dewatering centrifuge, for dosing purposes, and as fire water. Clean surface water from the wider HPP area that isn't harvested will be drained and discharged to join the existing refinery drainage system, discharging to the United Utilities WWTP via point S1.
BAT 9	Waste water collection and segregation 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).	The HPP Water Systems will contain two tanks which will provide a degree of buffer storage: the Waste Water Blending Tank which will be upstream of the MBR and receive recovered (dirty) process water streams, and the Clarified Water Tank which will receive clarified water upstream of the Dual Media Filtration Plant. Both tanks will have a one hour working volume for Phase 1 & 2, or three hours for Phase 1. Were the HPP to incur a serious outage such that the MBR could not process the recycled effluents to the necessary specification, the HPP would be shut down and the waste waters tankered off site for treatment. Within the HPP design there is no fixed facility for the transfer of dirty process waters to the refinery for treatment. Fire water storage will be incorporated into the design of the HPP in order to collect fire water run-off in the event of a fire.

BAT Conclusion	Techniques	Justification
BAT 10	Waste water treatment 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: a) Process-integrated techniques, b) Recovery of pollutants at source, c) Waste water pre-treatment, and d) Final waste water treatment.	As mentioned under BAT 2 above, the pollutants handled in the HPP water systems arise from the main process. There is little realistic scope either to prevent or reduce their generation, or recover them prior to waste water collection. The HPP water management strategy is therefore based around treatment for recycle. The HPP water treatment process comprises following sequence of techniques: i) De-oiling (for the rainwater only), ii) Clarification (for the raw water), iii) Biological treatment in the MBR, iv) Filtration, and v) Demineralization.
BAT 11	Waste water treatment 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.	The water pollutants handled by the HPP can be treated effectively by the proposed system. The HPP water treatment processes will ensure a demineraliser plant saline effluent which can be discharged via emission point W3 without the need for further treatment.
BAT 12	Waste water treatment In order to reduce emissions to water, BAT is to use an appropriate combination of final waste water treatment techniques.	See response to BAT 10.
Conformance with BAT:		✓

3.6.2 The conformance of the HPP with the Refining of Mineral Oil and Gas BAT Conclusions document [9] in relation to waste water is set out in Table 3-19.

Table 3-19 HPP Comparison with the Refining of Mineral Oil and Gas BAT Conclusions – Water Consumption and Waste Water

BAT Conclusion	Techniques	Justification
BAT 11	Emissions to water In order to reduce water consumption and the volume of contaminated water, BAT is to use all of the following techniques: i) Water stream integration, ii) Water and drainage system for segregation of contaminated water streams, iii) Segregation of non-contaminated water streams (e.g. once-through cooling, rain water), and iv) Prevention of spillages and leaks.	This BAT issue is largely addressed by BAT 8 and BAT 10 in Table 3-18. See above. Regarding the prevention of spillages and leaks, the Environment Agency's assessment of Essar's current capability in this regard, given in the Decision Document for V009 of the Essar Permit, [11] states: "*The installation has existing risk-based inspection procedures. In addition, there is spill kit and emergency procedures. Interceptors are actively de-sludged".* The existing procedures and spill kits will be reviewed and expanded, as necessary, to incorporate the new HPP.
BAT 12	Emissions to water In order to reduce the emission load of pollutants in the waste water discharge to the receiving water body, BAT is to remove insoluble and soluble polluting substances by using all of the following techniques: i) Removal of insoluble substances by recovering oil, ii) Removal of insoluble substances by recovering suspended solids and dispersed oil, and iii) Removal of soluble substances including biological treatment and clarification.	This BAT issue is addressed by BAT 3, BAT 10 and BAT 11 in Table 3-18. See above.
BAT 13	Emissions to water When further removal of organic substances or nitrogen is needed, BAT is to use an additional treatment step: i) Removal of insoluble substances by recovering oil, ii) Removal of insoluble substances by recovering suspended solid and dispersed oil, iii) Removal of soluble substances including biological treatment and clarification, and iv) Additional treatment step.	This BAT issue is addressed by BAT 10 and BAT 11 in Table 3-17. See above.
Conformance with BAT:		✓

Reliability and Availability

Table 3-20 HPP Comparison Against Hydrogen Production BAT Guidance – Reliability and Availability

Considerations & Guidance
Environmental impacts of equipment or systems being unavailable should be identified, with the need for redundancy, buffer storage, etc. considered. *Such impacts within the facility could include for example:* • *Disruption to operation, with flaring required on shutdown and subsequent start-up.* • *Requirement for venting of captured CO_2, for example when downstream CO_2 compression, CO_2 conditioning or export route is not available.* • *Requirement for short term turndown of hydrogen production and flaring of hydrogen if the downstream export route or demand is lower than minimum feasible hydrogen production rate.* • *Loss of performance of emissions abatement systems* *Target availability for systems critical to environmental performance should be established, with proposed configuration supported by reliability, availability, and maintainability assessments.*
HPP Status
• The HPP has a designed availability of at least 93.5% averaged over its lifetime calculated with respect to hydrogen production as a proportion of total requested hydrogen production assuming 8760 h/y operation. The availability takes account of both planned and unplanned maintenance, and includes the reliability of all utilities and services (including the electricity supply). The plant is designed so that no planned outage is greater than 30 days from hydrogen off to hydrogen on (full load to full load). • The main process units will be developed in a phased approach in that there will be a separate **LCH** unit and CO_2 Removal Unit built for each phase of the project. These units and their associated equipment are CAPEX intensive and therefore investment in Phase 1 to support Phase 2 would not be supported. • The CO_2 Dehydration unit has been sized for Phase 1 only as there is no foreseen benefit in oversizing the Phase 1 package for Phase 2. • A single ASU will be provided as part of Phase 1 and sized to handle the total Phase 1 flow. An additional ASU will be added during Phase 2. This arrangement is preferred for ASUs due to their high CAPEX. • A single demineralizer water plant will be provided as part of Phase 1 and sized to handle the total Phase 1 flow. An additional demineralizer water plant will be added during Phase 2. This arrangement was selected as the design of demineralizer plants using RO treatment is highly modularised. • A single WWTP will be provided as part of Phase 1 and sized to handle 100% of the process effluent flowrate from the combined Phases 1 & 2. The reasoning for this is that a significant portion of the site civils work (including drainage systems) will be completed as part of Phase 1. As such, during Phase 1, the WWTP would need to be able to handle, not only the normal process rundown from a single unit, but also the drainage water from a larger area. This means the Phase 1 WWTP would need to be able to process up to 100% of the combined Phase 1 & 2 flowrate. • The ROG Compression package has been sized for Phase 1. Phase 1 will use the majority of the capacity of the dry ROG from the refinery complex. The design of the ROG compression for Phase 2 will thus be very different. For this reason no allowance has been made in the Phase 1 design for the Phase 2 ROG supply. • Two NG compressors (and their associated equipment) will be provided as part of Phase 1. Each will be sized to provide 150% of the Phase 1 flowrate and will operate as duty and spare. During Phase 2 a third, identical, compressor will be added to total three compressors, each capable of supplying 50% of the combined Phase 1 & 2 flowrate (i.e. 2 operating, 1 spare). This arrangement will ensure that multiple compressors are available during all project phases to ensure redundancy. • The flare will be designed with a capacity to relieve the inventory of the future arrangement of two process trains (Phase 1 & 2). A common flare header will serve Phases 1 and 2 with two risers - a wet/warm riser and a cold/dry riser up the common stack. Cont'd

Considerations & Guidance	
• Raw water and electrical supply service connections have been sized for Phases 1 and 2 combined in order that the Phase 1 plant does not require shutting down for the installation of Phase 2. Where tanks are required, a single tank will be provided as part of Phase 1 and will be sized to accommodate the expansions required for Phase 2 without any modification. The reason for this is the much larger plot area required for the provision of two separate smaller tanks. • For most pumps, two pumps will be provided during Phase 1, each sized to handle the entire flowrate of Phase 1 (thus operating as duty and spare). Two further pumps of the same size will be added during Phase 2. • A single exchanger (heaters and coolers) will be provided as part of Phase 1 and sized to handle the total Phase 1 flow. An additional identical type exchanger will be added during Phase 2 for the Phase 2 duty. The exception to this is for the oxygen/ nitrogen vaporisers which are provided as 1 x 100% of Phase 2 flow. When multiple ASUs are available there is redundancy in the supply of O_2/ N_2 therefore multiple vaporisers are not needed. In addition, it is likely only one train will require starting up at a time, therefore there is no requirement to supply multiple trains simultaneously.	
Conformance with BAT:	✓

Flexible Operation

Table 3-21 HPP Comparison Against Hydrogen Production BAT Guidance – Flexible Operation

Considerations & Guidance
Until sufficient hydrogen supply, hydrogen demand or hydrogen networks and storage capacity are established, hydrogen production plants may be required to provide flexible operation to balance variation in demand by hydrogen users. *It is expected that all hydrogen production plants will provide a level of flexibility, at least for example in terms of production capacity range.* *The need for high levels of flexibility will affect design and operation, with impacts such as:* • *A greater need for intermittent CO2 venting and feed gas or hydrogen flaring.* • *Greater periods of non-steady state operation with ramp-up and ramp-down of capacity.* • *A need for wider capacity turndown range.* • *More regular shutdown and start-up operations.* • *Lower energy efficiency, with potential need for process simplification and reduced heat integration to improve operability.* • *Reduced energy efficiency when operating at turndown or in non-steady state operation.* • *Additional energy requirements for start-up.* • *Reduced CO2 capture rates, particularly for non-steady state operation.* • *Increased emissions to atmosphere from combustion equipment when operating at turndown or non-steady state operation.* *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:* • *Rapid changes in capacity.* • *Demand for hydrogen below minimum turndown production capacity with the need for hydrogen to be temporarily flared.* • *Start-up following enforced shutdown.* *Considering the plant flexibility requirements and associated operating scenarios, the measures taken to maximise environmental performance should be described by the applicant, including for example process and equipment design, selected equipment capacities, and process control strategies.* *On the expectation that the flexibility needed from hydrogen production plants may reduce over time, the applicant should also demonstrate a strategy for maximising performance when such flexibility is not required.*
HPP Status
• The HPP is optimised for steady state operation at high throughputs in order to get return for the CAPEX invested in the project. However, it is recognised that there must be flexible operation to match the market served by Low Carbon Hydrogen. • The plant shall achieve a ramp up rate of at least 1%/minute and a ramp down rate of between 2%/minute and 5%/ minute. These rates are a balance between needing flexibility on hydrogen production whilst having a rate of variation of CO_2 production that can be accepted by the transport and storage system. • The whole plant shall be capable of turning down to 40% of maximum hydrogen output. (It is recognised that this will have implications for the design of the oxygen utility system). • There are no constraints on time to start-up or shut down other than those to achieve the required availability. • The plant has been designed to meet the basis of design, with equipment selection suitable for the range of duties required. Generally, for the phase 1 plant, the equipment is specified for 100% flow, and capable of turndown, as opposed to 2 x 50%, or 3 x 33% units.
Conformance with BAT: ✓

Flaring

Table 3-22 HPP Comparison Against Hydrogen Production BAT Guidance – Flaring

Considerations & Guidance	

Strategies to reduce flaring and associated emissions should be established, including:
• *Plant design to maximise equipment availability and reliability*
• *Minimising emissions under start-up, shutdown, and abnormal operations – Means of achieving this include:*
  ○ *use of flare gas recovery system with adequate capacity,*
  ○ *routing gas that would be flared to alternative users*
  ○ *the use of high integrity relief valves*
  ○ *other measures to limit flaring toother than normal operations*
• *Managing production of off-gas and balance against requirements for fuel gas using advanced process control etc.*
• *Special procedures to define operations, including start-up and shutdown, maintenance work and cleaning.*
• *Robust commissioning and handover procedures to ensure that the plant is installed in line with the design requirements.*
• *Robust return-to-service procedures to ensure that the plant is recommissioned and handed over in line with the operational requirements.*
• *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.*
• *Monitoring and reporting of gas sent to flaring and associated parameters of combustion.*	

HPP Status	
• The HPP flare system has been designed with sufficient capacity for all normal, abnormal and emergency operating conditions arising from Phase 1 and 2 combined. The worst case flaring scenario corresponds to full simultaneous blowdown via all Phase 1 and 2 blowdown valves due to an emergency event. • The issue of availability and reliability is addressed above. • In operation the PSA hydrogen recovery will be increased from BOL to EOL to ensure that there is not an over-production of tail gas which might otherwise be sent to flare. Between BOL and EOL the hydrogen recovery will increase by up to 1 % to balance the fuel requirements of the process. • The flare is designed for smokeless operation without steam assist. • At this stage in the project, detailed design of the flare has not yet been finalised. Further information, where required, can be provided once detailed design has been completed.	
Conformance with BAT:	✓

Table 3-23 HPP Comparison with the Refining of Mineral Oil and Gas BAT Conclusions – Flares

BAT Conclusion	Techniques	Justification
BAT 55	In order to prevent emissions to air from flares, BAT is to use flaring only for safety reasons or for non-routine operational conditions (e.g. start-ups, shutdown).	Flaring operations will be minimised and only used for off-spec operational and emergency conditions.
BAT 56	In order to reduce emissions to air from flares when flaring is unavoidable, BAT is to use the following techniques: i) Correct plant design, ii) Plant management, iii) Correct flaring devices design, and iv) Monitoring and reporting.	The HPP flare will be designed, fabricated and tested as per latest editions of: • API Standard 521: Pressure-Relieving and Depressurizing Systems. (The standard provides guidance, recommendations, and alternatives for the design of pressure-relieving and vapor de-pressuring systems at liquefied natural gas terminals, petrochemical facilities, gas plants, and other petroleum production facilities). • API Standard 537: Flare Details for Petroleum, Petrochemical, And Natural Gas Industries. (The standard specifies requirements and provides guidance for the selection, design, specification, operation, and maintenance of flares and related combustion and mechanical components used in pressure-relieving and vapor-depressurizing systems for petroleum, petrochemical, and natural gas industries).
Conformance with BAT:		✓

Venting and Purging

Table 3-24 HPP Comparison with the Refining of Mineral Oil and Gas BAT Conclusions – Venting and Purging

Considerations & Guidance	
The 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, CO, methane, ammonia vapour or methanol vapour. *Requirements for continuous venting may include for example:* • *Water vapour from CO_2 dehydration systems using circulating tri-ethylene glycol* • *Deaeration of steam condensate/ boiler feed waters* • *Gases from processing of waste water streams* • *Purge of tanks, vent or flare headers* *Requirements for intermittent venting may include for example:* • *CO_2 vented in abnormal conditions, such as when the downstream transportation and storage system is not available, or if the CO_2 does not meet the export specification* • *Venting needed as part of purging equipment as part of maintenance activities* *For each 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. Methane greenhouse gas emissions shall be eliminated as far as practicable.*	
HPP Status	
• Venting and purged tanks are identified in Section 3.7 fugitive emissions to air; where potential sources, identification of substances that may be emitted, and assessment of their likely significance is provided. Sources include: - Steam vents (GHR steam jacket vent and ATR Steam jacket vent, operated continuously) and pressure relief valves on the steam system (only operated during abnormal operation to reduce pressure in steam systems), giving rise to emission of demineralized water with very low concentrations of boiler treatment chemicals); - Vent on the TEG Still Column (vent comprising steam, with methanol emissions reduced to trace levels through use of a condenser); - Steam system deaerator vent (vents incondensable gases from steam system); and, - Vents on the amine, TEG storage and diesel fuel tanks (the latter supplying the emergency generator) comprising low levels of emissions from tank breathing losses. • Information on flaring is provided in Section 2.3 and Tables 3-22 and 3.23.	
Conformance with BAT:	✓

Unplanned Emissions to the Environment

Table 3-25 HPP Comparison Against Hydrogen Production BAT Guidance – Loss of Containment and Leak Detection and Repair

Considerations & Guidance
Loss of Containment *Consideration should be given to the environmental hazards posed by possible accidents and their associated risks specific to the hazards of the materials used, the operation and maintenance of the plant and the processes involved. This should include the practicality of measures to reduce risks and hazards and to respond to any accidents. In comparing the effectiveness of techniques to prevent emissions, consideration should not be limited to looking at normal operations, but also at the possibility of unintentional releases.* *In considering the composition of the fluids that could be released, potential for changes due to degradation during operation should be considered, for example:* *Strategies to the reduce the potential for of loss of containment and minimise environmental impacts should be established, including:* • *Use of special procedures and/ or temporary equipment to maintain performance when necessary to manage special circumstances such as spills, leaks, etc.* • *Use of a risk-based leak detection and repair programme where applicable in order to identify leaking components and to repair these leaks* • *Plant design to facilitate monitoring and maintenance activities by ensuring accessibility* • *Selection of high integrity equipment where available* • *Plant design to maximise inherent process containment features.* ***Leak Detection and Repair*** *A Leak Detection and Repair programme should be proposed, using industry best practice to manage releases from joints, flanges, seals and glands, etc. The proposals shall be appropriate to the capture solvents and other fluids used in the process.*
HPP Status
• The HPP vessels, pipework and components have been designed to appropriate design standards to ensure their integrity and reliability. Bulk storage tanks will be bunded (See Table 2-9). • Adequate containment will be provided for equipment and machinery where liquids may be spilled during operation or maintenance activities (see section 3.7). • Essar has existing procedures to identify and respond to leaks and spills across the Refinery site; these will be extended to included the HPP. • Essar's existing Leak Detection and Repair programme will be extended to include the HPP (see Table 8-1, POC6).
Conformance with BAT: ✓

3.7 Other BAT Measures

Fugitive Emissions

Fugitive Emissions to Air

3.7.1 Potential sources of fugitive emissions to air are:

- ROG, NG and process/ product gasses in pipework and process vessels;
- Pressure relief valves on the steam system (only operated during abnormal operation to reduce pressure in steam systems); and
- Vents on the amine, TEG storage and diesel fuel tanks (the latter supplying the emergency generator) and any spills of these materials.

3.7.2 Any fugitive emissions of gases may contain:

- VOCs (notably methane and ethane in the ROG, and methane in the NG, with low concentrations of methane in the PSA tail gas – see Tables 2-1 and 3-11 for gas composition);
- CO_2 (from leaks of reclaimed CO_2 containing gases); and
- Steam (demineralized water with very low concentrations of boiler treatment chemicals).

3.7.3 Fugitive emissions to air from liquids may contain:

- VOCs from diesel tank breathing losses, noting that the diesel tank is small (8 m^3) and not refilled frequently, as the emergency generator is only tested infrequently (monthly); and
- Amine or TEG containing nitrogen from the amine and TEG solution storage tanks, noting that these are only used occasionally (for initial filling and storage for plant drain-down) and thus displacement losses are only occasional. In addition, the amine and TEG tanks are under nitrogen blanket and are not open to the atmosphere, but are fitted with pressure valves (operating at a low pressure).

3.7.4 Measures to control VOC emissions are identified in Tables 3-26 and 3-27 below.

Table 3-26 HPP Comparison with the Refining of Mineral Oil and Gas BAT Conclusions – Fugitive Emissions

BAT Conclusion	Techniques	Justification
BAT 3	Solid materials storage and handling In order to prevent or, where that is not practicable, to reduce dust emissions from the storage and handling of dusty materials, BAT is to use one or a combination of the following techniques: i) store bulk powder materials in enclosed silos equipped with a dust abatement system (e.g. fabric filter), ii) store fine materials in enclosed containers or sealed bags, iii) keep stockpiles of coarse dusty material wetted, stabilise the surface with crusting agents, or store under cover in stockpiles, and iv) use road cleaning vehicles.	See Table 3-35 in the Raw Materials Section
BAT 18	BAT conclusions for integrated refinery management In order to prevent or reduce diffuse VOC emissions, BAT is to apply the following techniques: i) limiting the number of potential emission sources, ii) maximising inherent process containment features, iii) selecting high integrity equipment, iv) facilitating monitoring and maintenance activities by ensuring access to potentially leaking components, v) well-defined procedures for construction and assembly, vi) robust commissioning and hand-over procedures to ensure that the plant is installed in line with the design requirements, and vii) Use of a risk-based leak detection and repair (LDAR) programme in order to identify leaking components, and to repair these leaks.	The HPP is designed to relevant industry design standards to limit potential sources of VOC by minimising potential sources of leaks, including minimising the number flanged joints and setting valve performance specifications. Feed and process gas pressure relief valves or vents are routed to the flare system. HPP equipment layout has been designed to enable access for regular inspection and planned maintenance during normal operations, as well as major overhaul in shutdown periods. Essar will develop a Commissioning Plan, containing procedures to manage HPP commissioning, in line with the requirement of the Engineering and Projects Management System. Commissioning procedures will include measures to control fugitive emissions, including pressure testing and other leak detection monitoring, and regular checks of equipment during commissioning. The Commissioning Plan will include the production of formal hand-over documentation and operator training (see Table 8-1, POC6). Essar is establishing a LDAR programme across the existing installation; this will be extended to cover the HPP (see Table 8-1, POC6).
Conformance with BAT:		✓

3.7.5 The measures identified in above and in Table 3-27 also address key requirements in the EA Guidance "*Control and monitor emissions for your environmental permit*" [12] as they relate to the materials stored at the HPP.

Table 3-27 HPP Comparison with EA Guidance "Control and monitor emissions for your environmental permit" - VOCs

Technique	Justification	
• *Enclose any containers on your site* • *Fit equipment to capture VOCs on any vents on your site (such as scrubbers or filters)* • *Install sealed transfer (vapour balance) systems* • *Use sub-surface filling via (anti-syphon) filling pipes extended to the bottom of the container* • *Use floating roof tanks and bladder roof tanks* • *Use tank vent systems that minimise breathing losses, for example pressure/ vacuum valves, and fit knock-out pots where necessary* *If VOCs are released on your site, you must counter the release with techniques like adsorption (using a substance like a solid or liquid to absorb another substance, like a liquid or gas) or condensation (cooling or compressing a liquid to its saturation point) to capture the VOCs.* *You must also prevent vapour and fluid emissions by:* • *Managing inventories* • *Preventing leaks from any pipework or fluid transport systems* • *Using white paint, insulation and active temperature controls to reduce the temperature in any storage tanks*	The amine and TEG tanks are contained under a nitrogen blanket with pressure relief valves. Breathing losses are further minimised as the tanks are only filled or emptied occasionally. Measures to control leaks in pipework are identified in Table 3-25. Process vessels handling amine and TEG include knock-out pots, and downstream flash drums which remove any carried-over amines of TEG from the process gas streams. This is required to ensure the process gasses match the strict criteria set in the H_2 product and CO_2 product specifications (BS 14687-2019 and BS27913-2016). As the amine, TEG and diesel have relatively high boiling points, they are not considered to require further measures for control: such measures are more suited to substances with higher volatility.	
Conformance with BAT:		✓

Odour

3.7.6 Potential fugitive sources of odour from the HPP are:

- ROG upstream of the desulphurisation plant; and
- Sources of VOCs identified above (amine, TEG and diesel), noting that these substances have relatively high boiling points, and have low potential to give rise to odour nuisance.

3.7.7 The measures to control fugitive emissions to air identified in Table 3-26 and 3-27 will also therefore control fugitive odour emissions, and address EA Guidance "*Control and monitor emissions for your environmental permit*" [12].

3.7.8 Potential point source emissions that could otherwise give rise to odour are controlled by the use of regeneration systems and the use of a condenser:

3.7.9 Off-gases from the TEG still column. This stream comprises steam, with CO_2 (23.4 mol %) and methanol (9.5 mol%); there is no residual TEG carry-over as the TEG has been removed in the TEG regeneration system. Proposals to provide a condenser to remove the methanol emission are being pursued by the project. As the off-gases will comprise only CO_2 and trace water, there are therefore no emissions for control, this source has not been identified as a emissions point in Table 6-1. The HPP is therefore not considered likely to give rise to any off-site odour nuisance and there is no requirement for an Odour Management Plan, and Common Waste Water and Waste Gas Treatment/ Management System BAT Conclusion BAT 20 does not apply.

Fugitive Emissions to Water

3.7.10 Common Waste Water and Waste Gas Treatment/ Management System BAT Conclusions BAT 7, 8, 9 & 10, and Refineries BAT Conclusions BAT 11 & 12 apply in part to the segregation and collection of surface water; demonstration of compliance with these BAT Conclusions is shown in Tables 3-18 and 3-19 respectively.

3.7.11 EA Guidance 'Control and monitor emissions for your Environmental Permit' describes further measures for minimising fugitive releases to water; these are addressed in Table 3-28.

Table 3-28 HPP Comparison with EA Guidance "Control and monitor emissions for your environmental permit" – Emissions to Water

Technique	Justification
Emissions to Water *You must make sure any rainfall collection systems are kept separate from areas of the site which are or may be contaminated.* *Make sure your surfaces and containment or drainage facilities are resistant to spilled chemicals.* *Your management system must include a plan about how you will inspect and maintain your surfaces and containment facilities.* *The following are needed to prevent contaminated run off polluting groundwater or surface waters: A waterproof surface, spill containment kerbs, and sealed construction joints.*	Rainfall is collected in the Open Drainage System, which is segregated from the Closed Drainage System which collect process effluents. The Open Drainage System contains two drainage areas; • The "clean system" collects rainfall from areas that are unlikely to contain any contamination, e.g. roads, building roofs, the old tank farm area, and the unpaved southern area of the site, for collection in four sumps (to provide flow attenuation) and discharge at point T1 (CT2, see Plan in Appendix A1.0); • The "potentially contaminated system", which collects runoff from hardstanding in process areas (Process, AGI, ASU & Utilities areas) which drain to individual sumps in each area (4 in total), which allow hold-up before treatment in the Corrugated Plate Interceptor and treatment in the MBR, before being recirculated in the HPP Process.

Technique	Justification
	Process areas (the Process, AGI, ASU & Utilities areas) will be surfaced with high quality reinforced concrete hardstanding with spill containment kerbs and sealed construction joints. Roads and parking areas will have concrete or tarmac surfacing with concrete kerbs. Areas outside the processing areas and roads will have gravel surfacing to aid infiltration as part of the Sustainable Drainage System (SUDS) design. Essar have an existing inspection and maintenance programme which includes tanks, secondary containment, and surfacing; this will be extended to cover the HPP (POC8).
Piping and Drainage *You must design your site so that leaks from underground structures are prevented and any leaks can be detected quickly.* *You must keep a record of the route of any underground drains or pipework on your site.* *If you use oil in your operations, you must fit and maintain oil separators to surface water drainage systems to prevent discharges being contaminated by oil.*	There will be no subsurface bulk storage tanks. The Amine Drain Drum, TEG Drain Drum and Closed Drains Drum are sub-surface; they will be designed to ensure that they are water-tight and the drainage drums will be regularly inspected in accordance with Essar's existing inspection and maintenance programme. The only other sub-surface structures will be the open drains pipework and sealed drainage pits which collect clean and potentially contaminated surface water run-off. The as-built location of drains and sumps and interceptors will be recorded on a site drainage plan. Interceptors will be fitted to areas of the open drainage system that could be contaminated by oils.
Containing Emissions *Your sumps and bunds must be: waterproof, and resistant to any materials you're going to store in them.* *You must make sure sumps and bunds do not become contaminated or blocked as this may cause them to leak.* *You must: check that sumps and bunds are working correctly, for example that there are no cracks; hydraulically test any sump or bund if you're worried it is not working correctly; and fit a high-level probe to any sumps or bunds that you cannot check with an alarm to alert you before waste begins to escape containment.* *Your bunds must also have a capacity larger than both of the following: 110% of the largest tank the bund is protecting; or 25% of the combined volume of all the tanks the bund is protecting.* *Your bunds must also have no outlets (for example drains or taps); drain to a blind (completely enclosed) collection point; and have self-contained pipework that is separate from the container pipework* *Your bunds must have tanker connection points within the bund. If that's not possible, the tanker connections points must be contained to capture any leaks.* *If you need to use your bund to contain a leak you must make sure it's emptied to restore maximum capacity.*	All HPP storage tanks are above-ground. Tanks that contain potentially polluting materials will be bunded, see Table 2-9 for a list of tanks and bunding. All sumps, drainage drums and bunds will be: • Waterproof and resistant to the materials stored in them; • Subject to Essar's inspection, maintenance and testing programme (see POC8), which will address the requirements listed in EA Guidance "Control and monitor emissions for your Environmental Permit". Bunds will be designed, constructed and managed to meet the further requirements relating to capacities, containment, connections and management identified in EA Guidance "Control and monitor emissions for your Environmental Permit". The Amine Storage Tank, TEG Storage Tank, Cooling Medium Storage Tank, Waste Water Blending Tank, Sludge Blending Tank, and Thickened Sludge Holding Tank are fitted with high and low level controls connected to the Distributed Control System (DCS) alarms and Safety Instrumented System (SIS) trips. Delivery and offloading areas will be purposely designed areas, with in-built containment which can be isolated from the site drainage system. Material deliveries, storage and handling will be undertaken in accordance with site procedures; this included supervision of deliveries.

Technique	Justification
Storage areas for intermediate bulk containers, drums, bags *You must bund or kerb any area where environmentally harmful substances are stored (for example acids, chemical solvents, milk, lubricating oils and styrene).* *You must store substances separately if it may be risky to store them too near each other, for example because they're flammable or if two substances spilled and mixed could cause an explosion or harmful fumes.* *Do not use plastic IBCs (medium-sized containers that can be moved easily and are made out of plastic or metal) to store flammable materials.* *You must also:* • *Locate storage areas away from watercourses, sensitive groundwater areas such as Source Protection Zone (SPZ) 1, unprotected drainage systems and sensitive boundaries, for example near areas where people live or nature reserves;* • *Clearly mark your storage areas, and any containers and packages in them;* • *Define the maximum storage capacities for each of your storage areas and containers and stick to them;* • *Store containers, including empty containers, with lids, caps and valves secured and in place; and* • *Inspect your containers, drums and small packages at least once a week to check they're not damaged or leaking and put a procedure in place to replace or repair damaged or leaking containers.*	Raw materials and wastes will be stored in appropriate containers resistant to the substances contained. IBCs and drums and other containers will be stored in clearly marked, designated storage areas with identified capacities. They will be provided with bunded containment and will be situated on areas of hardstanding. Any incompatible materials will be identified and stored separately, where required. The HPP facility is not on a SPZ. Potentially polluting materials will not be stored on close to watercourses or sensitive boundaries. Essar's existing inspection and maintenance programme will be extended to cover the HPP (see Table 8-1, POC8).
Conformance with BAT:	✓

Noise and Vibration

Table 3-29 HPP Comparison Against Hydrogen Production BAT Guidance – Noise

Considerations & Guidance	
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.* *Equipment generating noise should be identified at the design stage, and their environmental performance should be considered for intended operations, including:* • *An environmental noise assessment* • *A noise management plan* • *Plant design to consider the selection of enclosures of noisy equipment or operations* • *Plant design to consider the location of noisy equipment or operations* • *Plant design to consider the use of embankments to screen the source of noise* • *Plant design to consider the use of noise protection walls*	
HPP Status	
• A Noise Assessment has been carried out for the HPP project (see Appendix A3.0), a summary of the impact assessment findings are summarised in Section 7.0. The report identifies noise-generating equipment, identifies noise control and mitigation measures and provides an assessment against specific BAT measures for noise. • The final selection of equipment will be carried out during detailed design; BAT will be applied to the selection of individual plant items, their siting, containment and abatement measures, in order to minimise noise levels generated at source. • The Refinery EMS includes measures to manage noise, which will be extended to cover the HPP (see Table 8-1, POC10); the Environmental Permit Variation EPR/FP3139FN/V009 Decision Document states [11]: *"Noise monitoring will be carried out if required. Noise is assessed as part of any project when designing new equipment. Complaints are monitored and the risk of noise generation from new site activities and turnarounds is assessed. Off-site monitoring has been undertaken, with the most recent data being in 2016. The number of noise complaints is at a very low level. More routine monitoring will only be required if noise becomes an issue for the site. The EA agree with the operator's stated compliance".*	
Conformance with BAT:	✓

Table 3-30 HPP Comparison with the Refining of Mineral Oil and Gas BAT Conclusions – Noise

BAT Conclusion	Techniques	Justification
BAT 17	Noise In order to prevent or reduce noise, BAT is to use one or a combination of the following techniques: i) make an environmental noise assessment and formulate a noise management plan as appropriate to the local environment, ii) enclose noisy equipment/ operation in a separate structure/ unit, iii) use embankments to screen the source of noise, and iv) use noise protection walls.	See Table 3-29 and the Noise Assessment Report (Appendix A3.0) for specific noise control and abatement measures. A Noise Management Plan has not been proposed, as the Noise Assessment showed that the operation of the HPP is predicted to give rise to, at worst, a minor adverse impact at the nearest sensitive receptor, and to give rise to negligible impacts at other noise sensitive receptors. The minor adverse effects at the Stables travellers' site, will be mitigated further as part of the detailed design process and through the further application of noise mitigation measures, including equipment selection, noise abatement and screening. Noise equipment will be contained in acoustic enclosures.
Conformance with BAT:		✓

Table 3-31 HPP Comparison with EA Guidance "Control and monitor emissions for your environmental permit" – Noise

BAT Conclusion	Techniques	Justification
BAT 22	Noise [ONLY APPLICABLE where noise nuisance can be expected or has been substantiated] 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 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.	Not applicable - noise nuisance is not expected at the HPP, nor substantiated at the current site.
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.	See the Noise Assessment Report (Appendix A3.0) for specific noise control and abatement measures.

BAT Conclusion	Techniques	Justification
	Appropriate location of equipment and buildings Increasing the distance between the emitter and the receiver and using buildings as noise screens.	Noise generating equipment will be located within the HPP site, away from the site boundary, as far as is practicable. Large buildings and structures have the potential to provide effective screening for certain sources; the potential to optimise siting of potentially noisy plant items will be reviewed at detailed design.
	Operational measures This includes: (i) improved inspection and maintenance of equipment; (ii) closing of doors and windows of enclosed areas, if possible; (iii) equipment operation by experienced staff; (iv) avoidance of noisy activities at night, if possible; (v) provisions for noise control during maintenance activities.	Plant inspection and maintenance will be carried out in accordance with Essar's existing processes, extended to cover the HPP plant; maintenance activities will be planned to minimise noise disturbance. The plant will be operated by suitable qualified and experienced operators, who will be trained in the Environmental Permit's requirements.
	Low noise equipment This includes low-noise compressors, pumps and flares.	The selection of particular models of plant has not yet been made. However, environmental performance, including noise emissions, will be a key part of the equipment selection process.
	Noise Control Equipment This includes: (i) noise-reducers; (ii) equipment insulation; (iii) enclosure of noisy equipment; (iv) soundproofing of buildings.	Equipment will be housed within acoustic enclosures, where required. Rotating items of plant will be mounted on appropriately specified anti-vibration mounts.
	Noise abatement Inserting obstacles between emitters and receivers (e.g. protection walls, embankments and buildings).	Large buildings and structures have the potential to provide effective screening for certain sources; the potential to optimise siting of potentially noisy plant items will be reviewed at detailed design.
Conformance with BAT:		✓

Emissions Monitoring

Table 3-32 HPP Comparison Against Hydrogen Production BAT Guidance – Monitoring and Measurement

Considerations & Guidance
Role of Monitoring
A key requirement of monitoring of the hydrogen production / CO_2 capture process is to demonstrate that the emissions from the process are not causing harm to the environment. Monitoring is also required to demonstrate that resources such as feed gas, electricity and water are being used efficiently, that the CO_2 capture rate is as expected, and that the hydrogen and CO2 products meet the necessary specifications for export.
Monitoring plans shall be included in the permit application for routine operation and for more extensive monitoring during the commissioning period. During the commissioning period, the operating envelope of the process will be established. Operation at this time may be outside the normal operating envelope, and it is important that the monitoring plan considers any risks, such as to air quality. On completion of commissioning, with operation within the established normal operating envelope, the monitoring plan for routine operation should be implemented.
In addition, for post combustion capture, the operator must demonstrate that the process is being managed to prevent (or minimise) the formation of degradation products, and that where they are formed (and may be released) they, and any capture solvent emissions, are abated to the appropriate level.
Monitoring emissions to air
Monitoring of emissions to air, will be required based on expected contaminants (e.g. ammonia, amine compounds, SO_2, NOx, CO, etc.) with appropriate methods and measuring techniques employed.
Monitoring shall consider, for example: • *NOx and CO emissions from combustion* • *SO_2 emissions from combustion where the fuel source contains sulphur* • *Ammonia emissions where SCR / SNCR is employed* • *Amine / amine degradation products and other volatile solvent emissions.*
CO_2 capture performance is expected to be monitored according to standards that are recognised under the UK ETS.
Key requirements for monitoring of process operations should be identified where these impact ultimately on environmental performance – including for example amine system performance, including monitoring of amine solvent quality such as amine concentration, pH and presence of degradation or corrosion products; amine temperatures; amine and wash water circulation rates; rich and lean amine CO_2 loading; and stripper reboil steam rates.
For combustion plant, monitoring is required to demonstrate compliance with the applicable emissions limits described in Section 5.11.
The Regulators will take a case by case decision on the monitoring requirements, based on the most apt monitoring principles and monitoring thresholds set out for individual pollutants in the BAT Conclusions for Refining of Mineral Oil and Gas or BAT Conclusions for Large Combustion Plant.
Where emerging techniques are used for hydrogen production with CO_2 capture, monitoring methods and standards may need to be developed. Proposals should be developed by the operator as part of the permitting activities.
Where post-combustion CO_2 capture is employed using amine solvent, monitoring of emissions of ammonia, volatile components of the capture solvent and likely degradation products such as nitrosamines and nitramines shall be included. Monitoring of specific pollutants arising from post-combustion capture may be by CEMs if available or periodic extractive sampling and where aerosol formation is expected must be isokinetic.
Monitoring Emissions to Water
Monitoring of emissions to water, will be required based on expected contaminants (e.g. ammonia, amine compounds, methanol, CO_2, etc.) 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).
Monitoring of CO_2 Capture Performance
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. *This, together with measurement of the flow and composition of feed gas, hydrogen product and CO_2 product streams, will allow monitoring of the CO_2 capture rate and CO_2 quality.* ***Monitoring of Process Performance*** *Key requirements for monitoring of process operations should be identified where these ultimately impact on environmental performance – including for example amine system performance, including monitoring of amine solvent quality such as amine concentration, pH and presence of degradation or corrosion products; amine temperatures; amine and wash water circulation rates; rich and lean amine CO2 loading; and stripper reboiler steam rates.* *Energy efficiency in the hydrogen production and CO2 capture processes should be monitored through measurement of feed and product gas flows and electrical power consumption to calculate overall energy consumption.* *Requirements for process performance monitoring, either online or offline, will also be a condition of the permit.*
HPP Status
• Provision has been made to undertake O_2, CO_2, SO_2, NOx and CO monitoring in the Feed Fired Heater and Steam Boiler exhaust stack exhaust stacks. Further information is given in Tables 3-33 and 3-34. No ammonia monitoring is proposed as SCR/ SNCR will not be used. • The relief gas flow to flare (actual and totalized) will be monitored. • The **LCH** Plant will form part of the Essar Refinery Environmental Permit (EPR/FP3139FN/V010). The only liquid process discharge from the **LCH** Plant – the waste brine from the Water Demineralization Plant – will be discharged through an existing outfall (W3). The outfall is covered by the existing Essar Environmental Permit which requires that the discharge be monitored and meets the authorised ELVs (in line with the Refining of Mineral Oil and Gas BAT Conclusions, BAT 10). The Water Demineralization Plant will be designed so that the brine from the process will meet the existing Environmental Permit monitoring and ELV requirements for discharge W3. • The Water Demineralization Plant design will permit the taking of water samples for laboratory analysis. • The export of CO_2 will be measured (temperature, pressure, flow) downstream of the CO_2 Compressor. The Process Licensor will undertake laboratory samples of product composition associated with performance guarantee. • As the HPP does not involve post-combustion CO_2 capture, instead using a close capture and recovery system, the potential for amine emissions and any degradation products are significantly reduced, and are confined to monitoring amine in fugitive releases and process monitoring including amine quality.
Conformance with BAT: ✓

3.7.12 The Refineries BREF BAT Conclusion Document notes that BAT is to monitor emissions to air and water using the monitoring techniques with at least the minimum frequencies given in the tables below and in accordance with CEN (European Committee for Standardization) standards. If CEN 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. Essar proposes the use of CEN monitoring standards, where available. Monitoring standards to be used are to be agreed with the EA as a Pre-Operational Condition (POC6).

Table 3-33 HPP Comparison Against Refining of Mineral Oil and Gas BAT Conclusions – BAT 4 & 5 Monitoring and Measurement – Emissions to Air and Key Process Parameters

Parameter	Process (combustion) unit size	Minimum Frequency	Monitoring Technique	Compliance Measures
SO_X, NO_X, and dust emissions	<50 MW_{Th}	Once a year and after significant fuel changes	Direct or indirect measurement	NOx and SOx monitoring proposed annually for the Feed Fired Heater and Steam Boiler emission points. Particulate monitoring is not regarded as appropriate as the fuel is clean, processed PSA gas. No monitoring of the Emergency Diesel Generator emissions is proposed. This is due to its small scale, and infrequent and short-duration operation. Also, the generator does not require periodic monitoring under MCPD requirements. Emissions will be controlled through regular maintenance and use of low sulphur diesel.
CO	All other combustion units (<100MWth)	Once every 6 months	Direct Measurement	6-monthly CO monitoring proposed for the Feed Fired Heater and Steam Boiler emission points, in accordance with BAT Conclusions. No monitoring proposed for the Emergency Diesel Generator for the reasons given above.
Parameters linked to pollutant emissions, e.g. O_2 content in flue-gas, N and S content in fuel or feed	All	Periodic (6 months) for O_2 content. For N and S content, periodic at a frequency based on significant fuel/ feed changes	Direct Measurement	O_2 content and gas parameters will be monitored as they are needed for correction to reference conditions. No monitoring of the NG feed is proposed as its composition is controlled at source. Nitrogen and sulphur monitoring of the PSA tailgas is proposed at 6 month intervals, or more frequently if the process feed gas mix changes significantly. It is suggested that the monitoring frequency is reviewed after one year.
Conformance with BAT:				✓

3.7.13 Chlorine compounds are removed from the incoming ROG; no monitoring is therefore proposed for dioxins of furans.

Table 3-34 HPP Comparison Against Refining of Mineral Oil and Gas BAT Conclusions – BAT 6 Monitoring and Measurement[1] – Diffuse VOC Emissions

Considerations & Guidance
BAT is to monitor diffuse VOC emissions to air from the entire site by using all of the following techniques: i. sniffing methods associated with correlation curves for key equipment; ii. optical gas imaging techniques; iii. calculations of chronic emissions based on emissions factors periodically (e.g. once every two years) validated by measurements. The screening and quantification of site emissions 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. (The noting that the "Common Waste Water and Waste Gas Treatment BAT Conclusions" states that this measures is confined to instances where large amounts of VOCs are handled).
HPP Status
• Potential sources of diffuse VOC emissions at the HPP are from: - ROG, NG and process/ product gasses in pipework and process vessels, and - The amine, TEG and the diesel storage tanks; noting that the amine and TEG solutions storage tanks are only used occasionally (for initial filling and storage for plant drain-down) and thus displacement losses are only occasional. Similarly. Diesel tanks are not refilled frequently, as the emergency generators are only tested infrequently (monthly). In addition, the amine and TEG tanks are not open to the atmosphere, but are fitted with pressure valves (operating a low pressure). • Fugitive emissions will be well controlled by design and regular inspection and maintenance measures (see fugitive emissions sections above). Essar operates a LDAR programme on the existing installation, which includes monitoring using an FLIR camera; this information, together with tank emissions data, is used to assess total fugitive emissions from the refinery [11]. Essar proposes to extend the LDAR programme to cover the HPP (see POC6).
Conformance with BAT: ✓

Note 1 This BAT Conclusion, relating to VOCs, is also included in the Common Waste Water and Waste Gas Treatment BAT Conclusions [8], BAT 5.

3.7.14 Refineries BAT 7 does not apply as waste gases are not sulphurised. BAT 8 does not apply as no monitoring of ammonia is proposed as SCR/ SNCR is not used.

Table 3-35 HPP Comparison Against Common Waste Water and Waste Gas Treatment BAT Conclusions – BAT 3

BAT Conclusion	Techniques	Justification
BAT 3	Monitoring For relevant emissions to water as identified by the inventory of waste water streams, 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).	This BAT Conclusion is addressed in Table 3-18.
Conformance with BAT:		✓

3.7.15 In accordance with the Common Waste Water and Waste Gas Treatment BAT Conclusions, no odour or noise monitoring is prosed as the facility is not considered likely to give rise to odour nuisance nor noise nuisance, when the proposed abatement measures are fitted (see Noise section).

Raw Materials

Raw and Auxiliary Materials

3.7.16 Information on the principal raw materials that will be used at the HPP is given in Table 2-8 and information on storage arrangements is provided in Table 2-9. This information is summarised in Table 3-37. Maintenance consumables, other than those identified as bulk items, are not specified because their level of usage indicates that significant environmental impacts are highly unlikely.

3.7.17 As the HPP is not yet operational, information on predicted quantities of the principal raw materials is indicative, based on data from comparable plant and available design data. Additional information on actual substances selected (e.g., water treatment chemicals) and refined estimates of quantities used will be provided by Essar prior to commencement of operation under a proposed pre-operational condition (see Section 8, POC10).

Water Use

3.7.18 Water used in the HPP will come from one of three sources, as identified in section 2-3:

- Raw water, supplied from the United Utilities supply to the Refinery (from the River Dee);
- Recycled process water, which is recycled in the MBR and demineraliser; and
- Site rainfall which is collected from the open drains, stored and then used in the process, which excess rainfall being discharged from the site as uncontaminated surface water at point T1 (CT2).

3.7.19 Water usage will be metered and on-going opportunities to minimise consumption will be considered as part of the IMS. Anticipated water usage data are provided in and quantified in Table 3-18 (BAT7).

3.7.20 In order the meet BAT the following general principles have been applied in sequence in order to control emissions to water:

- Water use will be minimised and wastewater reused or recycled where possible;
- Contamination risk to surface water will be minimised;
- Closed loop cooling systems will be used; and
- Where any potentially harmful materials are used, measures will be taken to prevent them entering the water circuit (see controls identified in Tables 3-18 and 3-19).

BAT Justification for Principal Raw Material Selection

3.7.21 Table 3-35 presents a summary of the BAT justification for the selection of the principal raw materials.

Table 3-36 BAT Justification for Principal Raw Material Selection

Raw Materials	Justification for Use
Feed Gases	ROG is a refinery by-product. Essentially, the HPP takes this gas stream, decarbonises it, and returns it (as H_2) for use in the refinery. This beneficial usage represents the very purpose of the HPP. Along with the ROG the plant also decarbonises NG, distributing the resulting H_2 and sending the recovered CO_2 to geological storage (see Section 1.2 "Background to HyNet"). The purpose of the HPP is to decarbonise the industrial fuel supply in the NW of England.
Water Use	Water use will be minimised by: • Recycling water within the **LCH** plant via the Saturator; • Recycling process wastewater streams back into the process through the MBR and demineraliser plant; • Using a proportion of site rainwater in the process; • Using closed loop cooling.
Amine	An amine solution is used in the CO_2 Removal Unit, and is essential to the process to enable the efficient removal of CO_2 from the reformed gas stream to produce the decarbonised product gas. The precise amine solution to be used will depend on the vendor package selected, however, it be selected taking environmental impacts into account, and the measures identified in Table 3-27 will be used to ensure it is contained effectively.
Catalysts	Catalysts are required to enable the process reactors to occur at required rates; they are selected taking environmental impacts into account, using less environmental harmful substances where practicable.
Water treatment chemicals selected for lowest environmental impact potential.	Water treatment chemicals will be selected taking environmental impacts into account. Industry standard chemicals with widely known properties will be selected.
Industrial gases (Oxygen and Nitrogen)	Oxygen is produced in the ASU, and is required for the operation of the ATR, promoting the conversion of feed gas to H_2 product and CO_2 for capture and sequestration. Nitrogen gas is used for inerting in the process. It is produced as a by-product of O_2 generation.
Emergency/ fuel	The Emergency Diesel Generator will be fired on diesel; this is regarded as BAT for emergency/ standby duty of this type. Low sulphur diesel reduces emissions of sulphur dioxide.

Raw Materials Quality Assurance

3.7.22 Principal and other significant raw materials will be supplied via negotiated contracts, which specify the composition, performance criteria and quality requirements for each material.

Raw Materials and Technology Review and Change

3.7.23 In line with current EA Permit conditions, the following tasks will be carried out:

- Take appropriate measures to ensure that raw materials and water are used efficiently in the activities by carrying out routine resource efficiency audits;
- Maintain records of raw materials and water used in the activities;
- Review and record at least every 4 years whether there are suitable alternative materials that could reduce environmental impact or opportunities to improve the efficiency of raw material and water use; and
- Take any further appropriate measures identified by a review.

Table 3-37 Raw Materials Inventory

Material	Use	Usage (t/yr unless otherwise stated)	Maximum Stored on Site	Properties / Active Ingredients	Hazard Code(s)	Fate	Environmental Impact
Refinery Off Gas (ROG)	Process reactant	109,500	Supplied to process	See Table 2-1	H220: Extremely flammable gas H280: Contains gas under pressure; may explode if heated	Converted to product gases	Produces decarbonised fuel
Natural Gas (NG)	Process reactant	155,000	Supplied to process	See Table 2-1	H220: Extremely flammable gas H280: Contains gas under pressure; may explode if heated H380: May displace oxygen and cause rapid suffocation	Converted to product gases	Produces decarbonised fuel
PSA Tailgas	Process co-product, fuel gas	45,550	Supplied to combustion plant	See Table 3-11	H220: Extremely flammable gas H280: Contains gas under pressure; may explode if heated	Consumed and combustion gases emitted to atmosphere	Consumption of process co-product
Mercury Guard Bed Catalyst (PURASPEC 1173)	Mercury Guard Bed	Changed when exhausted (depends on Hg content of incoming gas)	3.5 te in-vessel storage	TBD	TBD	Off-site recycling or disposal	Raw material consumption

Material	Use	Usage (t/yr unless otherwise stated)	Maximum Stored on Site	Properties / Active Ingredients	Hazard Code(s)	Fate	Environmental Impact
Hydrodesulphurisation Catalyst (PURASPEC 2571)	Hydrodesulphurisation Vessel	Changed after 4 years (expected life)	7.7 te in-vessel storage	nickel oxide, molybdenum oxide, sulphur, aluminium oxide	H251: Self-heat. 1 H318: Eye Dam. 1 H317: Skin Sens. 1 H341: Mutagenic. 2 H350i: Carc. 1A H373: STOT RE 2 H411: Aquatic Chronic 2	Off-site recycling or disposal	Raw material consumption
Chloride removal Absorbent (KATALCO 59-4)	Desulphurisation Vessels	Changed after 2 years (expected life)	16.8 te (8.4 te/vessel) In-vessel storage (2 vessels)	Sodium oxide, aluminium oxide	H314: Corr. 1A H318: Eye Dam. 1 H290: Corr. 1,H335: STOT SE 3 H302: Harmful if swallowed H332: Harmful if inhaled	Off-site recycling or disposal	Raw material consumption
Desulphurisation Absorbent (KATALCO 32-4)	Desulphurisation Vessels	Changed after 2 years (expected life)	72 te (38 te/vessel) in-vessel storage (2 vessels)	Zinc oxide and binder	H400: Aquatic Acute 1 H410, Aquatic Chronic 1 H361: Suspected of damaging fertility or the unborn child H302: Harmful if swallowed H332: Harmful if inhaled H373: STOT RE2	Off-site recycling or disposal	Raw material consumption

Material	Use	Usage (t/yr unless otherwise stated)	Maximum Stored on Site	Properties / Active Ingredients	Hazard Code(s)	Fate	Environmental Impact
Ultrapurification Catalyst (PURASPEC 2084)	Ultrapurification Vessel	Changed after 4 years (expected life)	5.4 te in-vessel storage	Zinc oxide, copper oxide, alumina	H400: Aquatic Acute 1 H410, Aquatic Chronic 1 H361: Suspected of damaging fertility or the unborn child H302: Harmful if swallowed H332: Harmful if inhaled H373: STOT RE2 H400: Aquatic Acute 1 H410, Aquatic Chronic 1	Off-site recycling or disposal	Raw material consumption
GHR Catalyst (KATALCO 23-4HQR / 23-4HQ)	GHR	Changed after 4 years (expected life)	24.4 te in-vessel storage	Nickel oxide, silica, aluminium oxide	H350i: Carc. 1A H372: STOT RE 1	Off-site recycling or disposal	Raw material consumption
ATR Catalyst (KATALCO 28-4Q)	ATR	Changed after 4 years (expected life)	17.5 te in-vessel storage	Platinum group metal on ceramic support, nickel oxide, silica, aluminium oxide	H350i: Carc. 1A H372: STOT RE 1	Off-site recycling or disposal	Raw material consumption
ITS Catalyst (KATALCO 83-5)	ITS Converter	Changed after 4 years (expected life)	70 te in-vessel storage	Copper oxide, zinc oxide, aluminium oxide	H400: Aquatic Acute 1 H410: Aquatic Chronic 1	Off-site recycling or disposal	Raw material consumption
Alumino-silicate ceramic inert fill	All catalyst beds apart from GHR (where they are not required)	Changed after 4 years (expected life)	71.6 te in-vessel storage	Alumino-silicate and alumin ceramic balls. Chloride-free	TBC	Off-site recycling or disposal	Raw material consumption
Oxygen Scavenger	Steam System	TBD	IBC/ drums in bunded area	Sodium erythorbate, Nalco Exilim-ox or all-volatile alternative	H317: Skin Sens. 1	Removed from boiler-blowdown in treatment system	Raw material consumption

Material	Use	Usage (t/yr unless otherwise stated)	Maximum Stored on Site	Properties / Active Ingredients	Hazard Code(s)	Fate	Environmental Impact
Phosphate	Steam System	TBD	IBC/ drums in bunded area	Phosphate (Na_2HPO_4 and Na_3HPO_4)	TBD	Removed from boiler-blowdown in treatment system	Raw material consumption
Amine	Steam System	TBD	IBC/ drums in bunded area	Amine mixture (cyclohexamine, morpholine, amino-methyl-propanol)	H314: Corr. 1A H318: Eye Dam. 1 H317: Skin Sens. 1	Removed from boiler-blowdown in treatment system	Raw material consumption
Amine	CO_2 Removal Unit	350 kg/yr	1043 te bunded tank	70% w/w solution 2,2methylimino)diethanol; N-methyldiethanolamine, piperazine [10]	H314: Corr. 1A H318: Eye Dam. 1 H317: Skin Sens. 1	Off-site recycling or disposal	Raw material consumption
Anti-foam	CO_2 Removal Unit – Anti-foam Injection Package	TBD – vendor specific	Bunded tank	TBD – vendor specific (Silicone-based) OASE® AntiFoam A	TBD	Off-site recycling or disposal	Raw material consumption
TEG	CO_2 Dehydration	TBD	72 te bunded tank	Tri-Ethylene Glycol solution	TBD	Off-site recycling or disposal	Raw material consumption
PSA Adsorbent	PSA	Changed every c.10 years	In-vessel storage	Silica pellets	TBD	Off-site recycling or disposal	Raw material consumption
Alumina/silica desiccant	ASU/Instrument air	TBD	TBD	Alumina, Silica	TBD	Off-site recycling or disposal	Raw material consumption
Sodium bisulphite solution	Water Demineralization Plant (de-chlorination)	TBD	2.6 te bunded tank	Sodium bisulphite solution (20% w/w)	H314: Corr. 1A H318: Eye Dam. 1 H335: STOT SE 3	Consumed.	Consumption of raw materials.

Material	Use	Usage (t/yr unless otherwise stated)	Maximum Stored on Site	Properties / Active Ingredients	Hazard Code(s)	Fate	Environmental Impact
Sodium hydroxide solution	Water Demineralization Plant	TBD	6 te bunded tank	Sodium Hydroxide (NaOH) solution (32% w/w)	H290: Corr. 1 H314: Corr. 1A H318: Eye Dam. 1	Consumed.	Consumption of raw materials.
N Supplement and micro-nutrient	MBR Plant	TBD	30 te bunded tank	Nitrogen-based and other micro-nutrients	TBD	Consumed.	Consumption of raw materials.
Phosphoric acid solution	MBR Plant	TBD	5 te bunded tank	Phosphoric acid	H302: Acute Tox. 4 (Oral) H314: Skin Corr. 1A H318: Eye Dam. 1 H350: Carc.1A H335: STOT SE 3 H401:Aquatic Acute 2 H290: Corr. 1 H315: Skin irritant 2 H319: Eye Irrit. 2	Consumed	Consumption of raw materials
Aluminium sulphate solution	Clarification plant	TBD	6 te bunded tank	Aluminium sulphate solution (8% w/w)	H315: Skin irritant 2 H319: Eye Irrit. 2 H290: Corr. 1	Incorporated in sludge - off-site disposal	Consumption of raw materials
Sulphuric acid solution	Clarification plant	TBD	0.8 te bunded tank/IBC	Sulphuric acid (33% w/w)	H290: Corr. 1 H314 - Skin Corr. 1A H315: Skin irritant 2 H318: Eye Dam. 1 H319: Eye Irrit. 2 H335: STOT SE 3	Neutralised in supernatant	Consumption of raw materials

Material	Use	Usage (t/yr unless otherwise stated)	Maximum Stored on Site	Properties / Active Ingredients	Hazard Code(s)	Fate	Environmental Impact
Sodium hypochlorite solution	Dual Media Filtration Plant	TBD	6 te bunded tank	Sodium hypochlorite solution (10% w/w)	H314: Corr. 1A, H400: Aquatic Acute 1 H410, Aquatic Chronic 1 H318: Eye Dam. 1	Neutralised in supernatant	Consumption of raw materials
Flocculant polymer	Dewatering centrifuge plant	TBD	Bunded tank/IBC	Polymers	H412: Aquatic Chronic 3 H317: Skin Sens. 1	Incorporated in sludge - off-site disposal	Consumption of raw materials
Liquid oxygen	Back-up for the ASU	TBD	670 m^3 in double-skin oxygen tanks	Oxygen	H270: May cause or intensify fire; oxidiser H281: contains refrigerated gas; may cause cryogenic burns or injury.	Consumed in ATR reactions	Consumption of raw materials
Liquid nitrogen	Back-up for the ASU	TBD	300 m^3 in double-skinned nitrogen tanks	Nitrogen	H281: contains refrigerated gas; may cause cryogenic burns or injury.	Vented to atmosphere	None- main constituent of air
Lubrication oils	Lubrication machinery	<20	Machinery, IBCs and drums with secondary containment	Mineral oil	H412: Aquatic Chronic 3	Off-site recycling or disposal	Raw material consumption
Coolant	Cooling circuits	TBD	4200 te in bunded tank and cooling system	Propylene glycol solution (33%w/w)	TBD	Off-site disposal (infrequent)	Raw material consumption

Material	Use	Usage (t/yr unless otherwise stated)	Maximum Stored on Site	Properties / Active Ingredients	Hazard Code(s)	Fate	Environmental Impact
Diesel	Emergency Generator Package	<10	8.5 te in double-skinned self-bunded tank	Gas oil	H226: Flammable Liquid 3 H373: STOT RE2 H304: May be fatal if swallowed and entered airways H351: Suspected of causing cancer H322: Acute Toxic 4 H315: Skin Irritant 2 H227: Combustible liquid H411: Aquatic Chronic 2	Consumed and combustion gases emitted to atmosphere.	Consumption of non-renewable raw materials Emission of combustion gases to atmosphere

Table 3-38 HPP Comparison Against Refining of Mineral Oil and Gas BAT Conclusions - BAT 3 – Solid Materials Storage

BAT Conclusion	Techniques	Justification
BAT 3	Solid materials storage and handling In order to prevent or, where that is not practicable, to reduce dust emissions from the storage and handling of dusty materials, BAT is to use one or a combination of the following techniques: i) store bulk powder materials in enclosed silos equipped with a dust abatement system (e.g. fabric filter), ii) store fine materials in enclosed containers or sealed bags, iii) keep stockpiles of coarse dusty material wetted, stabilise the surface with crusting agents, or store under cover in stockpiles, and iv) use road cleaning vehicles.	• The HPP does not involve the handling and storage of dusty or fine materials on a regular basis. Removal and charging of catalysts, absorbents and support materials will be carried out by a specialist contractor. The catalysts and absorbents are typically supplied as granules or pellets and measures will be taken to minimise any dust arisings in material handling, for example by minimising the height of drops in charging. • Road cleaning vehicles are used on a regular basis across the refinery.
Conformance with BAT:		✓

Avoidance, Recovery and Disposal of Wastes

3.7.24 The waste streams from the HPP are identified in Table 3-39, together with an initial estimate of annual waste arisings during operation, and proposed waste storage and handling arrangements.

3.7.25 Essar will extend their existing waste management controls to the HPP wastes. This includes the application of the waste hierarchy to maximise materials re-use, prevent waste, minimise waste generation and maximise recycling and recovery of waste.

3.7.26 Wastes will be handled to minimise releases of pollutants to the environment. Wastes will be segregated and prepared for onward transport, being transferred from the Refinery by registered carriers to appropriately licensed facilities, using the correct written information, i.e. hazardous waste consignment notes for hazardous waste, waste transfer notes for non-hazardous controlled wastes.

Table 3-39 HPP Waste Arisings

Description	EWC Code	State	Containment	Fate	Quantity
Spent catalysts	16 08 03	Solid	Bulk tanks	Recycling/ metals recovery	Up to 290 te/4 years
Spent inert support media	17 01 07	Solid	Bulk tanks	Re-use in HPP/Disposal	Up to 77 te/4 years
Water treatment sludges	06 05 02* 06 05 03	Solid	Bunded tank	Disposal	10,040 te/year
Refractory linings, internal supports	16 11 06	Solid	Skips	Disposal	TBD – expected every c.10 years
Waste amine	16 05 09	Liquid	Bulk amine/ TEG tanks	Disposal	Up to 993 te – expected occasionally c.10 years
Waste TEG	16 05 09	Liquid	Bulk amine/ TEG tanks	Disposal	Up to 97 te– expected occasionally c.10 years
Waste oils	13-02-06*	Liquid	Bunded tank	Recycled	c.40 te/year
Other maintenance wastes	Various	Solid	Various	Recycled/ Disposal	Variable, as generated by maintenance activities

Table 3-40 HPP Comparison Against Refining of Mineral Oil and Gas BAT Conclusions – BAT 14, 15 &16 Wastes

BAT Conclusion	Techniques	Justification
BAT 14	Waste generation and management In order to prevent or, where that is not practicable, to reduce waste generation, BAT is to adopt and implement a waste management plan that, in order of priority, ensures that waste is prepared for reuse, recycling, recovery or disposal.	Prior to commissioning, the operator will review the waste management proposals identified in Table 3-38 for their continued suitability and to ensure wastes are prevented or managed as high up the waste hierarchy as possible (see POC8). The operator will review and record at least every four years whether changes to waste management measures should be made and take any further appropriate measures identified by a review.
BAT 15	Waste generation and management In order to reduce the amount of sludge to be treated or disposed of, BAT is to use one or a combination of the following techniques: i) Sludge pre-treatment, and ii) Reuse of sludge in process units.	Sludges generated in the HPP waste treatment system (from the CPI, Backwash Settlement Tanks, Clarification Plant and MBR) will be pre-treated by dewatering in the Dewatering Centrifuge Plant which reduces the volume of sludge to be removed by tanker for off-site disposal. The HPP sludges do not require de-oiling and there is no opportunity to re-use sludges in the HPP process.

BAT Conclusion	Techniques	Justification
BAT 16	Waste generation and management In order to reduce the generation of spent solid catalyst waste, BAT is to use one or a combination of the following techniques: i) Spent solid catalyst management, and ii) Removal of catalyst from slurry decant oil.	Catalysis and absorbents will be changed out according to a catalyst management plan. The change-out and recharging with new catalyst and absorbents will be carried out by a specialist contractor. The catalysts and absorbents will be sent for metals recovery, subject to prevailing metals market conditions. Catalysts and will not mix with oils in the HPP process.
Conformance with BAT:		✓

Energy Efficiency

3.7.27 The Environment Agency has provided guidance on the subject of energy efficiency in Section 13 of its pre-application advice to Essar Oil UK Limited [Letter re "Pre application advice – Enhanced service", EPR/FP3139FN/V012. 16/6/21. Environment Agency]. This guidance has been reproduced in the table below wherein the status of the HPP design has been summarised on an item by item basis.

Table 3-41 Energy Efficiency – Guidance and Status

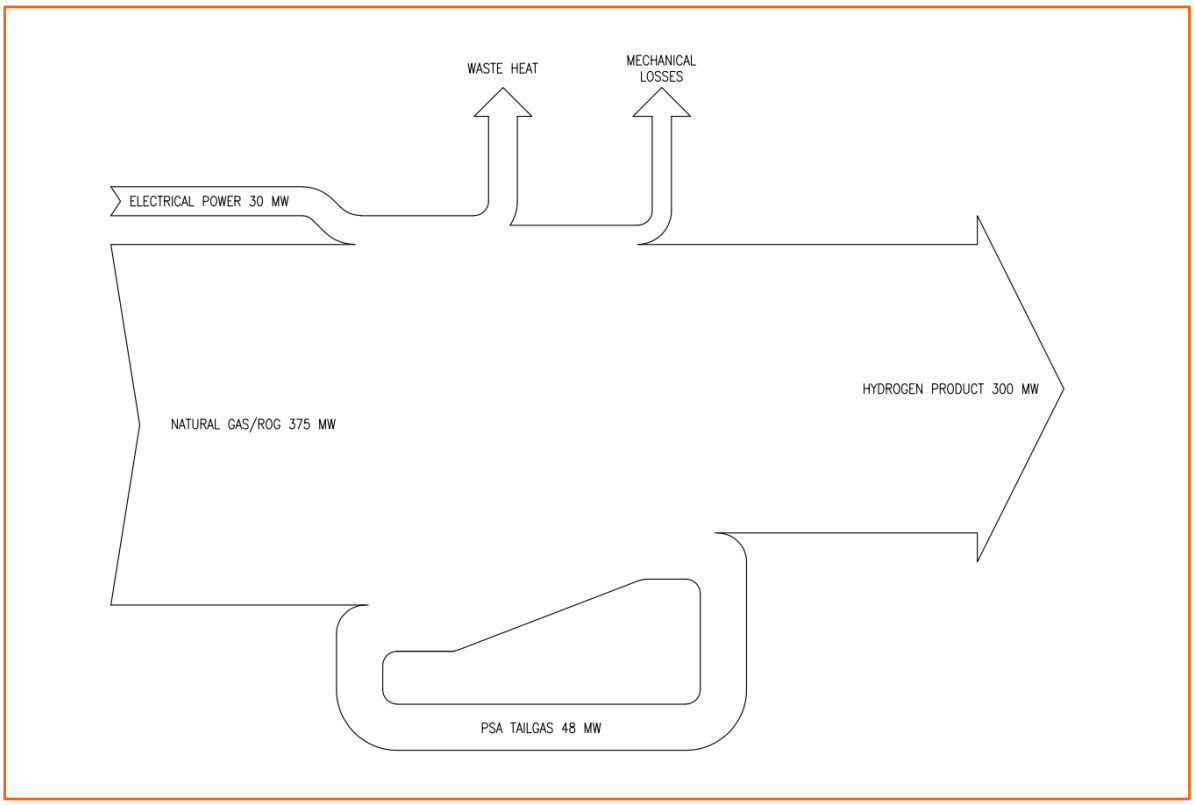
EA Guidance	HPP Status
The Environment Agency expects that a complete application should address in detail the proposed energy integration and energy efficiency measures included in the design. In general, you should refer to the relevant guidance in the latest available version of the guidance document titled 'Review of Best Available Techniques (BAT) for Hydrogen Production from Methane and Refinery Fuel Gas with Carbon Capture'.	Key energy performance parameters for the HPP are provided in Section 3.3, as required by the BAT Guidance for Hydrogen Production [2]. These parameters include: • Feed Gas Energy Conversion; • Electrical Power Consumption; and, • Overall Energy Conversion. With regard to heat integration and process cooling, Table 3-13 identifies the heat exchangers in the plant and the heating and cooling that is occurring between various process gases and fluids.

EA Guidance	HPP Status
The key energy sources and energy users of the proposed process should be identified, along with an explanation of how any excess heat would be reused among the available thermal levels of the process and waste heat is minimised.	Energy data for the key energy sources and energy users is given below. All figures are given as MW. Motor/ equipment data are for absorbed loads. The energy content of the gas feed and product streams are given as LHV. **Key Energy Sources** • Natural gas/ ROG feed (375) • Electrical power supply (30) **Key Energy Users** • Hydrogen Compressor (2.4) • CO_2 Compressor (5.65) • Natural Gas Compressor (2.2) • Oxygen Vapouriser (1.3) • Nitrogen Vapouriser (1.3) • Natural Gas Heater (5.0) • ROG Compressor (1.5) • Primary Fire Pump (1.3) • ASU (13.5) • H_2 product (300)

EA Guidance	HPP Status
	Excess Heat Heat transfer around the HPP has been maximised. It is highlighted that the purpose of the plant is to process natural gas/ROG into a decarbonised (hydrogen) energy stream. Losses of heat energy from the process have a direct effect on the rate of H_2 production and have thus been minimised to optimise the plant's commercial return. There are two principal sources of waste heat on the HPP: • the Cooling Medium System which reduces the heat of the incoming "warm" cooling medium, and in doing so discharges heat energy to atmosphere at a temperature of around 45˚C; and, • the Feed Fired Heater and Steam Boiler which discharge combustion gases to atmosphere at a temperature of 140ºC. The heat from the cooling medium system is not considered useful. The temperature is too low for the recovered heat to be used for process heat, hot water, or even space heating. The Feed Fired Heater and Steam Boiler discharge waste heat at a higher temperature than the cooling medium system, but represent a waste heat resource of only around 5 MW in total. This is a very modest amount low grade heat. Its recovery is not economically feasible for this reason alone, but is in any case compounded by the absence of any nearby users, the elevation above grade at which heat exchangers would need to be installed, and the high water content of the exhaust gases (a consequence of burning gas with a high concentration of hydrogen) which bring corrosion and materials selection issues. For information on the heat integration of the ASU see section on heat integration below.
A simplified heat balance should be provided, showing the energy integration of the process and energy transfer from higher to lower energy levels in a clear way, for example in the form of a Sankey diagram.	A simplified heat balance is shown in Figure 3-1.
The overall energy efficiency of the plant should be calculated and presented, along with a description of the key assumptions made to work that out and the proposed validation methods at the commissioning stage of the plant. The Process / Energy Efficiency Key Performance Parameters figures presented in the guidance 'Review of Best Available Techniques (BAT) for Hydrogen Production from Methane and Refinery Fuel Gas with Carbon Capture' should be calculated and presented in the application.	For the overall energy efficiency of the HPP refer to Section 3.3. It is proposed that the commissioning stage validation methods necessary to demonstrate the overall energy efficiency of the HPP will be developed as a Pre-operational Condition (see POC5, Section 8).

EA Guidance	HPP Status
Particular consideration should be given to the energy efficiency measures and heat integration of combustion equipment (boilers, fired heaters), reactors and gas compressors (for example air compressor in the ASU, CO2 compressor, hydrogen compressor if applicable) and selection of cooling system.	See above comments on energy integration and overall plant energy efficiency data. In this area the BAT guidance states that: "*Within the hydrogen production process, heat integration will typically be through gas/ gas exchange, including in gas heated reformer where used; or through heat recovery for steam generation and superheating, including demineralised and boiler feed water heating*". This is an accurate summary of the HPP scheme. It is highlighted that there will be no heat integration between the ASU and the wider HPP for reasons of safety. The soundness of this design approach is underscored by the BAT guidance which notes that "*The form of heat integration should be selected to avoid additional hazards (e.g. through combining oxygen production and hydrocarbon streams)*".
An explanation should be given of the energy efficiency options considered in the design, even if it is proposed not to take some of them forward. If less efficient process options are proposed, these should be justified on a technical or cost-benefit basis against more efficient options discarded.	At the early stage of the design process a comparison was made between the benefits of the HPP design over steam methane reforming (SMR) in terms of cost, CO_2 capture rate, and scalability. A comparison was also made between the energy efficiency of the two different schemes. Details are presented in Section 3.2 The design process focussed on the heat integration of the HPP (this is reflected in the number of heat exchangers throughout the process) as this is the primary means of optimising the energy efficacy of the plant.
We understand there is no electric power generation proposed as part of the proposal (other than small sized standby diesel generators that would be used for limited hours in the case of loss of power supply from the grid). The rationale for the proposed configuration, entailing the import of outsourced electric power, as opposed to its on-site production in a combined heat and power (CHP) plant fully integrated within the process, should be explained and justified.	The HPP represents of a first-of-a-kind plant in terms of its overall processing objectives and combination of systems. For this reason the design focus has, from the outset, been on the avoidance, wherever possible, of engineering system complexity and ensuring the reliability of the HPP. The adoption of CHP has not therefore been considered at this stage of the plant's development.
CHP readiness requirements do not apply to installations that do not include power generation, however, as the proposed combustion units exceed 20 MW thermal input, the requirements of Article 14 of the Energy Efficiency Directive are applicable. You should therefore submit a cost-benefit analysis following with our draft guidance ('Draft guidance on completing cost-benefit assessments for installations under Article 14 of the Energy Efficiency Directive') or provide a justification that any waste heat generated by the proposed plant is not available at a useful temperature. Even low grade energy might be efficiently utilised if lower temperature users are identified, for example in other refinery processes, and we would expect you to provide evidence in the application that you have explored all the available options to minimise waste heat.	Article 14 of the Energy Efficiency Directive requires a cost-benefit analysis of the feasibility of district heating for applicable plant. HyNet falls under item 5(c): "*an industrial installation with a total thermal input exceeding 20 MW generating waste heat at a useful temperature level is planned or substantially refurbished, in order to assess the cost and benefits of utilising the waste heat to satisfy economically justified demand, including through cogeneration, and of the connection of that installation to a district heating and cooling network*." As noted in the comments above, the HPP does not have a significant source of low grade heat because of the extent of heat integration incorporated within its design (noting this is key requirement of the BAT Guidance for Hydrogen Production).

Figure 3-1 Simplified HPP Heat Balance Diagram



Note: This is a simplified diagram that does not take into account energy interchanges throughout the process, nor does it include energy embodied in the compressed feed and product gases.

4.0 MANAGEMENT TECHNIQUES & ACCIDENT MANAGEMENT

4.1 Management Techniques

4.1.1 Essar has an existing Environmental Management System, certified to ISO14001:2015, that meets the requirements of BAT 1 of the Refining of Mineral Oil and Gas BAT Conclusions [9]. This will be updated, where necessary, to incorporate the new HPP and include any plant-specific management arrangements and procedures (see Section 8, POC10).

Table 4-1 HPP Comparison with the Refining of Mineral Oil and Gas BAT Conclusions - Environmental Management Systems

BAT 1. In order to improve the overall environmental performance of plants for the refining of mineral oil and gas, BAT is to implement and adhere to an environmental management system (EMS) that incorporates all of the following features:	
Technique	**Justification**
i. Commitment of the management, including senior management;	The operator already has an EMS that meets the requirements of BAT 1 of the Refining of Mineral Oil and Gas BAT Conclusions. The decision document for V009 of the existing permit (EPR/FP3139VN) [11] states: "*The operator has confirmed that all the features specified by the BAT Conclusion are incorporated into the existing Environmental Management System which is externally certified to ISO14001.* *References were provided for each sub-paragraph, along with a copy of their ISO14001:2004 Management System Certificate which is valid to 15 September 2018 (Certificate No. 189212-2015-AE-GBR-UKAS).* *We agree with the operator's stated compliance*." The existing EMS is now certified to ISO14001:2015. The EMS will be updated to incorporate the HPP, including any plant-specific emissions controls, management techniques and operating procedures. This update will include a review and update of the Accident Management Plan.
ii. Definition of an environmental policy that includes the continuous improvement for the installation by the management;	
iii. Planning and establishing the necessary procedures, objectives and targets, in conjunction with financial planning and investment;	
iv. Implementation of the procedures paying particular attention to: (a) structure and responsibility (b) training, awareness and competence (c) communication (d) employee involvement (e) documentation (f) efficient process control (g) maintenance programmes (h) emergency preparedness and response (i) safeguarding compliance with environmental legislation.	
v. Checking performance and taking corrective action, paying particular attention to: (a) monitoring and measurement (see also the reference document on the General Principles of Monitoring) (b) corrective and preventive action (c) maintenance of records (d) independent (where practicable) internal and external auditing in order to determine whether or not the EMS conforms to planned arrangements and has been properly implemented and maintained;	

BAT 1. In order to improve the overall environmental performance of plants for the refining of mineral oil and gas, BAT is to implement and adhere to an environmental management system (EMS) that incorporates all of the following features:	
Technique	**Justification**
vi. Review of the EMS and its continuing suitability, adequacy and effectiveness by senior management;	
vii. Following the development of cleaner technologies;	
viii. Consideration for the environmental impacts from the eventual decommissioning of the installation at the stage of designing a new plant, and throughout its operating life;	
ix. Application of sectoral benchmarking on a regular basis.	

4.2 Accidents and their Consequences

Accident Management Plan

4.2.1 Essar already operates a refinery-wide Accident Management Plan (AMP) [13] which has been developed in line with relevant EA Guidance. The intention is to extend the existing AMP, prior to commissioning, to include the Accident Risk Assessment (ARA) prepared for the HPP and appropriate accident management measures (see Section 8, POC10).

Accident Risk Assessment

4.2.2 The HPP ARA (see Appendix 4.0) identifies the accident hazards and risks associated with the HPP – for example, release of hazardous materials, or a fire – and against each accident hazard sets out the:

- Consequences of the accident happening;
- Risk severity;
- Measures which will be put in place to limit the likelihood of the accident's occurrence; and
- Measures which will be put in place to respond to the accident were it to occur.

4.2.3 The potential accidents associated with the operation of the HPP – i.e. input to the ARA – were identified during the HPP Project's ENVID workshop undertaken in September 2020. The ENVID workshop had similar objectives to those of the AMP, namely to:

- Identify potential environmental hazards associated with routine operations and incidents;
- Assess the potential severity of these events;
- Propose recommendations to eliminate, prevent, control or mitigate hazards as necessary; and
- Explore the opportunities for Inherently Safer Design.

4.2.4 The ENVID was carried out in the form of a review using structured guidewords to identify hazard and accident scenarios. The review was led by an independent facilitator from SNC Lavalin, while the ENVID team itself comprised multi-disciplinary personnel from SNC Lavalin, Essar Oil (UK) Ltd, Johnson Matthey and Progressive Energy Ltd (i.e. the Consortium). The HPP systems considered during the ENVID are summarised in Table 4-2.

Table 4-2 Scope of ENVID

HPP System	Sub-systems Assessed for Accident Scenarios
Process	• Low Carbon Hydrogen Unit • Carbon Capture Unit • CO_2 Dehydration • PSA package • Hydrogen Compressor • CO_2 compression and export • Amine storage vessel
Feeds	• Refinery off-gas compression • NTS natural gas compression • Hydrogen import (start-up hydrogen to be imported by tanker) • CO_2 tie-in from CF Fertiliser plant • CO_2 tie-in from Essar Refinery (future)
ASU	• Air Separation Units and O_2/ N_2 storage tanks
Flare & Pipelines Area	• Elevated flare and KO drum • NTS natural gas import pipeline • CO_2 export pipeline • Hydrogen export pipelines
Utilities and Offsites	• Cooling medium (33% glycol), waste water, demin water, storm water, foul water, water treatment, instrument/ plant air and electrical infrastructure

4.2.5 The likelihood of an identified accident, and its severity, were then assessed using the Essar Risk Assessment Matrix shown in Table 4-3. The guidance used with respect to environmental consequences is set out in Table 4-4 immediately thereafter.

4.2.6 It is noted that the ENVID scope covered the operational Phase 1 plant only; future project phases were not considered. Also, construction hazards associated with the construction of future phases adjacent to the live Phase 1 plant were not considered in this workshop as construction hazards were the subject of a separate workshop and Constructability Review.

Table 4-3 Essar Risk Assessment Matrix

CONSEQUENCE				SEVERITY	LIKELIHOOD				
					Never heard of in industry	Similar event has occurred in the global refining sector	Similar event has occurred in the UK refining sector	Likely to occur in the life of the facility or has occurred once or twice at the facility	Common occurrence at the facility
					Less than once per 1,000,000 years of operation	Once per 100,000 years of operation	Once per 1,000 years of operation	Once per 10 years of operation	Greater than once per year of operation
					$< 10^{-6}$ per annum	10^{-6} - 10^{-4} per annum	10^{-4} - 10^{-2} per annum	10^{-2} - 1 per annum	> 1 per annum
PEOPLE	ENVIRONMENT	ASSET DAMAGE	REPUTATION		A	B	C	D	E
No injury or health effect	No effect	No damage	No impact	0					
Slight injury or health effect	Slight damage	Slight damage (< $10k)	Low impact	1					
Minor injury or health effect	Minor damage	Minor damage ($10k to $100k)		2					
Major injury or health effect	Moderate damage	Moderate damage ($100k to $1M)	Medium impact	3					
Permanent Total Disability or single onsite fatality	Major damage MATTE Classification A or B	Major damage ($1M to $10M)	High impact	4					
Multiple onsite fatalities or single offsite fatality	Major damage MATTE Classification C	Massive damage ($10M to $100M)		5					
Multiple offsite fatalities + multiple onsite fatalities	MATTE Classification D	Catastrophic damage (> $100M)		6					

Table 4-4 Classification of Environmental Severity

Severity	Environmental Effect	Guidance
0	No effect	
1	Incidental	Substantiated incident with no impact – Common Incident Classification Scheme (CICS) Category 4. Any incident that is not classed as minor or more severe and: • Has no material impact, and • Is easily recoverable, and • Is not a voluntary report or mandatory notification to regulators, and • Does not cause valid complaints.
2	Minor	Minor or minimal impact on the environment, people and/ or property – CICS Category 3: • Water: Contamination localised around the point of discharge and/ or minor impact extending over a few kilometres of a stream (such as a thin oil sheen). • Land: Insignificant or temporary contamination of land (i.e. land has been contaminated with small amounts of non-hazardous waste) • Air: Short term, local effect on air quality arising from smells or visible impact (smoke and dust). • Noise: Mildly offensive, short-term and/ or intermittent noise that causes minimal effect on human senses. • Odour that is transitory and offensive to human senses (<10 complaints in one week). • Waste: Isolated waste management incident that does not involve hazardous waste. • Permit(s): Single permit breach requiring notification to the regulator, permit breach NOT giving rise to multiple complaints or Enforcement Action.
3	Serious	Significant impact on the environment, people and/ or property – CICS Category 2: • Water: Contamination up to few hundred metres in a larger water body and/ or effects over several kilometres (such as a heavy iridescent film). • Groundwater: Contamination plume within 50 m in any aquifer, hazardous substances discernible above pre-existing levels. • Ecology: Damage to a statutorily protected site or species (i.e impact on Mersey estuary- RAMSAR site; impact on biodiversity and/or fish). • Land: Significant but localised contamination of land. (i.e release of 100s of litres of oil to land). • Air quality: Noticeable and sustained deterioration in air quality from visible sources (dust and particulate fallout) or emission of toxic materials. • Noise: Abnormal and prolonged enough to cause significant effect on human senses. Temporary works of construction or maintenance may also be regarded as abnormal. • Odour: >10 complaints during one week or where people have to shelter (windows and doors closed). • Waste: An incident involving hazardous wastes. • Permit(s): Serious permit breach, repeated minor breach, permit condition breach giving rise to multiple complaints, Prohibited activity.

Severity	Environmental Effect	Guidance
4	Major	Major, persistent and/ or extensive impact on the environment, people and/ or property – CICS Category 1, MATTE Classification A or B event: • Water: Effect over several kilometres (>2 km) of a watercourse or a large area of still water, effect is still evident at least 7 days from the date that contamination enters the water. • Groundwater: Contamination plume extending beyond 50 m in any aquifer, hazardous substances discernible above pre-existing levels in the groundwater beyond 50 m in any aquifer. • Ecology: Major adverse effect on a statutorily protected site or species. (i.e. major effect on fish and/ or biodiversity). • Land: Persistent and/ or extensive contamination of land, which is likely to need extensive decontamination measures. • Air quality: Significant deterioration in air quality from visible sources (dust and particulate fallout) or emission of toxic materials for a sustained period, over an extensive area. • Noise: Effects include noise which is at a volume, duration or characteristic (intermittency, impulse or tone) that it is very offensive to human senses and prevents sleep. • Odour: >50 complaints during 24 hours where people have to shelter (windows and doors closed) or >100 complaints within 24 hours (where shelter is not necessary). • Permit(s): Major Permit Breach, condition breach giving rise to enforcement action, multiple permit breaches leading to Enforcement Action.
5	Severe	CICS Category 1, MATTE Classification C Event: • Damage that will lead to loss of use of natural resource over a wide area. • Impact of national environmental significance.
6	Catastrophic	CICS Category 1, MATTE Classification D Event: • Damage with long or very long-term harm duration • Impact of international environmental significance

Flood Risk Assessment

4.2.7 A Flood Risk Assessment (FRA) has been prepared as part of the Environmental Impact Assessment (EIA) for the HPP project that will be submitted to Cheshire West and Chester Council (CW&CC). The EA will be consulted on the FRA as part of the planning application process. A copy of the Environment Statement (the output of the EIA process) will be provided to the EA when it is issued.

5.0 SITE CONDITION

5.1.1 The HPP is located on an area of the Stanlow Refinery, included within the existing Refinery Environmental Permit, which was previously used for the Alcohols plant and for tank storage. Essar are in the process of producing a Site Condition Report and collecting Baseline Data to characterise the condition of ground and groundwater across the Refinery installation to address existing Improvement Conditions (IC35 and 36); this will include the area of land covered by the proposed HPP.

5.1.2 Substances that are proposed to be used and stored on the HPP site are identified in Tables 3-34 (raw materials) and Table 3-36 (wastes). Measures that will be adopted at the HPP site to contain, prevent and control releases of potentially hazardous substances are identified in Section 3.7 (see Table 3-25). All potentially polluting substances are provided with primary and secondary containment, with process areas located on hardstanding, and drainage from areas of pollution risk being collected in the "potentially contaminated" drains for treatment in the HPP wastewater treatment system.

5.1.3 Information on relevant hazardous substances stored on the HPP, their physical containment, and the management techniques adopted to prevent and control releases, will be included in the Site Condition Report that will be produced by Essar in response to existing improvement conditions IC35 and 36..

5.1.4 Any incidents that arise in the lifetime of the HPP which could impact on site condition will be documented by Essar, along with the measures taken to mitigate their impact, in accordance with EMS requirements, and the EA's lifetime records approach.

5.1.5 The activities at the HPP site will be carefully controlled both by local containment and operational techniques. The measures put in place will ensure that operations during the life of the HHP facility are unlikely to lead to pollution of groundwater or the ground, and will not lead to deterioration of the state of the land.

6.0 PROPOSED EMISSIONS

6.1 Overview

6.1.1 This section sets out the emissions from the HPP and identifies proposed emission limit values (ELVs) based on design data. The proposed emissions are compared with Associated Emission Levels (AELs) identified in BAT Conclusions and ELVs identified in relevant legislation, in order to demonstrate that the proposed emissions from the HPP are consistent with BAT. Since actual emissions data is not available (as the HPP is a new plant) it is proposed that emissions monitoring is carried out as part of commissioning to confirm that actual emission values (see section 8, POC6).

6.2 Emissions to Air

Proposed Emission Limits

6.2.1 Proposed ELVs for emissions to air from the HPP are shown in Table 6-1. It is highlighted that:

- SO_2 emission limit values are not proposed for combustion plant as they will be controlled by the sulphur content of the fuel (for NG, PSA tail gas and low sulphur diesel);
- Particulate matter (PM) emissions limits are not proposed for gaseous fuels;
- No ELVs are proposed for the standby diesel generator and the firewater pump due to their limited operation in testing and emergency. This is in line with the requirements of the Medium Combustion Plant Directive (MCPD) set out in EPR16 Schedule 25A; and,
- No ELVs are proposed for the flare as it is only for use in process upset (including start-up and shut-down) and emergency operations, which will only occur for a small proportion of total operating hours (expected to be well below 3% of operating hours).

Table 6-1 Emissions to Air

Ref.	Source[1]	Grid Reference	Parameter	Proposed ELV (mg/Nm^3) [2]
HPP-A-1	Feed Fired Heater	344462,375236	NOx (as NO_2)	80
			CO	100
			SO_2	No limit proposed
			PM	No limit proposed
HPP-A-2	Steam Boiler	34467,375247	NOx (as NO_2)	80
			CO	100
			SO_2	No limit proposed
			PM	No limit proposed
HPP-A-3	Flare	344337,375507	NOx (as NO_2)	No limit proposed
			CO	No limit proposed
			SO_2	No limit proposed
			PM	No limit proposed
HPP-A-4	Emergency Diesel Generator	344807,374935	NOx (as NO_2)	No limit proposed
			CO	No limit proposed
			SO_2	No limit proposed
			PM	No limit proposed
HPP-A-5	Firewater Pump	344861,374968	NOx (as NO_2)	No limit proposed
			CO	No limit proposed
			SO_2	No limit proposed
			PM	No limit proposed

Notes

1. Stack dimensions and the physical conditions of emissions are provided in the Air Quality Report in Appendix A2.0.

2. Reference conditions for Feed Fired Heater, Steam Boiler and all other emission points apart from diesel generator are 273.15K, 101.3 kPa dry gas, 3% O_2. Reference Conditions for the diesel generator are 273.15K, 101.3 kPa dry gas, 15% O_2.

Legislative and BAT Emissions Values

6.2.2 This section identifies the legislation and BAT Conclusions that apply to the HPP, and sets out the applicable AELs and ELVs contained in those documents. The latest version of the Hydrogen BAT Guidance Document [2] states that:

"*The emission levels for the combustion equipment in the scope of the hydrogen production and CCS plant will need to be identified from the existing sources of statutorily applicable emission limits, including the following:*

- *Medium Combustion Plant Directive*
- *Industrial Emissions Directive, Annex V*
- *BAT Conclusions and BRef for the Refining of Mineral Oil and Gas*
- *BAT Conclusions and BRef for Large Combustion Plant*
- *BRef for Large Volume Inorganic Chemicals (Ammonia and Fertilisers)*"

6.2.3 These sources are considered below.

Industrial Emissions Directive

6.2.4 The HPP Combustion Plant (Feed Fired Heater, Steam Boiler and Emergency Diesel Generator) have an aggregated thermal input capacity of 50.7 MWth. The plant will constitute Chapter II Industrial Emissions Directive (IED) combustion plant but not Chapter III (Ch III) plant. This is because each plant item over 15 MWth has its own stack, and will thus not fall under the aggregation rules, and will not be a Large Combustion Plant under Ch III of the IED[5]. The Large Combustion Plant BREF [14] does not, therefore, apply.

6.2.5 The IED does not set ELVs for Ch II plant. IED Ch III emission limits do not apply to the Phase 1 plant (the subject of this variation application). There is the possibility, depending on the layout of the Phase 2 plant, that IED Ch III requirements could apply in future; Ch III ELVs have therefore been included for information in Table 6-2 to cover this eventuality.

EPR16 Schedule 25A

6.2.6 The HPP Combustion Plant will also be Medium Combustion Plant under EPR16 Schedule 25A. The MCPD ELVs apply to the Feed Fired Heater and Steam Boiler,

[5] In cases where the waste gases of two or more combustion plants are, or could be, discharged through a common stack, the aggregation rules of Article 29 of the IED define whether and when such a combination of plants shall be considered as a single combustion plant. For the purpose of calculating the total rated thermal input, combustion plants with a rated thermal input below 15 MW shall not be considered.

but not to the Emergency Diesel Generator and diesel-driven Firewater Pump as they operate for fewer than 500 hours a year.

EPR16 Schedule 25B

6.2.7 The HPP Combustion Plant will not be Specified Generators under EPR Schedule 25B, as the Feed Fired Heater, Steam Boiler and Firewater Pump are not generators, and the Emergency Diesel Generator is an Excluded Generator as it is emergency plant operating for fewer than 50 hours a year.

BAT Guidance

6.2.8 The Hydrogen BAT Guidance Document [2] does not contain any specific emission limits or benchmark values for combustion plant emissions. The Large Volume Inorganic Chemicals BREF [15] does not specifically address emissions to air from plant used in the production of hydrogen as a product. Similarly, the Common Waste Water and Waste Gas Treatment/ Management Systems in the Chemical Sector BAT Conclusions [8] do not contain relevant AELs or benchmark values for emissions to air. The Refining of Mineral Oil and Gas BAT Conclusions [9] do, however, contain relevant AELs for emissions to air, and these are shown in Table 6-2.

Compliance of HPP with MCPD & IED ELVs and BAT AELs

6.2.9 Comparison of the proposed HPP ELVs with the MCPD, and IED Ch III ELVs and the Refineries BREF AELs shows that the HPP is within these BAT emission levels.

Table 6-2 Relevant BAT ELVs for Emissions to Air

Parameter	ELVs[1] (mg/Nm³)		
	MCPD	Refineries BAT Conclusions	IED Ch III
NOx	100[2]	30 - 100	100
CO	-	≤100	100
SO_2	35[3]	5 - 35	35
PM	-	5 - 25	5
Ammonia	-	5 -1 5[4]	-

Notes

1. Reference conditions for Feed Fired Heater, Steam Boiler and all other emission point apart from Emergency Diesel Generator are 273.15K, 101.3 kPa dry gas, 3% O_2. Reference Conditions for the diesel generator are 273.15K, 101.3 kPa dry gas, 15% O_2.
2. 200 mg/Nm³ when burning gases other than NG.
3. Only applies when burning gases other than NG.
4. Only applies where SCR/ SNCR is used.

6.3 Discharges to Water

6.3.1 Discharges to water comprise:

- Discharge of uncontaminated site drainage to the wider refinery drainage system, which runs to the west of the HPP site [exact location(s) to be determined later in detailed design] and is transferred to the United Utilities (UU) water treatment plant at existing transfer point S1; and,
- Discharge of demineralizer plant concentrate at point T1 (at CT2, already included in the existing permit) This will then flow from CT2 to discharge through point N38 to existing permitted discharge point W3.

6.3.2 Proposed discharges are shown in Table 6-3.

Table 6-3 Proposed Emission Values for HPP Discharges to Water

Ref.	Source	Grid Reference	Parameter	Proposed Discharge Value (mg/l unless otherwise stated)	Existing W3 Limit (Table S3b)
TBD	Uncontaminated Surface Water	TBD	No limit proposed	-	-
T1	Water Demineralization Plant concentrate	344022, 375296	Temperature	24.2 ˚C	32.5 ˚C
			pH	7.59	6-9
			Flow (actual)	42.37 m^3/h	3750 m^3/h
			Flow (design)	50.85 m^3/h	3750 m^3/h
			TSS	0.00	25
			COD	8.030	125
			BOD	5.996	-
			Ammonia	-	20 (as Total N)
			Methane	-	-
			Ethylene - Pentane	-	-
			Methanol	-	-
			Ethanol	-	-
			Amine	-	-
			Phosphates	≤3 (Total P)	-
			Chlorides	TBD	-
			Iron	TBD	-
			Chromium	≤0.025	-
			Copper	≤0.05	-
			Zinc	≤0.3	-

Ref.	Source	Grid Reference	Parameter	Proposed Discharge Value (mg/l unless otherwise stated)	Existing W3 Limit (Table S3b)
			Nickel	≤0.02	0.02
			Hydrocarbon oil	-	10
			Hydrocarbon oil index	-	2.5
			Benzene, toluene,ethyl benzene, xylene(BTEX)	-	Benzene 0.05 mg/l
			Cadmium	-	0.002
			Mercury	-	0.0002
			Lead	-	0.002
			Vanadium	-	-
			Cyanide	-	0.02
			Sulphide	-	1

6.3.3 It is proposed that where discharges of substances or physical parameters are already controlled by W3 discharge limits in the existing permit, these remain unchanged. Where substances not included in the W3 permitted discharge limits are discharged, it is proposed that discharge limits are set at the proposed discharge value identified in Table 6-3, subject to the findings of the water discharge assessment (see Section 7.3).

Legislative and BAT Discharge Values

6.3.4 The IED and MCPD do not contain relevant limits for discharges to water. The Hydrogen BAT Guidance Document [2] and the Large Volume Inorganic Chemicals BREF [68] do not contain any relevant emission limits or benchmark values for discharges to water. The Refining of Mineral Oil and Gas BAT Conclusions [9] and the Common Waste Water and Waste Gas Treatment/ Management Systems in the Chemical Sector BAT Conclusions [8] do contain relevant AELs for discharges to water; these are shown in Table 6-4.

Table 6-4 Relevant BAT AELs for Discharges to Water

Parameter	BAT AELs (mg/l unless otherwise stated)	
	Refineries BAT Conclusions	Common Waste Water and Waste Gas Treatment BAT Conclusions
TSS	5 - 25	5 - 35
COD	30 - 125	30 - 100
BOD	No BAT AEL	No BAT AEL [1]
Ammonia	1 - 25 (Total N)	5 - 25
Phosphates	-	0.5-3 (Total P)
Chlorides	-	-
Iron	-	-
Chromium	-	5 - 25 µg/l
Copper	-	5 - 50 µg/l
Zinc	-	20 - 300 µg/l
Nickel	0.005 - 0.100	5 - 50 µg/l
Notes 1. BAT Conclusions notes that average BOD5 from biological wastewater treatment plant will generally be ≤20 mg/l.		

6.3.5 Discharges from the HPP at W3 will meet BAT AELs. Proposed emission limits for substances without BAT AELs (phosphates, chlorides and iron) will be confirmed following completion of the W3 discharge assessment (see Section 7.3).

7.0 ENVIRONMENTAL RISK ASSESSMENT

7.1 Scope of Assessment

7.1.1 An Environmental Risk Assessment (ERA) has been compiled to determine the environmental risks posed by the HPP, and to ensure that there are no significant impacts on the environment or human health. The following assessments have been carried out in accordance with EA guidance:

- Air quality;
- Noise;
- Surface water;
- Global warming potential;
- Site waste;
- Fugitive releases; and,
- Odour.

7.1.2 There are no direct discharges to ground or groundwater, nor is there any disposal of waste to land on the HPP site.

7.1.3 Quantitative assessments of discharges to air and noise have been carried out and are provided in Appendices A2.0 and A3.0; their findings are summarised in section 7.3. Emissions to surface water are quantified and a *partial* assessment is provided in section 7.3 under the "Surface Water" heading. It is highlighted that further assessment will be carried out once the refinery-wide effluent assessment has been produced.

7.1.4 Emissions of greenhouse gases have been quantified in section 7.3 under the "Global Warming Potential" heading, and the impacts of wastes, fugitive emissions and odour impacts considered later in section 7.3. A qualitative ERA, following EA Guidance [17], is provided in Tables 7-2 to 7-5.

7.2 Sensitive Receptors

7.2.1 The HPP is situated on the "Alcohols" area, in the south-eastern quadrant of the Stanlow Refinery. The main sensitive properties and residential receptors which may be affected by the HPP are those in the villages of Thornton-le-Moors (approximately 325 m to the south), Elton and Elton Green, at their closest point approximately 185 m to the east of the site boundary, and the village of Ince, approximately 645 m to the north east of the site. North of Elton and east of Ince is the Encirc Glass factory, and further east is the Ince Park Biomass Energy Plant and the CF Fertilisers facility. Immediately to the east of the northern part of the site lies the University of Chester's Thornton Science Park which accommodates over 40 science and technology sector companies.

7.2.2 Ecological receptors include Mersey Estuary, approximately 1.6 km to the north of the site, which is a designated Ramsar site, Special Protection Area (SPA) and Site

of Special Scientific Interest (SSSI). The River Dee and Bala Lake SAC (also designated a SSSI) lies 8.9 km south west of the site at its closest point in Chester.

7.2.3 No other internationally designated sites, or SSSIs, Local Nature Reserve (LNRs), National Nature Reserves (NNRs) or ancient woodland were identified within a 2 km radius of the site boundary. There are a number of Local Wildlife Sites (LWS) within 2 km of the Site boundary, the closest of these is the Gowy Meadows and Ditches Local Wildlife Site which is approximately 520 m to the south west of the site. The other Local Wildlife Sites are identified in the Air Quality Report in Appendix A2.0.

7.2.4 The site partially lies within Thornton le Moors Air Quality Management Area (AQMA). This area encompasses the entire village of Thornton le Moors, its surroundings and parts of the adjacent area of Stanlow. It was declared in 2016 for exceedances of the Air Quality Standard (AQS) objective for sulphur dioxide (SO_2) associated with the refinery. There are also AQMAs in Ellesmere Port (Whitby Road/ Station Road) and Frodsham (A56/ Fluin Lane), and Chester (city centre), which were all declared for annual mean NO_2 with road traffic as the main source. The nearest of these is Ellesmere Port, approximately 4.5 km to the north west.

7.2.5 The Manchester Ship Canal and the River Mersey run in an east-west direction at a distance of 1.4 km and 2 km to the north of the site respectively. Gale Brook, partially culverted during the development of the refinery, is located approximately 60 m west of the site. This watercourse has not been classified by the EA. Thornton Brook runs approximately 1.1 km to the west to its confluence with the River Gowy approximately 1.4 km to the north west.

7.2.6 The Air Quality Assessment Report (Appendix A2.0) and the Noise Assessment Report (Appendix A3.0) provide further details of the sensitive receptors that could be affected by the HPP in relation to air quality and noise impacts.

7.3 Assessment Findings

Air Quality

7.3.1 The main sources of emissions to air from the HPP are the continuously-operating combustion plant (the Feed Fired Heater and Steam Boiler). Emissions from these plant have been modelled and their impacts on air quality have been assessed in the Air Quality Assessment Report presented in Appendix A2.0.

7.3.2 There are also some minor emissions sources which operate only occasionally:

- The flare, which operates during start-up and shut down, process upset or emergencies;
- The diesel generator and firewater pump, which are small plant which only operate for testing or in emergencies (typically <1 hour a month); and

7.3.3 Given their minor and transitory nature and the consequently negligible effect of their emissions on air quality, these sources have not been subject to quantitative assessment.

Stack Height Assessment

7.3.4 A stack height assessment was carried out to support the HPP design (see Appendix A2.0). The assessment modelled NOx emissions from the Feed Fired Heater and Steam Boiler at a range of stack heights at 5 m increments between 35 and 55 m. The maximum predicted ground level concentrations at each stack height were plotted. This illustrated that above a stack height of 40 m there was a noticeable reduction in the rate at which ground level concentrations of NOx decreased with each additional 5 m of stack height. Stack heights of 40 m were therefore selected for the HPP design, as representing BAT for dispersion.

Assessment Conclusions

7.3.5 The air dispersion modelling study estimated the impacts of emissions of NO_2, CO and SO_2 at human health and ecological receptors from the concurrent operation of the Feed Fired Heater and the Steam Boiler. Particulates were not considered as their emission from gas fired plant are negligible:

- The air quality assessment did not identify any likelihood of breaches of long or short-term air quality assessment criteria at human receptors for any pollutant or averaging period; and
- The long- and short-term impacts at both statutory and non-statutory ecological sites within the study area were also found to be negligible in terms of critical levels and loads.

7.3.6 On this basis, it is concluded that the impact of the Feed Fired Heater and the Steam Boiler at the HPP on local air quality is not significant.

Noise

7.3.7 A BS4142 noise assessment has been carried out to predict the impact of operational noise from the HPP site (see Appendix A3.0). Noise Sensitive Receptors (NSRs) were identified in the vicinity of the HPP, and noise survey results were used to establish the baseline noise climate in the area of the HPP site and establish the background noise level for the purposes of the assessment.

7.3.8 Worst case data on HPP noise levels were identified, together with data on noise attenuation measures on the main noise generating equipment. Noise modelling was carried out to predict noise levels at NSRs.

Assessment Conclusions

7.3.9 The noise modelling results are shown in Table 7-1.

Table 7-1 Noise Modelling Results

Receptor location	Predicted noise level (dBA)
The Stables travellers' site	47
Little Meadow travellers' site	46
Elton	43
Thornton Science Park	42
Thornton le Moors	41
St Mary's Church, Thornton le Moors	38
Elton Primary School	35
Ince	32

7.3.10 The noise modelling results identified that the highest predicted noise level at a NSR is 47 dBA at the Stables travellers' site to the south of the HPP facility. This compares with a night-time background noise assessment level of 46 dB LA_{90}. The BS4142 assessment concluded that the HPP is likely to cause, at worst, a low impact at the NSR during night-time. The impact during daytime and at other receptors will be lower, with results at or below the existing background noise level.

7.3.11 The noise assessment was based on worst-case plant noise data available at the current FEED stage of design; further information on noise levels from equipment will become available in the detailed design phase. This, coupled with the BAT management procedures and control measures that will be used at the installation to mitigate the noise impact (identified in the report in Appendix A3.0) will control noise generating activities so as to minimise the risk of annoyance or public nuisance.

Surface Water

7.3.12 There will be two surface water drainage networks forming the HPP Open Drainage System:

- Clean System, which will collect rainfall from areas that are unlikely to contain any contamination such as roads, building roofs, the old tank farm area and the unpaved southern area of the site. The water will be collected in four sumps and thence discharged to the wider Essar site drainage network, and onward to the UU treatment plant at S1;
- Potentially Contaminated System, which will collect run-off from hardstanding in process areas (process, ASU and Utilities areas) via individual sumps in each area (four in total). The water will be routed to the HPP CPI and from there, the de-oiled water will be fed to the MBR and re-used within the process.

7.3.13 The discharge of clean uncontaminated rainfall through the Essar collection systems will not give rise to any adverse environmental impacts. There are no planned emissions to groundwater, although some of the clean uncontaminated rainfall will infiltrate ground as part of SUDS design. There is potential for fugitive releases to water, and a qualitative assessment on the impact to receiving waters, ground and groundwater has been carried out and is presented in Table 7-5. The assessment concludes that the risk level is low.

7.3.14 The only discharge of process effluent is the reject water from the Water Demineralization Plant, which is discharged to the wider Essar Refinery site via the CT2 open sump, N38 interceptor and out through the existing W3 outfall to the Manchester Ship Canal. The composition of this discharge is shown in Table 6-3. The effluent stream will meet the ELVs listed in the Essar Refinery Permit [1] for W3, which are derived from the BAT Conclusions for Refining of Mineral Oil and Gas [9]. Additional substances not listed on the permit will meet the Refineries BAT AELs, and/ or Common Waste Water BAT AELs, where specified.

7.3.15 Essar are currently carrying out a review of site effluents to address an existing Permit Improvement Condition (IC38), which will result in changes to the effluents, flow rates and compositions discharged via the existing permitted discharge points. An assessment of the existing and the revised discharges (including those through W3) is currently being developed by Essar, using H1 or a more developed model, and is due to report in the next few months.

7.3.16 This assessment of existing and revised discharges will need to be completed first in order to provide a basis for the assessment of HPP discharges (which will be an additional element to the revised W3 discharges). Once the refinery-wide revised discharges assessment is submitted in response to IC38, Essar propose adding the HPP discharges to the revised case assessment model, and provide this assessment to the EA at the earliest opportunity.

Global Warming Potential

7.3.17 The global warming potential (GWP) of the HPP has been calculated in accordance with the EA's guidance [16]. The total GWP score for the facility is 17,405 teCO_2eq/year. This figure has been derived from direct CO_2 emissions from the combustion of PSA tail gas in the Feed Fired Heater and Steam Boiler and diesel fuel in the Emergency Diesel Generator. Indirect CO_2 emissions associated with electrical power consumption are zero, as the HyNet Project has a stated strategy to purchase green (zero-CO_2) electricity from the grid in the short-term, and in the medium term to replace some or all of the external CO_2-free electricity supply with electricity generated from the HPP product hydrogen sent to the proposed Stanlow Refinery hydrogen-fired Combined Heat & Power plant (there is a separate project to upgrade the existing CHP to use hydrogen fuel). It is highlighted that the use of green electricity (under a guarantee of origin from renewable energy sources), as opposed to "conventional" grid supply, results in a saving of 104,700 te CO_2 per annum (the saving can be calculated by setting the CO_2 conversion factor in Table 7-2 to 0.166).

Table 7-2 - Global Warming Potential

Energy	Source	Usage (MWh/yr)	Energy Conversion Factor	CO_2 Conversion Factor	GWP ($teCO_2eq/yr$)
Direct Emissions	Emergency Diesel Generator	34.8(1)	1.0	0.25	9
Direct Emissions	Feed Fired Heater	Note 2.			7,340
Direct Emissions	Steam Boiler	Note 3.			10,056
Indirect Emissions from HPP Electricity Use	Grid supply	262,800	2.4	0(4)	0
Total					**17,405**

Notes

1. The estimate of Emergency Diesel Generator GHG emissions is based upon operation of the unit for 12 hours per year.
2. The Feed Fired Heater GHG emissions have been calculated on the basis of the combustion of PSA tail gas at maximum continuous rating (MCR), 8760 hours per year (resulting in a CO_2 emission of 0.84 te/hr).
3. The Steam Boiler GHG emissions have been calculated on the same basis (resulting in a CO_2 emission of 1.15 te/hr).

The GWP contribution from the testing and emergency operation of the diesel-driven firewater pump has not been included due to its small scale and limited period of operation.

4. Indirect emissions from electricity use are zero as the electricity will be sourced from zero-CO_2 supply.

Site Waste

7.3.18 The HPP wastes are identified in Chapter 3. They include: water treatment sludges, spent catalysts and absorbents, spent inert support media, refractory linings and internal supports, waste amine, waste TEG, waste oils and other maintenance wastes. The majority of wastes are only generated on an occasional basis in line with the maintenance programme. However, water treatment sludges will be generated continuously during operations.

7.3.19 Essar will extend their existing waste management controls to the HPP wastes to ensure wastes will be managed in accordance with current practices and sites EMS

Fugitive Emissions

Fugitive Emissions to Air

7.3.20 Potential sources of fugitive emissions to air arise from ROG, NG and process/product gases in pipework and process vessels, pressure relief valves and vents on the amine, TEG and diesel storage tanks, along with any spills of these materials, which have the potential to give rise to releases of VOCs, CO_2, amine or TEG.

7.3.21 Controls are listed in Section 3.7 and summarised in Tables 3-23 and 3-24. It is also noted that pressure relief valves only operate during abnormal operation, the diesel tank is small and not refilled frequently, and the amine and TEG tanks are only used occasionally and are under a nitrogen blanket. In this context fugitive

emissions to air are considered minimised and are not predicted to give rise to any significant environmental impacts.

Fugitive Emissions to Water or Land

7.3.22 There will be bulk storage of raw materials and wastes, which include solids, liquids and sludges. Releases to land, groundwater and the surface water drainage system from spills and leaks are therefore theoretically possible. For this reason, a series of mitigation and control measures will be put in place:

- Tanks that contain potentially polluting raw materials will be bunded;
- Process areas will be surfaced with reinforced concrete hardstanding with spill containment kerbs and sealed construction joints;
- Surface water drainage will be segregated into 'clean' and 'potentially contaminated' drains with surface water from the process areas falling into the latter category and draining back to the process via the CPI;
- Deliveries of chemicals will be supervised by site staff; and
- Spill kits will be available with materials suitable for absorbing and containing minor spills. Site staff will be trained in their use and in the spill clean-up procedures.

7.3.23 With these controls in place, the risk to land and water from fugitive releases will be minimised. Full details of the control measures in place to minimise fugitive emissions to land and water are described in Section 3.7.

Odour

7.3.24 The Hydrogen BAT Guidance [2] does not identify odour as an issue, and the process is not inherently odorous:

- None of the process gases are released directly to atmosphere. Sulphur-containing feed gas, if it is relieved from the process, is combusted at the flare tip and discharged to atmosphere at a height of 60 m, ensuring good dispersion;
- Process absorbents – amine and TEG – are retained in a closed system and are not routinely discharged to atmosphere. They are both stored in tanks fitted with PSVs which limit, to a degree, tank venting;
- Both amine and TEG have relatively high boiling points and therefore have low potential to give rise to odour nuisance;
- Diesel is stored in a tank with an open vent. This is a small storage tank, diesel fuel has low volatility and the tank will only be filled infrequently; and
- The measures to control fugitive emissions to air identified in Section 3.7 will also control fugitive odour emissions.

7.3.25 The HPP is therefore not considered likely to give rise to any off-site odour nuisance.

7.4 Environmental Risk Assessment Summary

7.4.1 The main risks to the environment from the HPP are summarised in Tables 7-4 to7-5 in line with the EA's guidance for Environmental Risk Assessments [17]. Potential hazards have been evaluated in relation to the level of environmental risk they pose to receptors. For each hazard, the probability of exposure and consequence level have been categorised, and the categorisation has been used to establish an overall risk level using the following matrix:

Table 7-3 Risk Assessment Matrix

Risk Matrix		Consequence		
		High	**Medium**	**Low**
Probability of Exposure	**High**	High	High	Medium
	Medium	High	Medium	Low
	Low	Medium	Low	Low

7.4.2 The principles used when applying the probability and consequence rating are described below:

Probability of Exposure

- Low – An incident that is highly unlikely to occur without mitigation;
- Medium – A reasonably likely incident without mitigation; and
- High – An incident that is highly likely to occur without mitigation.

Consequence

- Low – An incident that would cause a negligible impact on receptors;
- Medium – An incident that would cause a slight impact on receptors; and
- High – An incident that would cause a serious threat to human health or the environment.

7.4.3 Finally, a residual risk level is established considering the control measures in place to mitigate that risk.

7.4.4 Accident hazards have been excluded from Tables 7-4 to 7-6 as they are addressed in the Accident Risk Assessment in Appendix A4.0. In accordance with EA Guidance [17] potential uncontrolled or unintended (fugitive) emissions are included in the ERA.

Table 7-4 ERA Summary - Emissions to Air

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of Risk	Risk Management	Residual Risk
Emission of combustion products from Feed Fired Heater, Steam Boiler, Diesel Generator, Firewater Pump and Flare	Feed Fired Heater, Steam Boiler, Diesel Generator and Flare	Release to air via stack/ flare	Local atmosphere Global atmosphere Site personnel Local residents Workforce at local businesses and amenity sites Local ecological sites	High	Low	Medium	Combustion units are maintained regularly and are designed and tuned to operate with permitted limits. Essar operates a preventative maintenance programme which includes the combustion plant. Routine emissions monitoring will be carried out to check compliance with permitted limits, where applicable. For further details of routine monitoring see Section 3.7.	Low
Emissions from vents/ off gases	CO_2 Compressor vent	Release to air via vent/ column	Local atmosphere Site personnel Local residents Workforce at local businesses and amenity sites	Medium	Low	Low	Emissions of amine is trace. HPP plant is maintained regularly. Essar operates a preventative maintenance programme. For further details of the prevention of odour releases to air, see Section 3.7.	Low

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of Risk	Risk Management	Residual Risk
Release of VOCs from diesel, amine and TEG tanks	Diesel, amine, TEG storage tanks	Fumes released to air by breathing/ displacement losses or following spill	Local atmosphere Site personnel Local residents Workforce at local businesses and amenity sites	Medium	Low	Low	Amine and TEG tanks are contained under a nitrogen blanket. Breathing losses minimised by occasional filling/ emptying of the tanks. Diesel, amine and TEG have relatively high boiling points, so have low volatility. Storage vessels are enclosed. Regular inspection and maintenance reduce the likelihood of leaks and spills. Essar operates a preventative maintenance programme which includes tanks. Pumps and valves are sealed. For further details of the prevention of fugitive releases to air, see Section 3.7. Accident Management Plan is in place to minimise and mitigate impact of an incident as part of the Installation's EMS.	Low

Table 7-5 ERA Summary - Emissions to Water/ Land

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of Risk	Risk Management	Residual Risk
Discharges of demineralizer plant effluent	Demineralizer plant	Discharge to Refinery drainage system, from there discharge via W3 to watercourse	Local watercourse	High	Low (pending further assessment see s.7.3)	Medium	Process maintenance and controls. Routine process monitoring is carried out to check compliance with permitted limits. For further details of routine monitoring see Section 3.7.	Low
Discharge of uncontaminated site runoff	Site drainage	Discharge to Refinery drainage system, from there discharge via S1 to United Utilities water treatment plant	UU Treatment Plant, then permitted discharge from treatment plant to watercourse	High	Low	Medium	Tanks are provided with secondary containment. Coolant and other maintenance fluids are provided with secondary containment. Pipelines are deployed away from site traffic. Spill kits are distributed at key locations across the site in the event of a spill. A spill procedure is in place and all staff trained. Records are available and kept up to date of all drainage structures including the routing of all drains. Essar operates a full preventative maintenance programme which includes tanks and bunds and checking for leaks and spills.	Low

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of Risk	Risk Management	Residual Risk
Contaminated run-off/ rainwater from site surfaces due to spill or leak of chemical/ fuel/ maintenance fluid	Contamination from materials stored on site	Percolation through and into soils Direct run-off from site across the ground and entering surface water drains or natural channels / ditches	Workforce Nearby natural habitats Ground Groundwater Surface water	Medium	Medium	Medium	Areas which may give rise to potentially contaminated surface water is discharged to the HPP WWTP where it is treated then reused in the HPP process. Tanks are provided with secondary containment. Coolant and other maintenance fluids are provided with secondary containment. Pipelines are deployed away from site traffic. Spill kits are distributed at key locations across the site in the event of a spill. A spill procedure is in place and all staff trained. Records are available and kept up to date of all drainage structures including the routing of all drains. Essar operates a full preventative maintenance programme which includes tanks and bunds and checking for leaks and spills. Accident Management Plan is in place to minimise and mitigate impact of an incident as part of the Installation's EMS. For further details on prevention of fugitive releases to water this can be found in Section 3.7.	Low

Table 7-6 ERA Summary - Noise & Odour Emissions

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of Risk	Risk Management	Residual Risk
Noise from HPP in routine operation	Noise from plant items	Noise propagation through the air	Local atmosphere Site personnel Local residents Workforce at local businesses and amenity sites Local ecological sites	High	Low	Medium	Siting, containment and abatement measures to minimise noise levels generated at source will be considered for noise generating plant items during detailed design. See the Noise Assessment Report. Essar operates a preventative maintenance programme which includes measures to prevent/ minimise noise generation and vibration. Spare parts are maintained on-site. External complaints will be immediately notified to Essar's Environmental Department/ Environmental Duty Officer for action who will then co-ordinate appropriate actions according to the nature of the communication.	Low
Noise from plant during testing or emergency operation	Noise generating plant, including engines, compressors valves and pumps.	Noise propagation through the air	Local atmosphere Site personnel Local residents Workforce at local businesses and amenity sites Local ecological sites	Medium	Low	Low	Siting, containment and abatement measures to minimises noise levels generated at source will be considered for noise generating plant items during detailed design. See the Noise Assessment Report. Essar operates a preventative maintenance programme which includes measures to prevent/ minimise noise generation and vibration. Spare parts are maintained on-site. External complaints will be immediately notified to Essar's Environmental Department/ Environmental Duty Officer for action who will then co-ordinate appropriate actions according to the nature of the communication.	Low

Hazard	Source	Pathway	Receptor	Probability of Exposure	Consequence	Magnitude of Risk	Risk Management	Residual Risk
Point source odour emissions from vents/ off gases	TEG Still Column vent	Release to air via vent/ column	Local atmosphere Site personnel Local residents Workforce at local businesses and amenity sites	Low	Low	Low	Emissions of TEG controlled by condenser, amine emissions are trace. HPP plant is maintained regularly. Essar operates a preventative maintenance programme. For further details of the prevention of odour releases to air, see Section 3.7	Low
Fugitive release of odour from pipelines or storage tanks	ROG upstream of desulphurisation plant and VOCs from amine, TEG and diesel storage tanks	Fumes released to air from breathing losses/ pressure relief valves	Local atmosphere Site personnel Local residents Workforce at local businesses and amenity sites	Low	Low	Low	Amine and TEG tanks are contained under a nitrogen blanket and PRVs are fitted to the storage tanks. Breathing losses minimised by occasional filling / emptying of the tanks. Diesel, amine and TEG have relatively high boiling points i.e. low volatility. Storage vessels are enclosed. Regular inspection and maintenance reduce the likelihood of leaks and spills. Essar operates a preventative maintenance programme which includes tanks. For further details of the prevention of fugitive releases to air, see Section 3.7.	Low

8.0 PRE-OPERATIONAL CONDITIONS

8.1.1 The following pre-operational conditions are proposed.

Table 8-1 Proposed Pre-Operational Conditions

Ref No.[NOTE]	Proposed Condition	Completion date
POC5	Prepare and provide a Commissioning Plan to the EA, identifying the proposed programme for commissioning, commissioning emissions monitoring, validation of energy efficiency and emissions, and reporting.	4 months prior to commissioning
POC6	Extend the refinery VOC LDAR programme (currently in development) to the HPP and agree the revised programme with the EA.	2 months prior to commissioning
POC7	Agree air emissions monitoring methods with the EA.	3 months prior to commissioning
POC8	Review the proposed waste management arrangements and the re-use, recycling, recovery and/ or disposal routes for wastes generated at the HPP. This shall include the development of a Catalyst Care Programme for spent catalysts and absorbents.	3 months prior to commissioning
POC9	Extend the existing refinery plant and equipment inspection and testing programme to the HPP and agree the revised programme with the EA.	2 months prior to commissioning
POC10	Extend the Refinery EMS to cover the HPP; this shall include relevant elements of the EMS, including noise management procedures and an update to the Accident Management Plan.	2 months prior to commissioning
POC11	Supply updated details of selected raw materials, their containment and projected use to the EA.	2 months prior to commissioning
POC12	Following the submission of the assessment report supporting the review of discharges across the Refinery in response to IC38, the Operator shall review the HPP demineralizer plant process emissions to water and provide an impact assessment of the HPP discharge, together with the revised discharges identified in response to IC38, at point W3. The report shall be submitted to the Environment Agency.	6 months after submission of the IC38 response
Note The list of proposed conditions starts at POC5 as POC1-4 are already in the existing Essar permit.		

9.0 REFERENCES

Ref No.	Title
[1]	Notice of variation and consolidation with introductory note. Essar Oil (UK) Limited. Variation application number EPR/FP3139FN/V010. 27.01.2020.
[2]	Guidance for Establishing Best Available Techniques for Hydrogen Production from Methane and Refinery Fuel Gas with Carbon Capture", 7415737-0001 Rev R5. 20.4.2021. Costain.
[3]	Reference Document on Best Available Techniques for Energy Efficiency. https://eippcb.jrc.ec.europa.eu/reference/energy-efficiency
[4]	BS EN ISO 50001:2018. Energy management systems. Requirements with guidance for use.
[5]	https://www.gov.uk/guidance/assess-the-impact-of-air-emissions-on-global-warming
[6]	Phase 2 SBRI Hydrogen Supply Competition Application Form – HyNet Low Carbon Hydrogen Plant. TRN 2039/09/2019. August 2019. Progressive Energy Limited.
[7]	HyNet North West – From Vision to Reality. https://hynet.co.uk/app/uploads/2018/05/ 14368_CADENT_PROJECT_REPORT_AMENDED_v22105.pdf
[8]	Commission Implementing Decision (EU) 2016/902 of 30 May 2016 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for common waste water and waste gas treatment/management systems in the chemical sector.
[9]	Commission Implementing Decision of 9 October 2014 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions, for the refining of mineral oil and gas.
[10]	OASE White Enriched Material Safety Data Sheet, 14.12.2017 Rev 3. BASF
[11]	Review of an Environmental Permit for an Installation subject to Chapter II of the Industrial Emissions Directive under the Environmental Permitting (England & Wales) Regulations 2016. Decision document recording our decision-making process following review of a permit. Variation Notice number EPR/FP3139FN/V009. 10 September 2018. Environment Agency. Essar Environmental Permit EPR/FP3139FN/V009 Decision Document, Environment Agency
[12]	Control and monitor emissions for your environmental permit, Environment Agency, 19 October 2020, Environment Agency www.gov.uk/guidance/control-and-monitor-emissions-for-your-environmental-permit

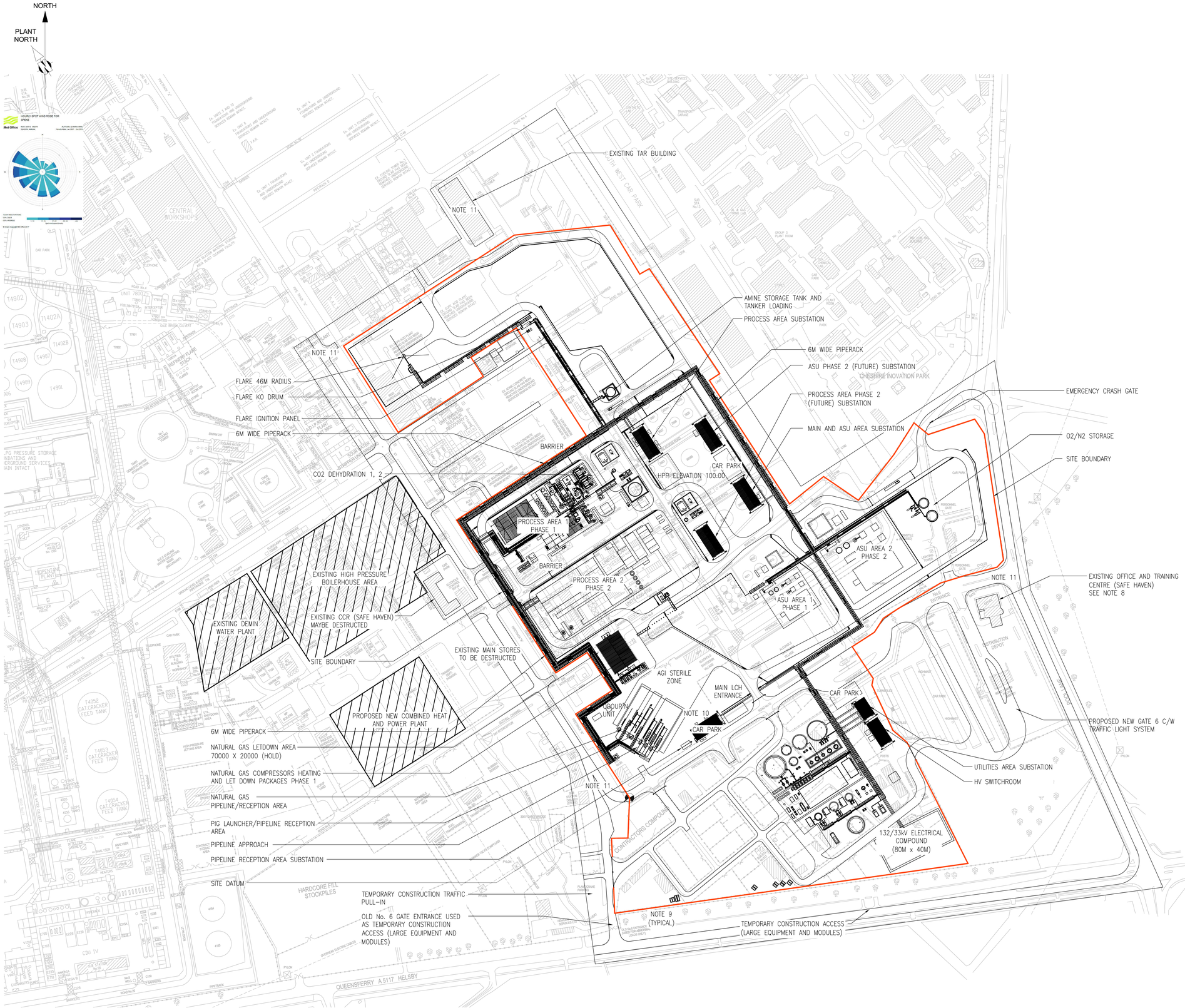
Ref No.	Title
[13]	Stanlow Manufacturing Complex On-Site Emergency Response Plan 2019; Stanlow & Tranmere HSSE Manual. Section 4 HSSE Procedures. March 2021. Essar; COMAH Safety Report, Volume 1 Section 6 - Emergency Response.
[14]	COMMISSION IMPLEMENTING DECISION (EU) 2017/1442 of 31 July 2017 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for large combustion plants (Large Combustion Plant BAT Conclusions).
[15]	Integrated Pollution Prevention and Control Reference Document on Best Available Techniques for the Manufacture of Large Volume Inorganic Chemicals - Ammonia, Acids and Fertilisers, European Commission, August 2007.
[16]	Assess the impact of air emissions on global warming, DEFRA, 01 February 2016 - https://www.gov.uk/guidance/assess-the-impact-of-air-emissions-on-global-warming#identify-greenhouse-gas-emissions
[17]	Risk assessments for your environmental permit - GOV.UK (www.gov.uk)

APPENDICES

A.1.0 PLANS AND DRAWINGS

A.1.1 SITE LAYOUT PLAN

A.1.2 DRAINAGE PLANS



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1. DELETED.
2. DELETED.
3. DELETED.
4. THE THORNTON SCIENCE PARK CONTAINS A SENSITIVE POPULATION.
5. DELETED.
6. EXISTING 33kV SUBSTATION AT THE PIPELINES APPROACH AREA TO BE RELOCATED.
7. DELETED.
8. FOR PHASE 1 THE EXISTING TRAINING CENTRE TO THE SOUTH EAST OF THE SITE IS COMPLIANT WITH THE DEP REQUIREMENTS FOR 150M, FOR PHASE 2 THE TRAINING CENTRE IS TO HAVE EITHER BLAST WALL ENHANCEMENT OR BE RELOCATED AT THE NEW SOUTH ENTRANCE ROAD AND GUARDHOUSE.
9. MAIN PIPELINE ISOLATION VALVES/ACCESS PIT (TYPICAL FOR ALL PIPELINES).
10. COMPOUNDS FOR NATURAL GAS,CARBON DIOXIDE AND HYDROGEN AGI OPERATOR AREAS.
11. A PEDESTRIAN ACCESS ROUTE WILL BE PROVIDED FROM THE EXISTING TRAINING CENTRE AT GATE 6 TO THE TAR BUILDING TO THE NORTH OF THE ALCS AREA. THIS WILL FOLLOW THE EXISTING ROAD ROUTING FROM GATE 6 TO THE WEST OF THE PLANT LINKING UP WITH THE EXISTING NORTH/SOUTH PAVED ACCESS ROUTES.

LEGEND

SITE BOUNDARY

SITE MONUMENT

MONUMENT No	NATIONAL GRID		LEVEL
	NORTHINGS	EASTINGS	
35	374971.418M	344558.907M	9.769M

HOLDS

REV.	DATE	REVISION DESCRIPTION	PREP'D	CHK'D	APP.
06	21/05/2021	RE-ISSUED FOR USE	JB	SG	MW
05	16/10/2020	RE-ISSUED ALCS SITE & REVIEW COMMENTS	JB	SG	MW
04	02/09/2020	ISSUED FOR INTERNAL REVIEW	JB	SG	MW
03	24/06/2020	RE-ISSUED FOR CONSORTIUM REVIEW	JB	SG	MW
02	27/03/2020	RE-ISSUED FOR CONSORTIUM REVIEW	JB	SG	MW
01	26/02/2020	ISSUED FOR CONSORTIUM REVIEW	JB	SG	MW

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SCALE 1:1500 | ORIGINAL DRAWING SIZE A0

PROJECT
LOW CARBON HYDROGEN (LCH) FEED

TITLE
SITE PLAN - ALCS AREA
PHASE 1

PROJECT NO.	DRAWING NUMBER	REV
5194812	5194812-000-46DP01-4-0002-01	06

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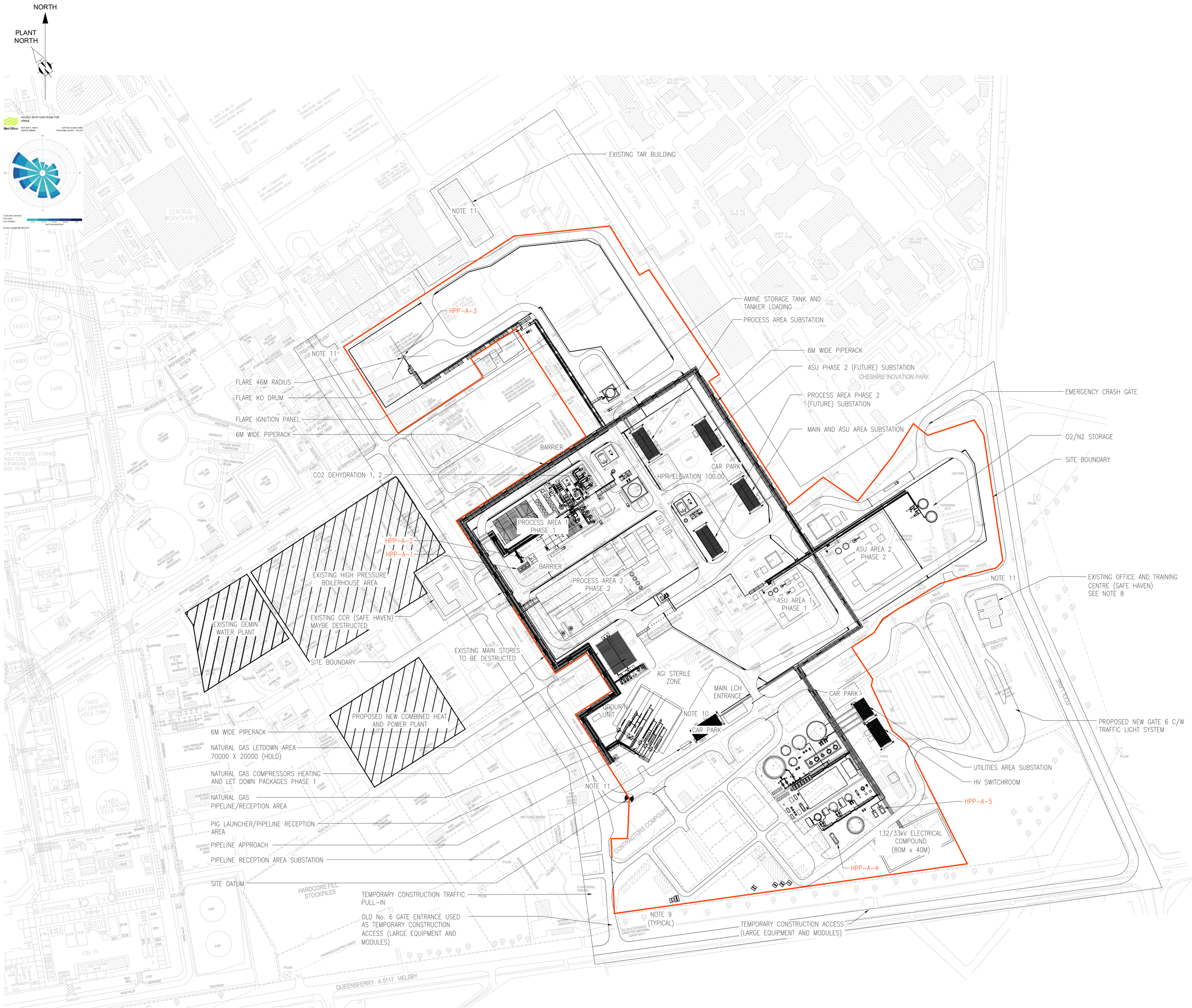

NOTES
1. DELETED.
2. DELETED.
3. DELETED.
4. THE THORNTON SCIENCE PARK CONTAINS A SENSITIVE POPULATION.
5. DELETED.
6. EXISTING 33kV SUBSTATION AT THE PIPELINES APPROACH AREA TO BE RELOCATED.
7. DELETED.
8. FOR PHASE 1 THE EXISTING TRAINING CENTRE TO THE SOUTH EAST OF THE SITE IS COMPLIANT WITH THE DEP REQUIREMENTS FOR 150M, FOR PHASE 2 THE TRAINING CENTRE IS TO HAVE EITHER BLAST WALL ENHANCEMENT OR BE RELOCATED AT THE NEW SOUTH ENTRANCE ROAD AND GUARDHOUSE.
9. MAIN PIPELINE ISOLATION VALVES/ACCESS PIT (TYPICAL FOR ALL PIPELINES).
10. COMPOUNDS FOR NATURAL GAS,CARBON DIOXIDE AND HYDROGEN AGI OPERATOR AREAS.
11. A PEDESTRIAN ACCESS ROUTE WILL BE PROVIDED FROM THE EXISTING TRAINING CENTRE AT GATE 6 TO THE TAR BUILDING TO THE NORTH OF THE ALCS AREA. THIS WILL FOLLOW THE EXISTING ROAD ROUTING FROM GATE 6 TO THE WEST OF THE PLANT LINKING UP WITH THE EXISTING NORTH/SOUTH PAVED ACCESS ROUTES.

LEGEND

SITE BOUNDARY

SITE MONUMENT

MONUMENT No	NATIONAL GRID		LEVEL
	NORTHINGS	EASTINGS	
35	374971.418M	344558.907M	9.769M

HPP-A-1 – FEED FIRED HEATER
HPP-A-2 – STEAM BOILER
HPP-A-3 – FLARE
HPP-A-4 – EMERGENCY DIESEL GENERATOR
HPP-A-5 – FIREWATER PUMP

HOLDS

REV.	DATE	REVISION DESCRIPTION	PREP'D	CHK'D	APP.
01	08/07/2021	ISSUED FOR CONSORTIUM REVIEW	JD	JP	MW

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SCALE 1:1500 | ORIGINAL DRAWING SIZE A0

PROJECT
LOW CARBON HYDROGEN (LCH) FEED

TITLE
SITE PLAN - ALCS AREA
PHASE 1 - AIR EMISSION POINTS

PROJECT NO.	DRAWING NUMBER	REV
5194812	5194812-000-4PDP01-4-0001-01	01

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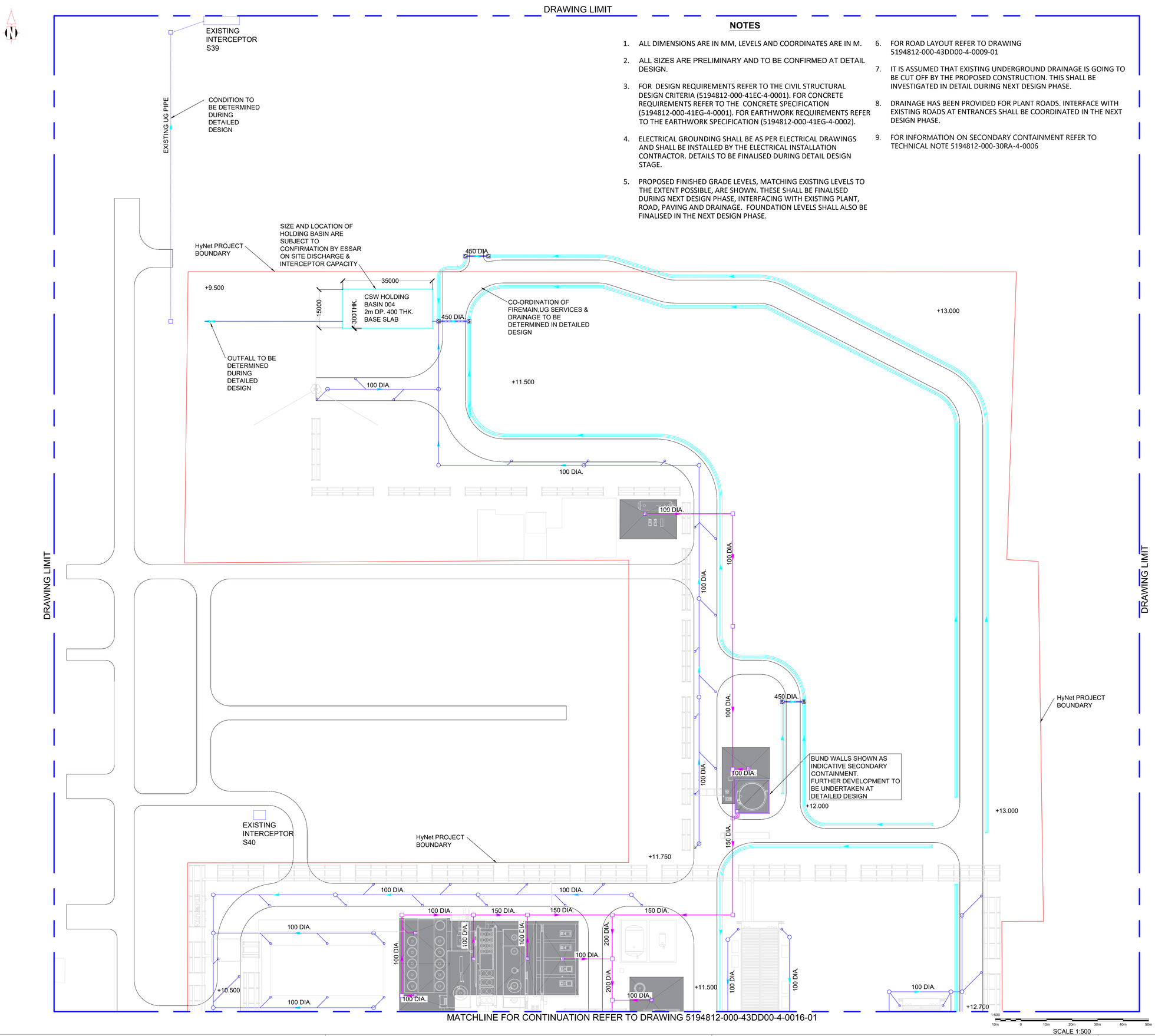
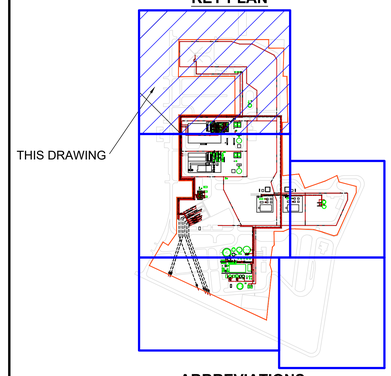


NOTES

1. ALL DIMENSIONS ARE IN MM, LEVELS AND COORDINATES ARE IN M.
2. ALL SIZES ARE PRELIMINARY AND TO BE CONFIRMED AT DETAIL DESIGN.
3. FOR DESIGN REQUIREMENTS REFER TO THE CIVIL STRUCTURAL DESIGN CRITERIA (5194812-000-41EC-4-0001). FOR CONCRETE REQUIREMENTS REFER TO THE CONCRETE SPECIFICATION (5194812-000-41EG-4-0001). FOR EARTHWORK REQUIREMENTS REFER TO THE EARTHWORK SPECIFICATION (5194812-000-41EG-4-0002).
4. ELECTRICAL GROUNDING SHALL BE AS PER ELECTRICAL DRAWINGS AND SHALL BE INSTALLED BY THE ELECTRICAL INSTALLATION CONTRACTOR. DETAILS TO BE FINALISED DURING DETAIL DESIGN STAGE.
5. PROPOSED FINISHED GRADE LEVELS, MATCHING EXISTING LEVELS TO THE EXTENT POSSIBLE, ARE SHOWN. THESE SHALL BE FINALISED DURING NEXT DESIGN PHASE, INTERFACING WITH EXISTING PLANT, ROAD, PAVING AND DRAINAGE. FOUNDATION LEVELS SHALL ALSO BE FINALISED IN THE NEXT DESIGN PHASE.
6. FOR ROAD LAYOUT REFER TO DRAWING 5194812-000-43DD00-4-0009-01
7. IT IS ASSUMED THAT EXISTING UNDERGROUND DRAINAGE IS GOING TO BE CUT OFF BY THE PROPOSED CONSTRUCTION. THIS SHALL BE INVESTIGATED IN DETAIL DURING NEXT DESIGN PHASE.
8. DRAINAGE HAS BEEN PROVIDED FOR PLANT ROADS. INTERFACE WITH EXISTING ROADS AT ENTRANCES SHALL BE COORDINATED IN THE NEXT DESIGN PHASE.
9. FOR INFORMATION ON SECONDARY CONTAINMENT REFER TO TECHNICAL NOTE 5194812-000-30RA-4-0006

KEY PLAN



ABBREVIATIONS

AOC	ACCIDENTLY OIL CONTAMINATED
CONC	CONCRETE
CSW	CLEAN STORM WATER
DIA.	DIAMETER
DP	DEEP
HDPE	HIGH DENSITY POLYETHYLENE
P.C.	PRECAST CONCRETE
THK.	THICK
UG	UNDERGROUND
uPVC	UNPLASTICISED POLYVINYL CHLORIDE

LEGEND

- +9.500 — GRADE ELEVATION
- FLOW ARROW
- PUMPED MAIN
- AOC DRAIN (HDPE)
- AOC MANHOLE P.C. CONC. WITH HEAVY DUTY COVER
- AOC CATCH BASIN P.C. CONC. BS EN 1917 and BS 5911 WITH HEAVY DUTY GRATING
- VALVE CHAMBER
- 150 DIA. — PIPE SIZE DIAMETER IN mm
- P.C. CONC. SURFACE WATER TRAPEZOIDAL DITCH 300 BASE WIDTH
- CSW CONC. CULVERT
- CSW SUMP
- HEAVY DUTY GRATING
- CSW MANHOLE P.C. CONC. RING BS EN 1917:2002 WITH HEAVY DUTY COVER
- CSW DRAIN (UPVC)
- CSW GULLY
- 200 THK. CONCRETE PAVING (CATCHMENT AREA)
- 300 WIDE P.C. CHANNEL WITH HEAVY DUTY GRATING
- CAR PARK ASPHALT FINISH

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03	23-03-2021	ISSUED FOR USE	KH	PL	PS
02	12-03-2021	ISSUED FOR CONSORTIUM REVIEW	KH	PL	PS
01	05-03-2021	ISSUED FOR INTERNAL REVIEW	KH	PL	PS

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PROJECT

LOW CARBON HYDROGEN (LCH) FEED

TITLE

PAVING AND DRAINAGE LAYOUT SHEET 1

PROJECT NO.	DRAWING NUMBER	REV.
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DRAWING LIMIT

MATCHLINE FOR CONTINUATION REFER TO DRAWING 5194812-000-43DD00-4-0017-01

MATCHLINE FOR CONTINUATION REFER TO DRAWING 5194812-000-43DD00-4-0018-01

PHASE 2 PROCESS UNIT DRAINAGE TO BE A SELF CONTAINED SYSTEM WITH AOC SUMP PUMPED TO WASTE WATER TREATMENT

PUMPED TO WASTE WATER TREATMENT

AOC SUMP 2.3m DP. 400 THK. BASE SLAB

BUND WALLS SHOWN AS INDICATIVE SECONDARY CONTAINMENT. FURTHER DEVELOPMENT TO BE UNDERTAKEN AT DETAILED DESIGN

EXISTING DRAINAGE FROM TANK BUNDS TO BE DISINVESTED

EXISTING TANKS AND BUNDS ARE PROPOSED TO BE DEMOLISHED BY ESSAR. IT IS PROPOSED TO REPURPOSE THIS AREA TO A GRAVELLED LAYDOWN AREA BY TRIMMING FOUNDATIONS, REMOVING THE PAVING AND LAYING OUT GRAVEL TOPPING. DRAINAGE SYSTEM TO BE DETAILED WHEN THE LAYDOWN CONCEPT IS FINALISED POST FEED

CAR PARK

HEAVY DUTY GRATING

P.C. CHANNEL

EXISTING INTERCEPTOR S30

CSW HOLDING BASIN 003 2m DP. 400 THK. BASE SLAB

OUTFALL TO BE DETERMINED DURING DETAILED DESIGN

SIZE AND LOCATION OF HOLDING BASIN ARE SUBJECT TO CONFIRMATION BY ESSAR ON SITE DISCHARGE & INTERCEPTOR CAPACITY

CSW HOLDING BASIN 002 2m DP. 400 THK. BASE SLAB

CSW HOLDING BASIN 001 2m DP. 400 THK. BASE SLAB

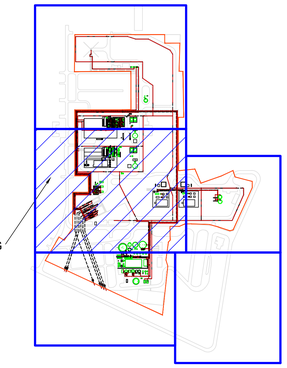
INCOMING PROCESS LINES

CO-ORDINATION OF FIREMAIN UG SERVICES & DRAINAGE TO BE DETERMINED IN DETAILED DESIGN

HyNet PROJECT BOUNDARY

SCALE 1:500

KEY PLAN



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SCALE 1:500 | ORIGINAL DRAWING SIZE A0

PROJECT

LOW CARBON HYDROGEN (LCH) FEED

TITLE

PAVING AND DRAINAGE LAYOUT SHEET 2

PROJECT NO.	DRAWING NUMBER	REV.
5194812	5194812-000-43DD00-4-0016-01	03

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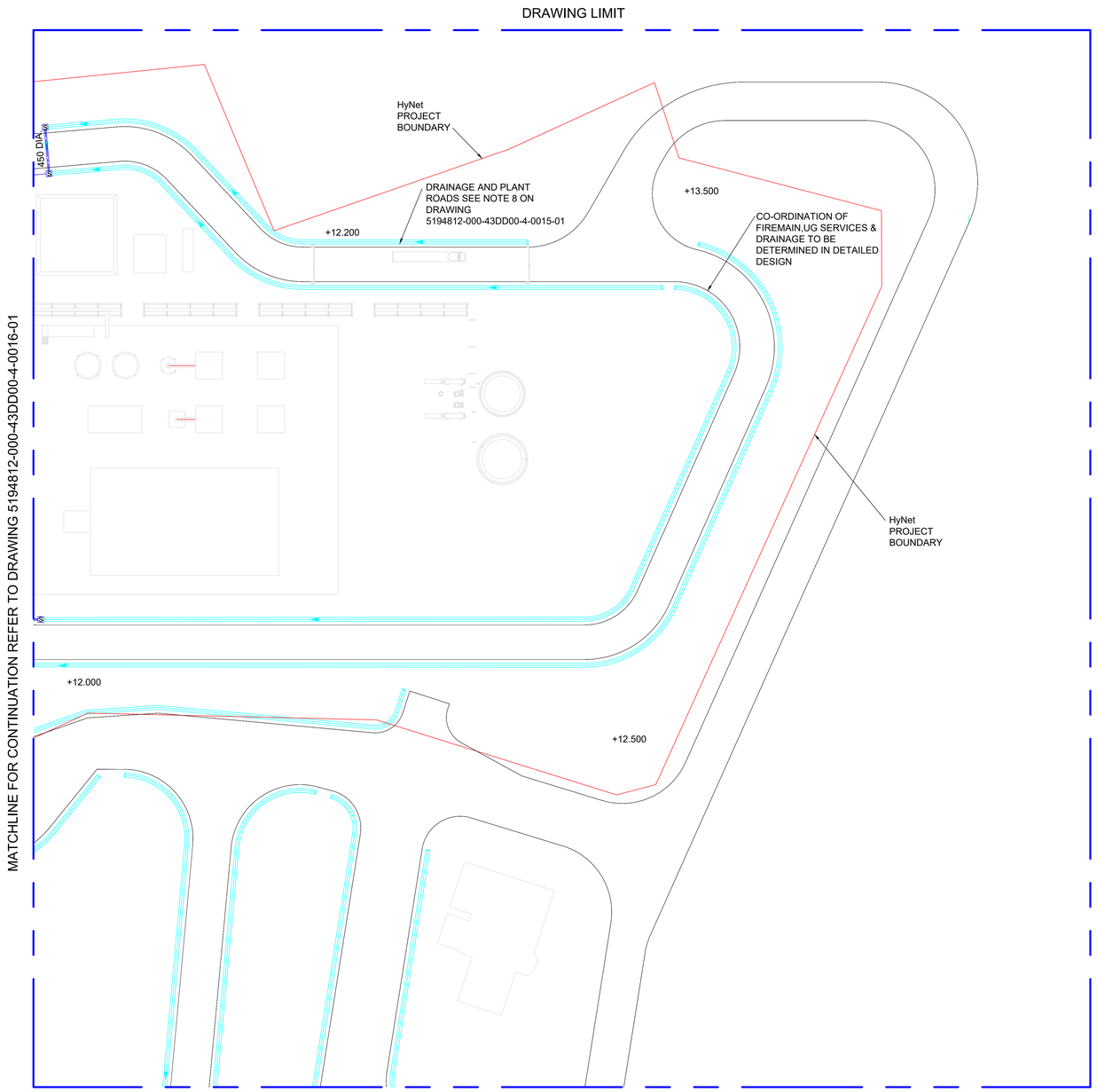

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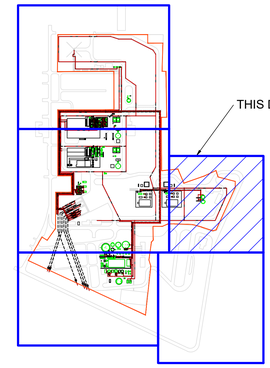

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PROJECT

LOW CARBON HYDROGEN (LCH) FEED

TITLE

PAVING AND DRAINAGE LAYOUT
SHEET 3

PROJECT NO.	DRAWING NUMBER	REV
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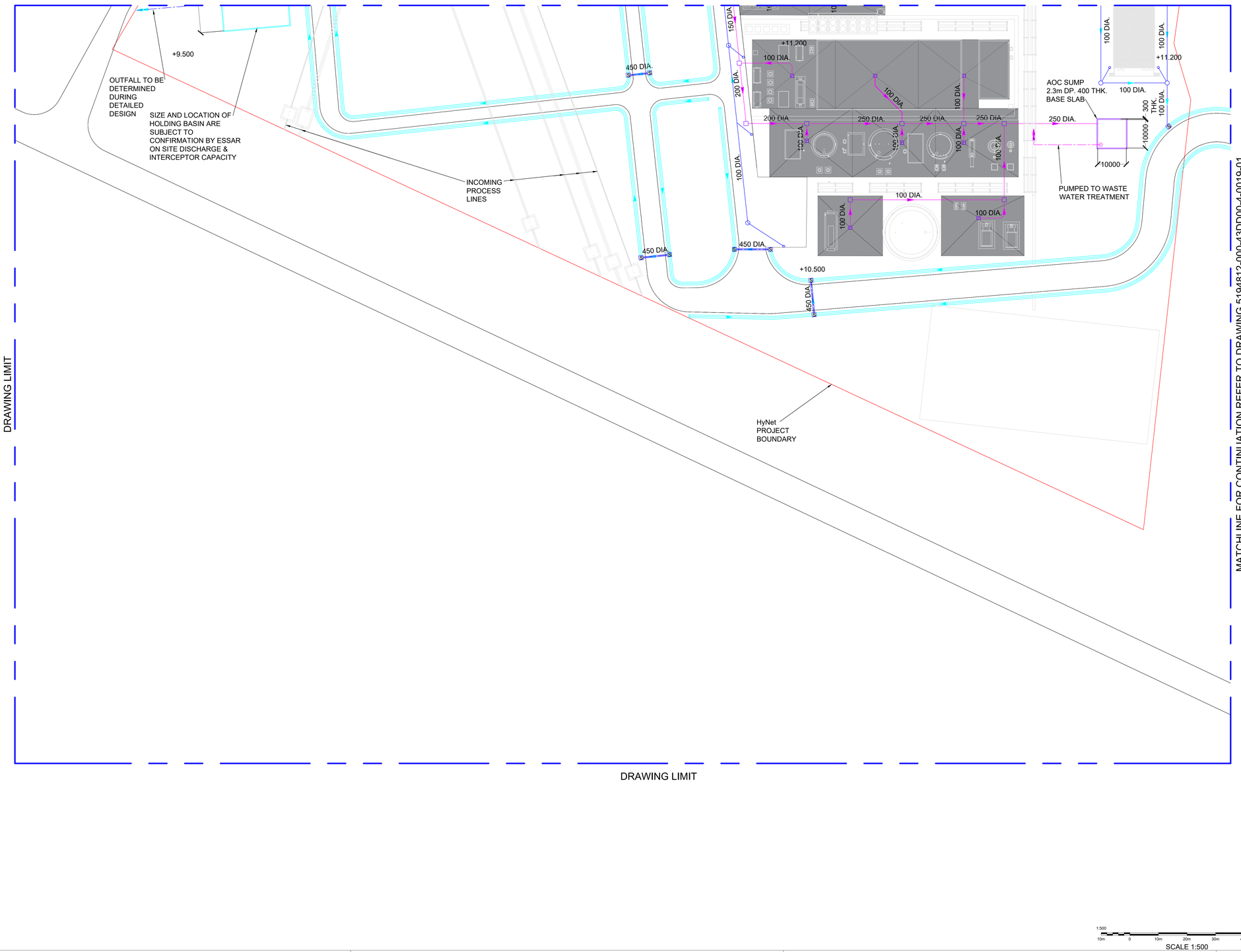

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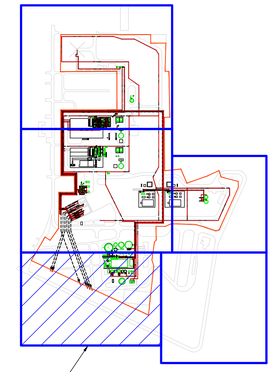
KEY PLAN



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PROJECT
LOW CARBON HYDROGEN (LCH) FEED

TITLE
PAVING AND DRAINAGE LAYOUT
SHEET 4

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450 DIA

DRAINAGE AND PLANT ROADS SEE NOTE 8 ON DRAWING 5194812-000-43DD00-4-0015-01

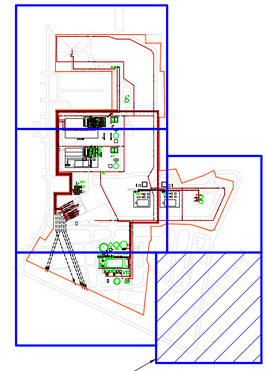
MATCHLINE FOR CONTINUATION REFER TO DRAWING 5194812-000-43DD00-4-0018-01

DRAWING LIMIT

DRAWING LIMIT

SCALE 1:500

KEY PLAN



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01	05-03-2021	ISSUED FOR INTERNAL REVIEW	KH	PL	PS

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PROJECT

LOW CARBON HYDROGEN (LCH) FEED

TITLE

PAVING AND DRAINAGE LAYOUT
SHEET 5

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A.2.0 AIR QUALITY ASSESSMENT

HyNet Hydrogen Production Plant

Air Quality Assessment Phase 1

17 June 2021

5194812 HyNet Air Quality Assessment Phase 1

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This document has 35 pages including the cover.

Document history

Document title: Air Quality Assessment Phase 1

Document reference: 5194812 HyNet Air Quality Assessment Phase 1

Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
0.1	Permit Application Draft	MDL	SJS	SH		
1.0	Permit Application Issue	MDL	SJS	SH	JBD	17/06/21

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1. Introduction

This air quality assessment was prepared by Atkins Ltd in support of the Environmental Permit Regulation (EPR) variation application for the operation of the Hydrogen Production Plant (HPP) in the former “Alcohols” site of Stanlow Oil Refinery in Ellesmere Port. The assessment considers the Phase 1 emissions of the HPP.

The HPP is located within the refinery which lies within the administrative authority of Cheshire West and Chester Council. The HPP is in a relatively rural area, where development is largely industrial and commercial, although there are residential properties located close to the site boundary to the south and east. The site partially lies within the Thornton le Moors AQMA which was declared in 2016 due to exceedances of the Air Quality Strategy (AQS) objective for sulphur dioxide (SO_2) associated with emissions from the refinery.

2. Scope of Assessment

The Feed Fired Heater and the Steam Boiler will be the predominant sources of pollutant emissions to the atmosphere from the HPP. The main pollutants emitted from the Feed Fired Heater and Steam Boiler will be oxides of nitrogen (NOx) and carbon monoxide (CO) with trace amounts of SO_2.

The ROG feed gas will have a maximum hydrogen sulphide (H_2S) content of 13.6 ppmv. Sulphur will be removed through a desulphurisation process which will reduce the sulphur content in the feed gas to a very low level of a few parts per billion (ppbv) (see Table 2-1 of the main permit application). The sulphur content of natural gas, which will be used at start up, is less than 5 ppm. Particulate matter is not a pollutant of concern for gaseous fuels and therefore does not require assessment.

This study considers the HPP Phase 1 emissions in isolation. Consideration of emissions from other sources at the refinery have been excluded from the scope as per the correspondence between Essar and the Environment Agency National Permitting Service dated March 10, 2021. This approach is deemed acceptable where the air dispersion modelling can demonstrate that process contributions (PC) are environmentally insignificant at all human and ecological receptors (i.e. contribute less than 1% of applicable long term standards and 10% of applicable short term standards). In addition, it can be demonstrated that the annual emissions from the new HPP are lower than those of the equipment that was on the Alcohols part of the site. Details of the annual emissions comparison are provided in Appendix 8.A.3.

Other pollutant sources associated with the HPP will only operate intermittently. These are the flare, diesel-fired emergency generator and diesel-fired firewater pump. They have been excluded from the detailed air quality assessment based on limited hours of operation. The flare would operate infrequently during start-up, shutdown and process upset conditions. The diesel generator and firewater pump would only be run for occasional testing and in emergencies, such as loss of power.

An exploratory atmospheric dispersion modelling study for a range of stack heights was undertaken at the early stage of the assessment. The results were compared to air quality standards, in order to ensure that a suitable stack height representative of BAT was incorporated in the design and used as the basis of the detailed assessment.

3. Objectives

The objectives of this air quality assessment are:

- review the baseline conditions in the local area including air quality monitoring and background pollutant concentrations;
- describe the methodology used for the atmospheric dispersion modelling including the meteorological data, treatment of buildings and terrain, source emissions data, discrete model receptors and the relevant air quality criteria;
- undertake a stack height sensitivity study, to ensure that a suitable stack height representative of the Environment Agency’s requirements for BAT is incorporated in the design;

- undertake a dispersion modelling study of the stack emissions of the Feed Fired Heater and the Steam Boiler for Phase 1 normal operation and assessment of the impacts on human health and ecological receptors;
- evaluate modelled increments to short-term and long-term ground level concentrations of NOx, CO and SO_2 in the context of the national air quality objectives, considering the existing ambient air quality; and
- present conclusions of the study.

4. Air Quality Criteria

4.1. Human Health Criteria

The Government's AQS for England, Scotland, Wales and Northern Ireland[1] provides details of national air quality standards and objectives for a number of local air pollutants including NO_2, SO_2 and CO. These criteria are defined in the Air Quality Standards Regulations 2010 SI 2010/1001[2]. The air quality criteria for the protection of human health for the key pollutants relevant to the study are shown in Table 4-1.

Table 4-1 - Air Quality Criteria for Human Health

Pollutant	Effect
Nitrogen dioxide, NO_2	Hourly average concentration should not exceed 200 µg/m^3 more than 18 times a year
	Annual mean concentration should not exceed 40 µg/m^3
Carbon monoxide, CO	Maximum daily running eight hourly average concentration should not exceed 10,000 µg/m^3
	Maximum hourly average concentration should not exceed 30,000 µg/m^3
Sulphur dioxide, SO_2	Daily average concentration should not exceed 125 µg/m^3 more than 3 times a year
	Hourly average concentration should not exceed 350 µg/m^3 more than 24 times a year
	15-minute average concentration should not exceed 266 µg/m^3 more than 35 times a year

4.2. Ecological Criteria

The EU has set limit values for the protection of vegetation for oxides of nitrogen based on the work of the United Nations Economic Commission for Europe (UNECE) and World Health Organisation (WHO) and these limit values have been incorporated into The Air Quality Standards Regulations.

The limit value for oxides of nitrogen for the protection of vegetation is an annual mean of 30 µg/m^3. This is the same as the AQS objective. The limit values for the protection of vegetation apply to locations more than 20 km from towns with more than 250,000 inhabitants, or more than 5 km from other built-up areas, industrial installations or motorways. For this project, the criterion of 30 µg/m^3 has been applied on a precautionary basis to all ecological sites included in the assessment.

In addition, the Environment Agency guidance for permitting requires an assessment against a non-statutory guideline of 75 µg/m^3 for short term (daily mean) oxides of nitrogen.

Critical loads for nitrogen and acid deposition have been set by the UNECE that represent (according to current knowledge) the exposure below which there should be no significant harmful effects on sensitive elements of the ecosystem. The critical loads vary by type of ecosystem and habitat and are available from the APIS website[3]. They key criteria are provided in the results section for the relevant assessed locations.

[1] https://www.gov.uk/government/publications/the-air-quality-strategy-for-england-scotland-wales-and-northern-ireland-volume-2
[2] http://www.legislation.gov.uk/uksi/2010/1001/pdfs/uksi_20101001_en.pdf
[3] Air Pollution Information System (APIS) http://www.apis.ac.uk

5. Baseline Conditions

A review of baseline air quality in the vicinity of the HPP has been undertaken. Data have been drawn from the following sources:

- Boundaries of AQMAs[4];
- Local authority air quality annual reports and associated monitoring data in the study area[5,6]; and
- Background maps from Department for Environment, Food and Rural Affairs' (Defra) Air Information Resource (UK-AIR) website[7].

5.1. Air Quality Management

There are currently four AQMA within the administrative boundaries of Cheshire West and Chester Council. The HPP lies partially within the AQMA for Thornton le Moors, declared in 2016 for exceedances of the AQS objective for SO_2 associated with the Stanlow Oil Refinery's operations at the time. An action plan was produced for the area in 2017[8].

Other AQMAs include Ellesmere Port (Whitby Road/Station Road) and Frodsham (A56/Fluin Lane), and Chester (city centre), which were all declared due to exceedances of the annual mean objective for nitrogen dioxide with road traffic as the main source. The nearest of these is Ellesmere Port, approximately 4.5 km to the north west.

5.2. Existing Air Quality

5.2.1. Monitoring Data

The Cheshire West and Chester Council's Air Quality Annual Status Report (ASR) published in 2019[9] provides the latest publicly available information on local air quality monitoring in the area. The latest measured concentrations for the year 2019 are available from the Cheshire West and Chester Council website.

Continuous Monitoring Sites

Cheshire West and Chester Council operates seven continuous monitoring sites (CMS) in 2018, the latest year of available data. The closest CMS to the facility is at Thornton Le Moors approximately 700 m south west of the HPP. Concentrations of nitrogen dioxide and particulate matter are recorded at this site, and the annual mean concentrations for 2018 (the most recently reported year) for both pollutants are 13 µg/m^3, i.e. less than half the relevant AQS objectives of 40 µg/m^3.

Monitoring data are also available for sulphur dioxide, a pollutant of concern within the local area and the reason for the AQMA designation in Thornton Le Moors. The available data for 2018 (the most recently reported year) show that there were 66 exceedances of the 15-minute average air quality standard.

The measured NO_2 concentrations in the last five years at the CMS operated by the local authority are presented in Table 5-1. Concentrations of NO_2 at all sites are below the AQS objective for annual mean, with the exception of the roadside site in Chester, which measured 40 µg/m^3 in 2017 and 2018. This site is located approximately 9 km southwest of the HPP within the Chester City Centre AQMA and is therefore not representative of the air quality conditions around the HPP.

[4] Defra Air Quality Management Areas http://uk-air.Defra.gov.uk/aqma/maps
[5] https://www.cheshirewestandchester.gov.uk/documents/pests-pollution-food-safety/pollution-and-air-quality/air-quality-review-and-assessment/reports/air-quality-annual-status-report-2019.pdf
[6] https://www.cheshirewestandchester.gov.uk/residents/pests-pollution-food-safety/pollution-and-air-quality/air-quality-monitoring/air-quality-monitoring.aspx
[7] UK-Air: Air Information Resource, DEFRA, 2018. http://uk-air.Defra.gov.uk/
[8] https://www.cheshirewestandchester.gov.uk/documents/pests-pollution-food-safety/pollution-and-air-quality/air-quality-review-and-assessment/action-plans/action-plan-thornton-le-moors-041019.pdf
[9] https://www.cheshirewestandchester.gov.uk/documents/pests-pollution-food-safety/pollution-and-air-quality/air-quality-review-and-assessment/reports/air-quality-annual-status-report-2019.pdf

Table 5-1 - Annual Mean Nitrogen Dioxide Concentrations at Continuous Monitoring Sites (µg/m³)

Site Name	Type	Distance/Direction	NO_2 Concentration (µg/m³)				
			2014	2015	2016	2017	2018
Boughton	Roadside	9 km SSW	32	30	29	27	25
Chester	Roadside	9 km SW	-	-	-	40	40
Frodsham	Urban background	7.7 km ENE	19	15	16	16	14
Library	Urban background	4.2 km WNW	22	20	22	20	19
Thornton Le Moors	Industrial	700 km SW	-	16	16	13	13
Whitby Road	Roadside	4.2 km WNW	**41**	40	40	36	37

Values in **bold** indicate exceedances of the annual mean AQS objective

Passive Sampling

Cheshire West and Chester Council measures NO_2 at 85 locations using diffusion tubes, a passive sampling method entailing subsequent laboratory analysis. A total of 40 tubes are located within the Chester City Centre AQMA, over 10 kilometres south of the HPP. There are five sites in Ellesmere Port, seven in Frodsham, one in Helsby and one in Elton; all are classified as roadside sites due to proximity to traffic sources.

The highest measured concentration measured at a relevant site in 2019 was 37 µg/m³, just under the criterion of 40 µg/m³ at the junction of the A56 and Fluin Lane in Frodsham. On the A5032 Ellesmere Port, concentrations were 25 to 35 µg/m³. On the A56 in Helsby, the concentration was significantly less at 21 µg/m³ and in Elton, where the tube is essentially in a background setting, it was 16.8 µg/m³. The measured concentrations at diffusion tube sites at relevant locations within the study area are shown in Table 5-2.

Table 5-2 - Annual Mean Nitrogen Dioxide Concentrations at Local Authority Passive Sampling Sites (µg/m³)

Site Name	OS Coordinate (m)		NO_2 Concentration (µg/m³)				
	x	y	2015	2016	2017	2018	2019
Church Street, Frodsham	351762	377862	29	31	30	31	30
(A56) High Street, Frodsham	352146	378139	40	**44**	39	39	37
Fluin Junction, Frodsham	352171	378140	**41**	**42**	**41**	38	37
Fluin Lane (Manor Farm), Frodsham	352189	378094	33	37	33	35	29
Rock Cottage High Street, Frodsham	352023	378121	-	-	-	34	31
Fluin Lane (terrace), Frodsham	352176	378105	34	35	34	32	30
Trinity Gardens, Frodsham	351993	378102	-	-	-	33	31

Site Name	OS Coordinate (m)		NO_2 Concentration ($\mu g/m^3$)				
	x	y	2015	2016	2017	2018	2019
Helsby Hillside School, Helsby	349518	375954	-	-	-	23	21
Newsagent Station Rd, Ellesmere Port	340406	376724	36	36	35	32	-
Richfield Recruitment, Ellesmere Port	340180	376338	39	40	37	37	35
Station Rd, Ellesmere Port	340435	376790	36	37	34	34	31
U of C Academy, Ellesmere Port	339687	375972	-	-	-	29	25
Whitby Road, Ellesmere Port	340196	376363	35	34	32	36	31
Mulberry Close*, Elton	346252	375324	-	-	-	-	17

Values in bold exceed the annual mean AQS objective

* Estimated grid reference

5.2.2. Background Concentrations

Estimates of background pollutant concentrations are published on the Defra LAQM website[10] for every one-kilometre grid square in the UK for a base year of 2018. Data for future years are based on the extrapolation and interpolation of empirical measurements and modelled dispersion of road and industrial sources. In each grid square the background concentrations are made up of contributions from the different source sectors such as roads, and industry within and surrounding that particular grid square.

Average annual mean background concentration estimates for the year 2021 for the grid squares covering the immediate study area (344500, 375500 and 344500, 374500) are shown in Table 5-3.

Table 5-3 - Defra Mapped Annual Mean Background Concentrations

Pollutant	Defra Mapped Annual Mean Background Concentrations ($\mu g/m^3$)
NO_x	17.1
NO^2	12.7
PM_{10}	10.6
$PM_{2.5}$	6.9
SO_2*	5.6
CO**	151

* Sulphur dioxide concentration estimates are the Defra 2001 mapped average

**Carbon monoxide estimated from Defra 2001 mapped average value of 0.40 mg/m^3 using factor of 0.446 for the year 2021

Due to the variable nature of the study area, NO_2 concentrations measured by the diffusion tubes in Mulberry Close in Elton and Richfield Recruitment in Ellesmere Port are considered to best represent modelled receptors in the areas of Elton and Ellesmere Port respectively, while the concentration measured at the Hillside School in Helsby were used for the selected receptors located on high ground in Helsby. In each case, the measured values are deemed to be representative of the conditions in the local area and more appropriate than Defra's

[10] https://uk-air.defra.gov.uk/data/laqm-background-home

mapped background concentrations. This is because diffusion tube measurements include a contribution from the existing refinery sources and the ubiquitous urban background, in addition to local road traffic contributions. The diffusion tube data therefore provide a robust background suitable for use in the assessment.

For all other pollutants, the Defra mapped backgrounds are considered suitable.

5.3. Sensitive Receptors

5.3.1. Human Health

Selected representative discrete receptors for human health (Receptors D1 to D26) were chosen for inclusion in the model based on their proximity to the site, position relative to the prevailing wind and sensitivity to air pollution, both over short and long-term exposure periods. The closest sensitive properties to the HPP site boundary are those in the population centres of Ince, Elton, Thornton Le Moors and Ellesmere Port, which are to the north, east, south and west of the plant respectively. There are also non-residential receptors to the northeast within the Thornton Science Park.

The modelled receptors are listed in Table 5-4 and shown in Figure 5-1. They represent the areas likely to be most affected by the stack emissions in the local area. The receptors were modelled at a height of 1.5 metres above local ground level to represent average breathing height.

Table 5-4 - Sensitive receptors for air quality

Receptor ID	Receptor Name	Grid Reference, m		Classification*
		Easting	Northing	
D1	1-7 Pool Lane, Ince	344919	376257	Long term
D2	1-4 Park Cottages, Kinsey's Lane, Ince	344956	376553	Long term
D3	Wood Farm, Kinsey's Lane, Ince	344725	376727	Long term
D4	Rose Cottage, Marsh Lane, Ince	345357	376904	Long term
D5	12 Station Road, Ince	345320	376047	Long term
D6	1 The Paddock, Elton	345233	375454	Long term
D7	Yew Tree Close, Thornton-le-Moors	344289	374466	Long term
D8	5 Oval Crescent, Ellesmere Port	340310	375356	Long term
D9	Telford Road, Ellesmere Port	341156	375623	Long term
D10	Robinson Road, Ellesmere Port	341062	375936	Long term
D11	Shephard Close, Ellesmere Port	340706	376755	Long term
D12	Thornton Science Park, Sutton Library, Stanlow	344854	375813	Short term
D13	Ince Village Hall, Pool Lane	344919	376257	Short term
D14	Elton Primary School, Elton	345592	375535	Long term
D15	Elton Community Centre	345779	375574	Short term
D16	16 Station Close, Elton	345444	375881	Long term
D17	Pond Cottages, Elton Green	345198	374986	Long term
D18	Munsong, Mount Pleasant, Elton	345498	375753	Long term
D19	Bents Cottages, Poole Lane, Thornton Le Moors	344226	374703	Long term
D20	St Mary's Church, Thornton Le Moors	344166	374562	Short term
D21	Little Meadow Green, Thornton Le Moors	344714	374799	Long term
D22	The Stables, Thornton Le Moors	344958	374847	Long term
D23	Carriage Drive, Frodsham	351384	376665	Long term
D24	Forest Hills Hotel and Leisure Complex, Frodsham	351705	376902	Short term
D25	Hill Road North, Helsby	349502	375082	Long term
D26	Commonside, Alvanley	350825	374122	Long term

*Short-term receptors relevant to exposure periods of one hour or less

5.3.2. Ecological Sites

The impact assessment for ecological sites considers the relevant national and local ecological designations (sites of special scientific interest (SSSI), national nature reserves (NNR), local nature reserves (LNR), local wildlife sites (LWS) and ancient/semi ancient woodlands) within 2 km of the site boundary and the European and international designations (Ramsar sites, Special Areas of Conservation (SAC) and Special Protection Areas (SPA)) within 10 km of the site boundary.

There are two statutory ecological sites with an international or European designation within 10 km of the HPP boundary:

- the Mersey Estuary SPA and Ramsar (also designated a SSSI), approximately 1.6 km north of the Site boundary at its closed point and extending north; and
- the River Dee and Bala Lake SAC (also designated a SSSI), 8.9 km south west of the Site boundary at its closest point in Chester.

The Mersey Estuary SPA comprises large areas of saltmarsh and extensive intertidal sand and mudflats, with limited areas of brackish marsh, rocky shoreline and boulder clay cliffs, within a rural and industrial environment. The intertidal flats and saltmarshes provide feeding and roosting sites for large and internationally important populations of waterfowl[11].

The River Dee and Bala Lake SAC is important due to the habitat it provides for plant communities and a number of species, including several fish, otter and floating water plantain. It consists of water courses of plain to montane levels.

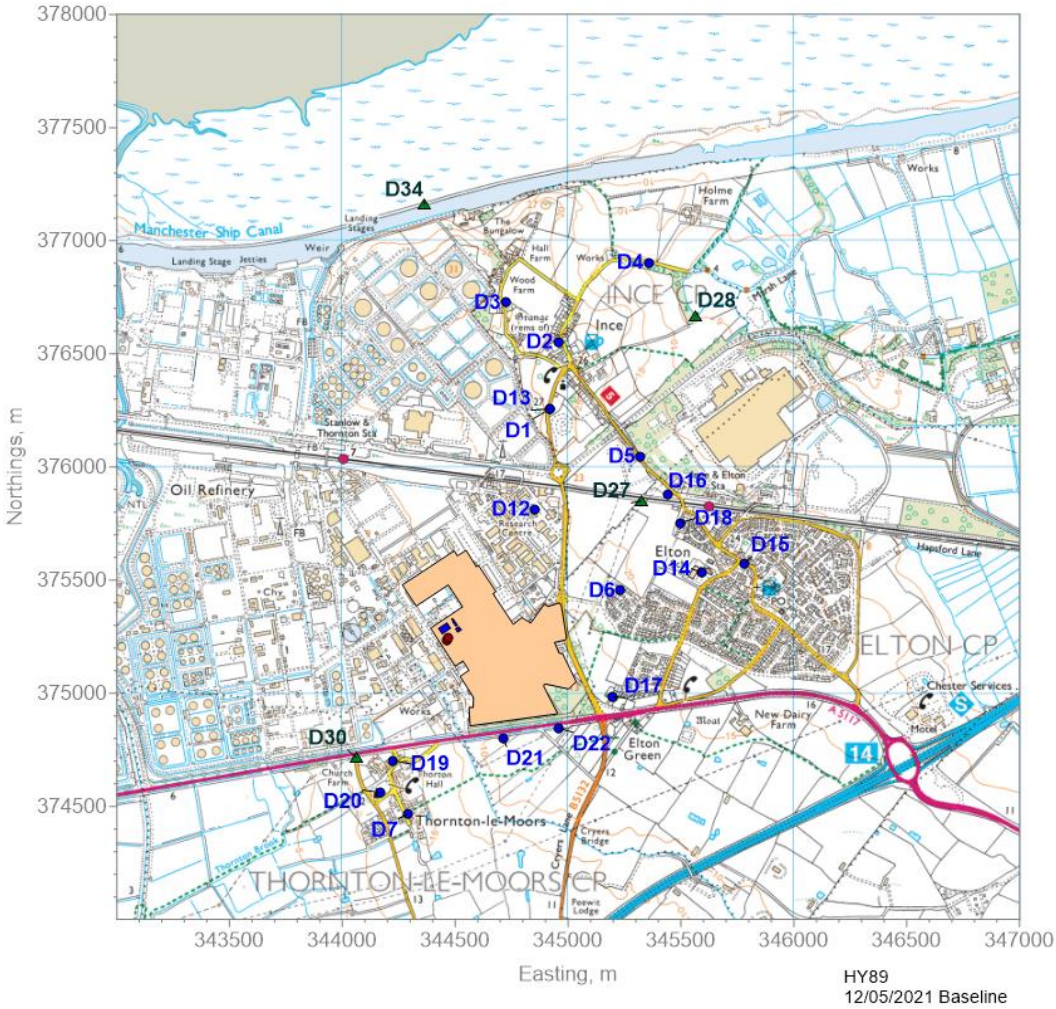
No other SSSIs, nor any LNR, NNR or ancient/semi ancient woodlands were identified within a 2 km radius of the Site boundary. However, there are a number LWS within 2 km of the Site boundary as identified from local authority mapping[12]. These include:

- Gowy Meadows and Ditches, 515 m to the south west;
- Station Road Railway, 554 m to the north east[13];
- River Gowy, 1.3 km to the west;
- Hoblane Ponds, approximately 1.5 km south east;
- Frodsham and Helsby and Ince Marches, 1.5 km to the east;
- Wervin Meadows, 1.8 km to the south west; and
- Shellway Road Pond South, 1.9 km to the west.

The ecological sites were included as discrete receptors in the model (D27 to D35). Those within the model grid area are shown in as green triangles.

[11] http://publications.naturalengland.org.uk/publication/5790848037945344?category=4582026845880320
[12] https://maps.cheshirewestandchester.gov.uk/cwac/webmapping
[13] While still shown as a designated area, the majority of the site has been built on, http://inside.cheshirewestandchester.gov.uk/GetFile?fileUrl=/icwac%20documents/4367%200015%20ellesmere%20port%20ldo%20ecological%20scoping%20final%20draft%20text.pdf&extension=pdf

Figure 5-1 - Modelled Human Health and Ecological Receptors



6. Methodology

6.1. Modelling Software

The atmospheric dispersion modelling was undertaken using the US EPA model AERMOD (version 19191), as incorporated by Trinity Consultants Inc. in the software BREEZE AERMOD. AERMOD includes two data pre-processors for streamlining data input: AERMET, a meteorological pre-processor, and AERMAP, a terrain pre-processor. The model can address both local topography and building downwash effects concurrently, where relevant to the study. The model provides reasonable estimates over a wide range of meteorological conditions and modelling scenarios.

6.2. Meteorology

The Speke (formerly Liverpool John Lennon Airport) meteorological station was deemed the most appropriate site with adequate records in the format required for the dispersion modelling study. This station is located approximately six kilometres to the north-west of the HPP. Hourly sequential meteorological data for the five-year period from 2016 to 2020 were used in the dispersion model.

In accordance with the US EPA modelling guidance, the near-field land use within a one-kilometre radius of the site was evaluated to determine the surface roughness length[14]. Land uses were specified by directional

[14] Surface roughness length is a measure of the height of obstacles to wind flow. It is not equal to the physical dimensions of obstacles but is generally proportional to them.

sector. The Bowen ratio[15] and albedo[16] were determined by the land use categories within the far-field, represented by a 10 x 10 km square centred on the site. The percentages of each type of land use were estimated based on inspection of Ordnance Survey mapping and aerial photography. The far-field land use proportions are simply averaged over the area and are independent of distance or direction from the site.

Urban, cultivated land, deciduous woodland and water comprised 39%, 29%, 7% and 25% respectively. The pre-processor generates appropriate default annual average values for these parameters based on the land use information. The derived values used for surface parameters are presented below in Table 6-1 for the land within a 1 km radius around the HPP stacks.

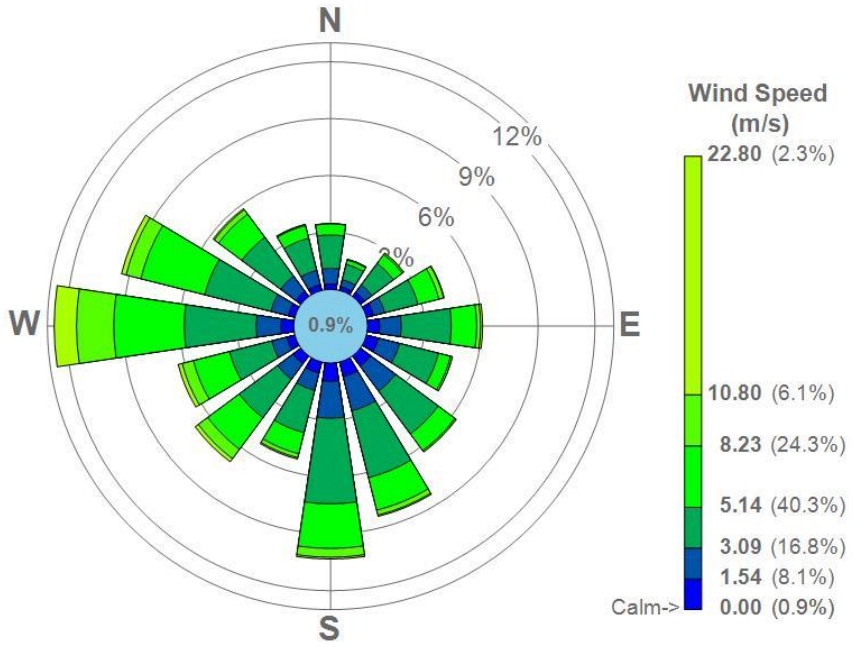
Table 6-1 - Site Surface Characteristics

Sector	Degrees	Albedo	Bowen Ratio	Surface Roughness, m
0 - 140	Urban	0.2175	1.025	1.00
140 - 160	Deciduous woodland[17]	0.2175	1.025	0.900
160 - 220	Cultivated Land	0.2175	1.025	0.0725
220 - 360	Urban	0.2175	1.025	1.00

The meteorological data for Speke were used to generate a five-year frequency distribution of wind speed and direction. The data are presented as a wind rose diagram in Figure 6-1. It is evident from the data that winds from the west and adjoining sector to the north west are the most frequent, with secondary prevailing winds from the south, south-south east and adjoining sectors, and the south west. Winds from the north-north west to east-south east are relatively infrequent.

[15] The Bowen ratio is a measure of the amount of moisture at the earth's surface. This influences other parameters which in turn affect atmospheric turbulence.
[16] Noon-time albedo is the fraction of incoming solar radiation reflected from the ground when the sun is directly overhead. Adjustments are made in AERMET to incorporate the variation in the albedo with solar elevation angle.
[17] It is noted this is a narrow sector representing a corner of the site to the south east. A sensitivity run was carried out using meteorological data processed assuming 0 – 160 as urban, and no material difference found in maximum ground level concentrations.

Figure 6-1 - Wind Rose Diagram for Speke, 2016-2020



6.3. Receptors

Ground level concentrations across the study area were modelled through a Cartesian receptor grids using a 100 metre resolution grid covering an area of 4 by 4 kilometres. Boundary receptors at 100 metre intervals were also included. All grid receptors were modelled at a height of 1.5 metres above ground level.

Discrete receptors were also specified for certain sensitive properties and ecological sites (described above).

6.4. Buildings and Terrain

The layout of the HPP is shown in Figure 2.3, and as a three-dimensional view in Figure 2.4 in the main supporting information report.

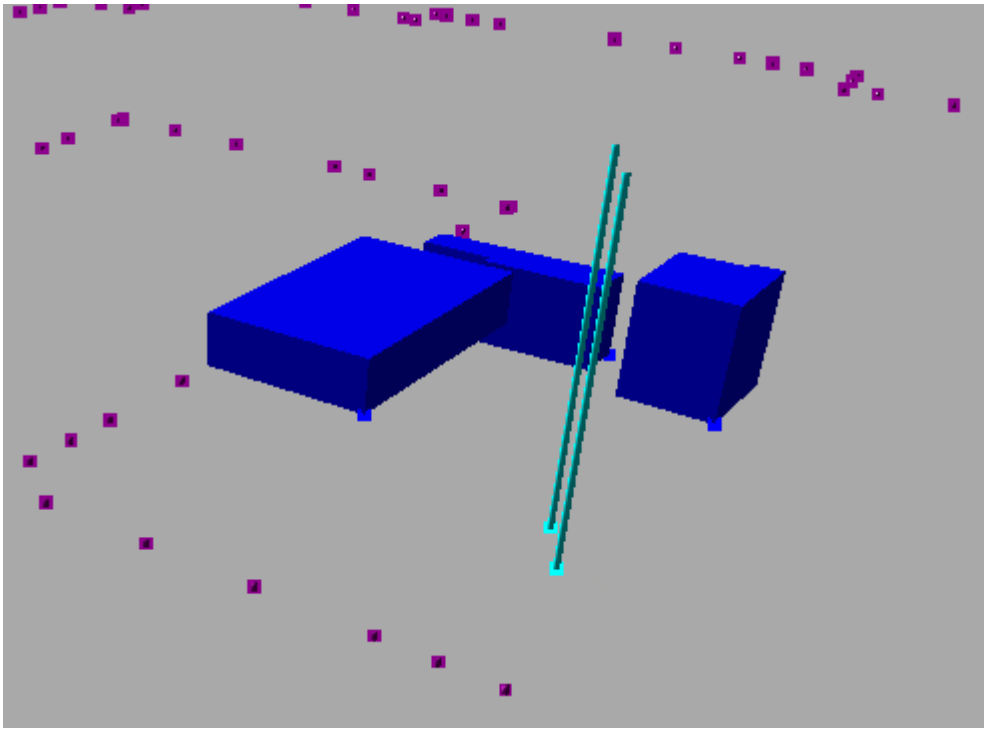
Building height information was derived from schematics and from the Navisworks model for the project. A three-dimensional image of the buildings included in the AERMOD model is shown in Figure 6-2, with the HPP Phase 1 viewed from the south west. The two light blue lines represent stacks for the Feed Fired Heater and the Steam Boiler.

The Dutch Barn, which comprises a pitched roof structure on stilts 14.75 m above the ground, is shown in the top-centre of the figure, behind the Feed Fired Heater and the Steam Boiler stacks. The CO_2 Capture Unit is situated adjacent to the Dutch Barn while the HPP is shown in the right. These units are open, porous structures. They have been represented in the model as solid rectangular cuboids dimensionally smaller than the actual plant (up to 50% of height) to reflect the anticipated degree of airflow through them[18]. The figure also shows the boundary receptors, described above, as purple dots.

All model objects and sources were modelled at a height of 11 metres above Ordnance Datum (AOD). Terrain elevations for all off-site receptors were used in the dispersion model, as derived from Ordnance Survey digital terrain data files (in “DEM” format). The terrain in the immediate study area around the facility is generally flat, however an area of high ground was identified over 3 km to the east at Helsby and Frodsham. Discrete receptors in this area were included in the model following a sensitivity study which identified the potential for higher hourly concentrations in this area (see Section A.2).

[18] Using Physical Modelling to Refine Downwash Inputs to AERMOD (Guerra, S. and Petersen, R.), Air and Waste Management Association (A&WMA), October 2016, https://pubs.awma.org/flip/EM-Oct-2016/guerra.pdf

Figure 6-2 - Schematic Showing Modelled Structures and Stacks



6.5. Stack Height Sensitivity Study

A stack height sensitivity analysis was conducted to evaluate the sensitivity of the concept design to an increase or decrease in stack height, in order to reach the optimum discharge conditions and to ensure adequate dispersion of pollutants in accordance with BAT.

The study evaluated both the Phase 1 only and full development (Phases 1 and 2) emissions. The heights considered were 30, 35, 40, 45, 50 and 55 metres above ground level. For each scenario the Feed Fired Heaters and Steam Boilers were modelled with identical stack heights. The maximum hourly and annual ground level pollutant concentrations for each incremental change in stack height were modelled as described above for the main study. The analysis was specifically focused on the oxides of nitrogen emissions from the Feed Fired Heater and the Steam Boiler, as the criteria for this pollutant (and NO_2) are the most challenging to achieve.

To account for cumulative impacts from Phases 1 and 2, the model for the full development included buildings for the two phases. The pollutant mass emission rate for Phase 2 is twice that of Phase 1 alone.

The findings of the stack height sensitivity study are presented in Section A.4. A stack height of 40 metres was selected based on BAT and the results of the sensitivity analysis, both for Phase 1 and Phase 2.

6.6. Modelled Scenario

A single operational scenario for emissions from the Phase 1 Feed Fired Heater and Steam Boiler has been modelled. This represents the normal operational conditions for the concurrent operation of the Feed Fired Heater and the Steam Boiler. For the purpose of this assessment it was assumed that both sources operate continuously and at full load throughout the year, ignoring temporary shut-down periods for maintenance. The assessment presented in this therefore based on a conservative assumption.

The Feed Fired Heater and the Steam Boiler each discharge through individual stacks and were therefore modelled as separate point sources.

Each emission source was modelled to discharge at a height of 40 metres above ground (the height having been determined from a stack height sensitivity study undertaken prior to the assessment, see above).

6.7. Source Characteristics

The Feed Fired Heater and the Steam Boiler operating as part of the HPP will be continuous sources of oxides of nitrogen, which would arise from the combustion of PSA tail gas (and natural gas on start-up). There would also be minor emissions of carbon monoxide from the combustion process. These emissions are invariably of insignificant environmental effect but have been modelled for completeness.

The emission characteristics for the Phase 1 Feed Fired Heater (F-101) and the Steam Boiler (B-101) used in the modelling are summarised in Appendix A.

Calculations of the pollutant emissions from both sources were derived from relevant BAT AELs (see the main application Supporting Information Document Section 6.2) NOx and CO concentrations: 80 mg/Nm^3 for NOx and 100 mg/Nm^3 for CO. These are considered to be consistent with the Environment Agency Pre-Application Advice on EPR benchmark values.

The normalised flow rates were determined from mass balance calculations using the thermal input for the Feed Fired Heater (20.2 MW) and the Steam Boiler (27.6 MW) .

The stack diameters were estimated in order to provide a value in the range 10-15 m/s for the exhaust gas velocity, a suitable assumption for both the heater and the boiler.

The same model inputs were used in the stack height sensitivity study for Phase 1; for Phase 2 the flow rate and mass emission rate were doubled and an effective diameter calculated to retain the same efflux velocity.

6.7.1. Other Sources/Pollutants

Natural gas, which may be used infrequently at start up, has a very low sulphur content of less than 5 ppm total sulphur, so would not materially contribute to emissions.

Sulphur will be removed from the feed gas through a desulphurisation process to comply with a maximum limit. The HPP project has currently agreed a limit on the sulphur content of feed gas equivalent to 13.6 ppm H_2S. If the ROG content of H_2S increases, it would reduce the equipment performance and lifetime thus the plant is designed against this, although occasionally there could be peaks above the design level. If this happened, the ROG would be diverted elsewhere within the Stanlow refinery and is outside the scope of this application.

For these reasons, sulphur dioxide emissions from normal operation are anticipated to be negligible. A calculation is nevertheless presented in the results section for the maximum 15-minute mean concentration, due to the presence of the AQMA.

There could occasionally be flaring of some sulphur containing gas but this would be very infrequent, anticipated to be just a few times year for short durations (a few hours only). The flare emissions would be discharged at a height of 50 m above ground level at high temperature and thus dispersion would be very effective for both NOx and SO_2 emissions.

The standby diesel generator and firewater pump are only expected to operate for very limited periods throughout the year, for testing and emergency use.

For these reasons, and in order to present a proportionate assessment, these three sources have not been included in the detailed modelling study.

6.8. Interpretation of Results

Model results have been compared to relevant Ambient Air Directive (AAD) limit values, national AQS objectives and other air quality criteria for permitting set out in the Environment Agency's online guidance for air emissions risk assessment[19].

6.8.1. Human Health

Environment Agency online risk assessment guidance states that modelled long-term increments to concentrations "Process Contributions" (PC) may be added to the background annual mean concentration to derive a "Predicted Environmental Concentration" (PEC), for comparison with criteria. For short-term PCs, which is interpreted as hourly or less in line with Defra Technical Guidance[20], the PEC may be obtained by adding the PC to twice the background annual mean concentration.

[19] https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit (May 2021)
[20] Defra, Local Air Quality Management, Technical Guidance (TG16), https://laqm.defra.gov.uk/technical-guidance/ (April 2021)

For an assessment against the air quality objective for nitrogen dioxide, an additional step is required to convert the oxides of nitrogen, principally in the form of nitrogen monoxide, to nitrogen dioxide. The oxides of nitrogen emissions from engines are almost entirely in the form of nitrogen monoxide. As the plume travels and mixes with air, the nitrogen monoxide slowly oxidises to form nitrogen dioxide.

The Environment Agency worst case conversion ratios[21] for NO_X to NO_2 of 35% for short-term and 70% for long-term average concentrations, were used in the impact assessment[22]. The estimated maximum ground level NO_2 concentrations at off-site locations and at selected sensitive receptors were compared to key AAD criteria of 200 µg/m^3 as an hourly mean and 40 µg/m^3 as an annual mean as NO_2. Due to the low modelled concentrations for this study, there was no requirement to undertake post-processing to determine the short-term result as a percentile for comparison to the hourly AAD.

No post-processing of model results was required as a direct comparison can be made to CO short term standards for the 1-hour and 8-hour mean (30,000 and 10,000 µg/m^3 respectively).

To estimate maximum 1 hour mean SO_2 concentration, the maximum modelled 1-hour mean NOx concentration was factored by the ratio of emission rates for the two pollutants. To estimate a 15 minute mean concentration from the 1 hour concentration, a factor of 1.34 was applied as per Environment Agency permitting guidance.

6.8.2. Ecological Sites

An assessment of the effect of the HPP emissions at designated nature conservation sites was undertaken to determine compliance with the critical level for oxides of nitrogen for the protection of vegetation of 30 µg/m^3 annual mean as well as the non-statutory daily average criterion of 75 µg/m^3. The modelled PCs were compared to the assessment criteria to determine the likelihood of significant impacts.

Oxides of nitrogen can also contribute to dry nitrogen and acid deposition at sensitive sites. This was calculated from NOx (assuming 100% conversion to NO_2) using AQTAG deposition rates[23] for grassland and vegetation. Where the modelled increment to the critical load is greater than 1%, it is then added to the background rate of nitrogen deposition (taken from the Air Pollution Information System (APIS) website[24]). The total rate is again compared with the relevant critical load. Ranges for critical loads rather than fixed values are provided to allow for natural variation, uncertainties about deposition values and temporal variability of available data. Typically, the lower value in the range is used in the assessment.

Where the calculated nitrogen deposition rate increases by less than 1% of the critical load or background rate, Natural England advises that this can be interpreted as being not significant. However, it should be noted that an exceedance of this criterion would not indicate that the increment is either significant or unacceptable, merely that a more detailed interpretation of the data is required by an ecologist.

7. Results

7.1. Human Health Receptors

7.1.1. Nitrogen Dioxide – Annual Mean

The modelled long-term average oxides of nitrogen concentrations for Phase 1 were factored by 0.70 to estimate NO_2 concentrations, for comparison with the AAD. The long-term results presented are the maximum of the five individual annual averages modelled at each receptor, and therefore account for inter-annual variation within the meteorological dataset.

The assessment of annual average NO_2 concentrations at human health receptor locations for Phase 1 operation is presented in Table 7-1. The maximum modelled annual mean PC at each receptor was added to the selected background concentration (35 µg/m^3 in Ellesmere Port, 17 µg/m^3 in Elton, 21 in Helsby and Frodsham) to calculate the PEC. The PEC is presented as a percentage of the EAL value in Table 7-1 to inform the evaluation of significance.

[21] Environmental permitting: air dispersion modelling reports - GOV.UK (www.gov.uk)
[22] https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports (January 2021)
[23] Air Quality Advisory Group, 2014, AQTAG06, Technical Guidance on detailed modelling for an appropriate assessment for emissions to air. Deposition velocity values also presented in https://iaqm.co.uk/text/guidance/air-quality-impacts-on-nature-sites-2020.pdf
[24] http://www.apis.ac.uk/ (accessed April 2021)

Table 7-1 - Maximum Annual Average Concentrations of Nitrogen Dioxide and Contribution to Air Quality Criteria

Receptor ID	Description	NO_2 PC (µg/m³)	PC/AAD (%)	NO_2 PEC (µg/m³)	PEC/AAD (%)
D1	1-7 Pool Lane, Ince	0.1	0.2	16.9	42.2
D2	1-4 Park Cottages, Kinsey's Lane, Ince	<0.1	0.1	16.8	42.1
D3	Wood Farm, Kinsey's Lane, Ince	<0.1	0.1	16.8	42.1
D4	Rose Cottage, Marsh Lane, Ince	<0.1	0.1	16.8	42.1
D5	12 Station Road, Ince	0.1	0.2	16.9	42.2
D6	1 The Paddock, Elton	0.1	0.4	16.9	42.4
D7	Yew Tree Close, Thornton-le-Moors	0.1	0.2	16.9	42.2
D8	5 Oval Crescent, Ellesmere Port	<0.1	0.0	35.2	88.0
D9	Telford Road, Ellesmere Port	<0.1	0.0	35.2	88.0
D10	Robinson Road, Ellesmere Port	<0.1	0.0	35.2	88.0
D11	Shephard Close, Ellesmere Port	<0.1	0.0	35.2	88.0
D12	Thornton Science Park, Sutton Library, Stanlow	0.1	0.3	16.9	42.3
D13	Ince Village Hall, Pool Lane	0.1	0.2	16.9	42.2
D14	Elton Primary School, Elton	0.1	0.2	16.9	42.2
D15	Elton Community Centre	0.1	0.2	16.9	42.2
D16	16 Station Close, Elton	0.1	0.2	16.9	42.2
D17	Pond Cottages, Elton Green	0.2	0.5	17.0	42.5
D18	Munsong, Mount Pleasant, Elton	0.1	0.2	16.9	42.2
D19	Bents Cottages, Poole Lane, Thornton Le Moors	0.1	0.3	16.9	42.3
D20	St Mary's Church, Thornton Le Moors	0.1	0.2	16.9	42.2
D21	Little Meadow Green, Thornton Le Moors	0.2	0.5	17.0	42.5
D22	The Stables, Thornton Le Moors	0.2	0.5	17.0	42.5
D23	Carriage Drive, Frodsham	<0.1	0.0	21.4	53.5
D24	Forest Hills Hotel and Leisure Complex, Frodsham	<0.1	0.0	21.4	53.5
D25	Hill Road North, Helsby	<0.1	0.0	21.4	53.5
D26	Commonside, Alvanley	<0.1	0.0	21.4	53.5

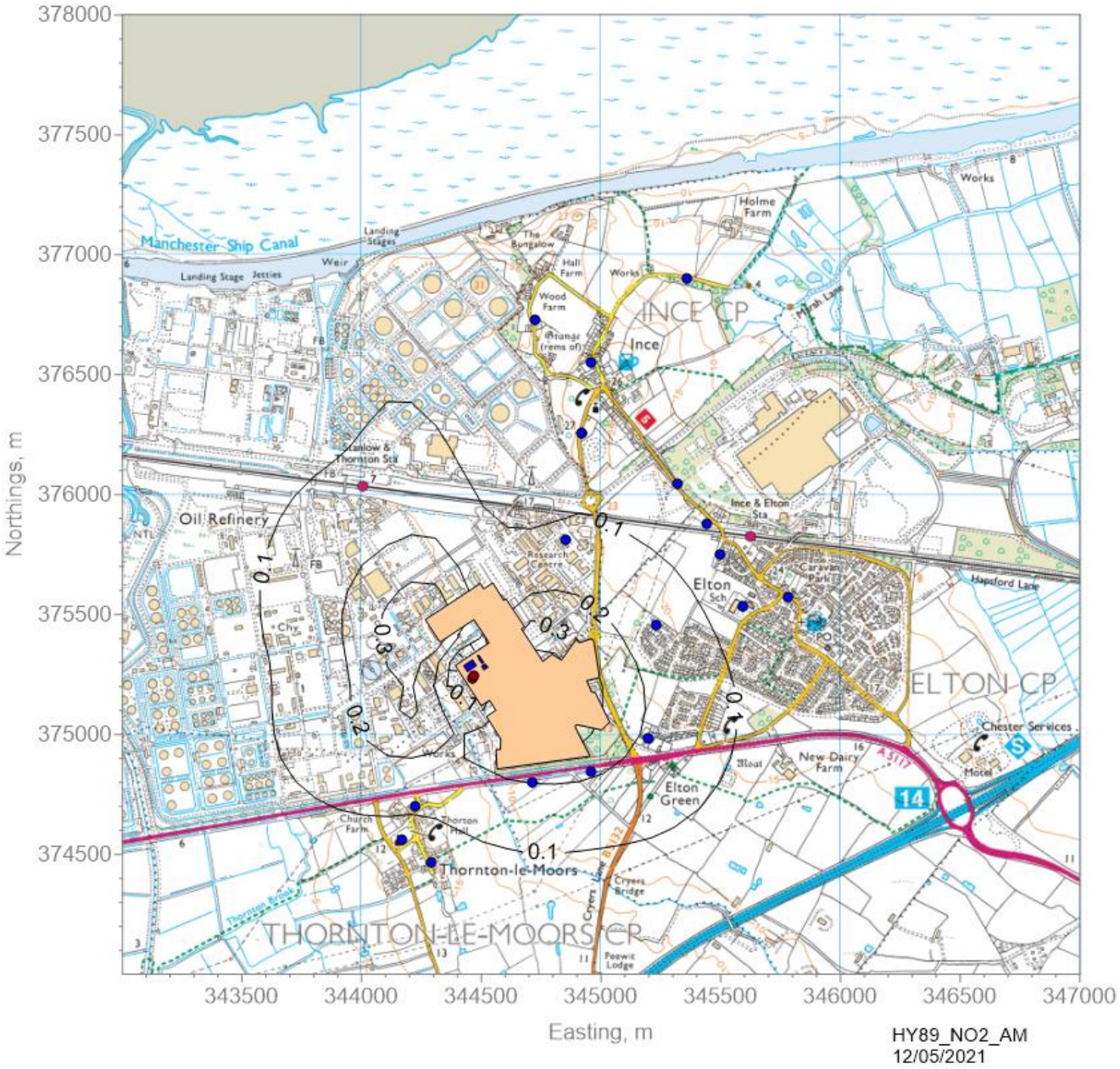
The modelled results at sensitive receptors show that:

- the maximum PC as NO_2 is 0.2 µg/m³ or 0.5% of the AAD criterion at Receptor D22;
- modelled PECs are all well below the annual mean AAD criterion of 40 µg/m³.

The maximum annual mean contribution at the closest receptor to the Ellesmere Port AQMA is less than 0.1 µg/m³.

A contour plot for the maximum annual mean NO_2 concentrations at all receptor locations for Phase 1 is presented in Figure 7-1. This figure represents the maximum individual annual mean result at each receptor in a five year period.

Figure 7-1 - Maximum Annual Mean Nitrogen Dioxide Concentrations, µg/m³



7.1.2. Nitrogen Dioxide – 1 hour mean

The modelled short-term average oxides of nitrogen concentrations were factored by 0.35 to estimate NO_2 concentrations, for a comparison with the hourly AAD criterion of 200 µg/m³. The short-term results presented are the maximum modelled hourly concentration at each discrete receptor point over the five years of hourly sequential meteorological data used.

The maximum modelled hourly mean PC at each was combined with twice the measured background concentration to calculate the short term PEC to allow a comparison with the hourly AAD.

The assessment of the hourly average NO_2 concentrations at human health receptor locations for Phase 1 operation is presented in Table 7-2.

Table 7-2 - Maximum Hourly Average Concentrations of Nitrogen Dioxide and Comparison to Air Quality Criteria

Receptor ID	Description	NO_2 PC ($\mu g/m^3$)	PC/AAD (%)	NO_2 PEC ($\mu g/m^3$)	PEC/AAD (%)
D1	1-7 Pool Lane, Ince	1.1	0.5	34.7	17.3
D2	1-4 Park Cottages, Kinsey's Lane, Ince	1.0	0.5	34.6	17.3
D3	Wood Farm, Kinsey's Lane, Ince	1.0	0.5	34.6	17.3
D4	Rose Cottage, Marsh Lane, Ince	0.9	0.5	34.5	17.3
D5	12 Station Road, Ince	1.0	0.5	34.6	17.3
D6	1 The Paddock, Elton	1.3	0.6	34.9	17.4
D7	Yew Tree Close, Thornton-le-Moors	1.3	0.6	34.9	17.4
D8	5 Oval Crescent, Ellesmere Port	0.4	0.2	70.8	35.4
D9	Telford Road, Ellesmere Port	0.5	0.3	70.9	35.5
D10	Robinson Road, Ellesmere Port	0.6	0.3	71.0	35.5
D11	Shephard Close, Ellesmere Port	0.6	0.3	71.0	35.5
D12	Thornton Science Park, Sutton Library, Stanlow	1.2	0.6	34.8	17.4
D13	Ince Village Hall, Pool Lane	1.1	0.5	34.7	17.3
D14	Elton Primary School, Elton	1.0	0.5	34.6	17.3
D15	Elton Community Centre	0.9	0.5	34.5	17.3
D16	16 Station Close, Elton	1.0	0.5	34.6	17.3
D17	Pond Cottages, Elton Green	1.3	0.6	34.9	17.4
D18	Munsong, Mount Pleasant, Elton	1.0	0.5	34.6	17.3
D19	Bents Cottages, Poole Lane, Thornton Le Moors	1.5	0.7	35.1	17.5
D20	St Mary's Church, Thornton Le Moors	1.3	0.7	34.9	17.5
D21	Little Meadow Green, Thornton Le Moors	1.5	0.8	35.1	17.6
D22	The Stables, Thornton Le Moors	1.4	0.7	35.0	17.5
D23	Carriage Drive, Frodsham	0.5	0.3	43.3	21.7
D24	Forest Hills Hotel and Leisure Complex, Frodsham	0.3	0.2	43.1	21.6
D25	Hill Road North, Helsby	0.9	0.4	43.7	21.8
D26	Commonside, Alvanley	3.2	1.6	46.0	23.0

The modelled results at sensitive receptors show:

- the maximum 1 hour PC from a five-year dataset at any sensitive receptor is 3.2 µg/m^3 i.e. less than 2% of the AAD of 200 µg/m^3.
- the maximum PEC is 71 µg/m^3 i.e. less than 36% of the AAD of 200 µg/m^3.

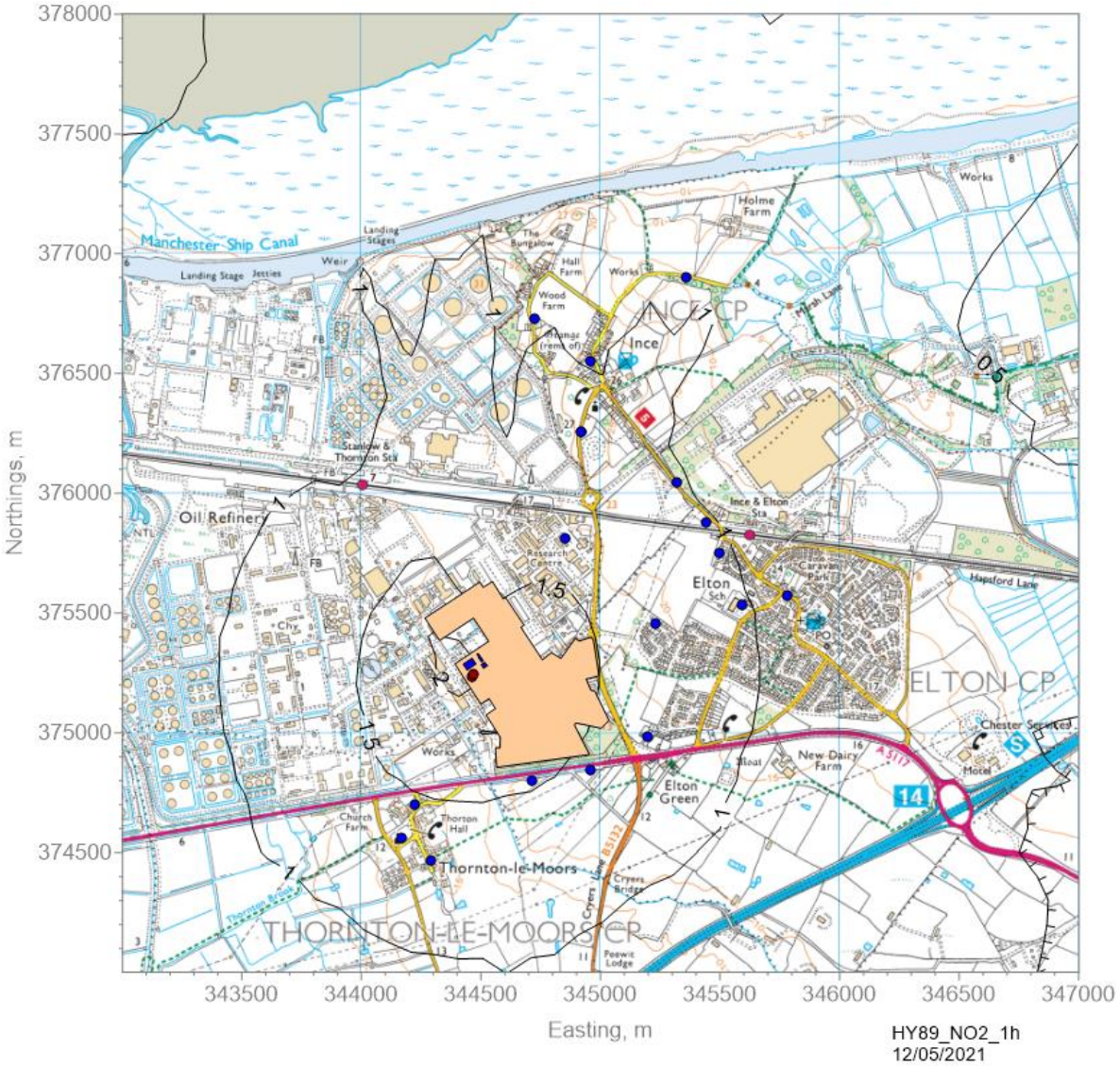
It should be noted that the receptor showing the maximum hourly concentration (i.e. D26) is located in Helsby, over three kilometres east of the site, and is 96m above the sea level. The high result at this location is due to the combined effect of the elevated terrain and the predominant wind direction. The influence on the terrain on the model results has been investigated as a sensitivity test as shown in Section 8.A.2.

The maximum 1 hour NO_2 PC from the five-year dataset at a sensitive receptor in proximity to the site is 1.5 µg/m^3 at receptor D19 to the south west. This is a negligible increment of less than 1% of the AAD of 200 µg/m^3.

The maximum 1 hour NO_2 PC from the five-year dataset at the closest modelled receptor to the Ellesmere Port AQMA is approximately 0.6 µg/m^3. This is a negligible increment of less than 1% of the AAD of 200 µg/m^3.

A contour plot for the maximum hourly NO_2 concentrations at all receptor locations in a five-year period for Phase 1 is presented in Figure 7-2.

Figure 7-2 - Maximum Hourly Nitrogen Dioxide Concentrations, µg/m³



7.1.3. Carbon Monoxide – 8 hour and 1 hour mean

The maximum modelled short-term PC at each receptor was derived from a five year meteorological dataset.

- The maximum 8 hour PC from a five-year dataset anywhere in the modelled domain is 3.8 µg/m³ i.e. less than 0.1% of the EAL of 10,000 µg/m³.
- The maximum 1 hour PC from a five-year dataset anywhere in the modelled domain is 11.6 µg/m³ i.e. less than 0.1% of the EAL of 30,000 µg/m³.

These maximum modelled CO concentrations for both the 1 hour and 8 hour period means are negligible and no further consideration of PEC is required.

7.1.4. Sulphur Dioxide

A sensitivity study for sulphur dioxide has been undertaken for comparison with the 15-minute standard due to the presence of the AQMA at Thornton le Moors. The calculation used a PSA tail gas sulphur content of 5 mg/Nm³ and fuel consumption rate for the Feed Fired Heater and Steam Boiler of 6.62 kNm³/hr and 9.07 kNm³/hr respectively. The total sulphur dioxide mass emission rate was calculated to be 0.04 g/s SO_2 compared to 0.82 g/s for NOx.

The maximum hourly NOx concentration modelled at discrete sensitive receptors is 9.3 µg/m^3 which equates to a maximum 1-hour SO_2 process contribution of 0.5 µg/m^3. Factoring this value by 1.34 gives an estimated maximum 15-minute concentration of 0.66 µg/m^3, just 0.25% of the AAD value of 266 µg/m^3.

Even in the unlikely event of the maximum permitted H_2S content of PSA tail gas of 13.6 ppm (20 mg/m^3 i.e. four times higher) there will be no material contribution to the existing SO_2 concentrations in the area as the maximum PC will be less than 1% of the AAD.

7.2. Ecological Receptors

An assessment has been undertaken for statutory and non-statutory designated ecological sites in the HPP study area. There are two sites with a European designation within 10 kilometres of the site boundary and one SSSI and several LWS within two kilometres.

7.2.1. Within two kilometres

Statutory

The highest annual mean NOx PC in a five-year dataset modelled for Phase 1 within Mersey Estuary SPA/SSSI (the only European designated site identified within two kilometres) is 0.07 µg/m^3. This is a negligible increment at just 0.2% of the critical level of 30 µg/m^3.

A contour plot for the annual average concentrations for NOx is presented in Figure 7-3.

Non-Statutory

The modelled long term average PCs for Phase 1 are presented in Table 7-3. The results show:

- the maximum NOx PC is at Gowy Meadows and Ditches LWS (0.16 µg/m^3 i.e. 0.54% of the EAL);
- At no locally designated site within 2 km is the EA screening criterion (i.e. 100% of the critical level) exceeded.

Table 7-3 - Long Term Results at Non-Statutory Ecological Sites within 2 km

Site	NOx PC, µg/m^3	NOx PC/EAL, %
Station Road Railway Site LWS	0.12	0.39
Frodsham and Helsby and Ince Marshes LWS	0.06	0.21
River Gowy LWS	0.05	0.18
Gowy Meadows and Ditches LWS	0.16	0.54
Shelway Road Pond South LWS	0.03	0.11
Wervin Meadows LWS	0.03	0.08
Hoblane Ponds LWS	0.04	0.12

Short term

The maximum modelled daily mean PC at any designated site within two kilometres is 1.4 µg/m^3 at Gowy Meadows and Ditches. This increment is less than 2% of the non-statutory assessment criterion of 75 µg/m^3.

7.2.2. Within ten kilometres

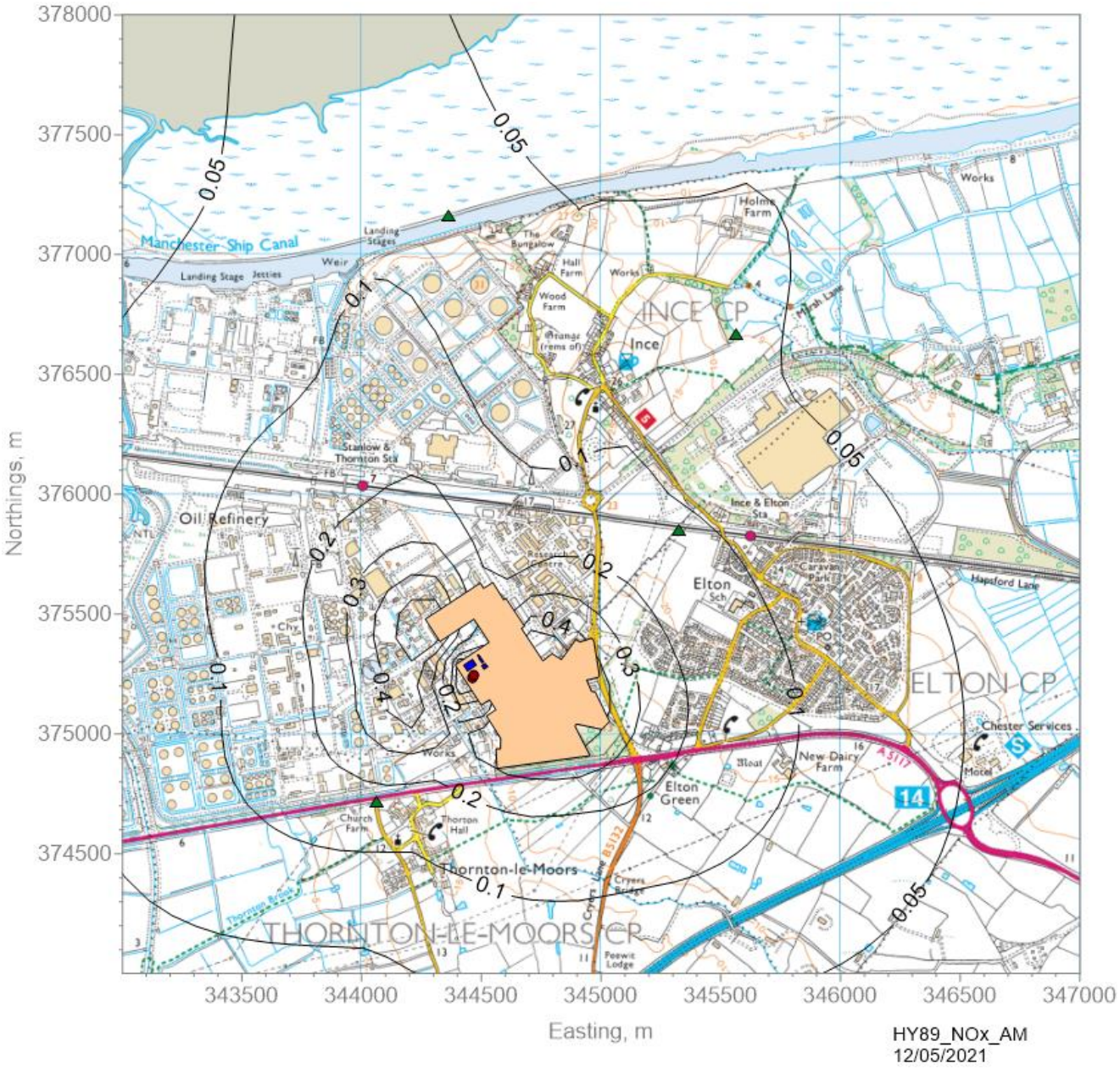
Long term

The River Dee and Bala Lake SAC is the only European designated site identified between two and 10 kilometres of the HPP. The maximum annual mean PC modelled in a five-year dataset is 0.003 µg/m^3. This is a negligible contribution of 0.01% to the critical level of 30 µg/m^3.

Short term

The maximum modelled daily mean PC at River Dee and Bala Lake SAC is 0.06 µg/m^3. This is a negligible contribution of less than 0.1% to the daily mean, non-statutory criterion of 75 µg/m^3.

Figure 7-3 - Maximum Annual Nitrogen Oxide Concentrations, µg/m^3



7.2.3. Nitrogen and Acid Deposition

An estimation of incremental nitrogen and acid deposition rates has been undertaken for the two European sites within 10 km and the closest SSSI and LWS. The habitats, nitrogen and acid deposition critical loads used in the assessment are:

- Mersey Estuary SPA – saltmarsh habitat, 20-30 kgN/ha/yr and 0.498 keq/ha/yr CLmaxN[25];
- Mersey Estuary SSSI – rich fens, 15-30 kgN/ha/yr and 0.498 keq/ha/yr CLmaxN;
- River Dee and Bala Lake SAC – floating plantain, 3-10 kgN/ha/yr, no CLmaxN available (waterbody);
- Gowy Meadows and Ditches LWS – lowland grazing marsh, 20-30 kgN/ha/yr and 5.701 keq/ha/yr CLmaxN;
- Station Road Railway Site - Broadleaved, Mixed and Yew Woodland, 10-20 kgN/ha/yr and 1.74 keq/ha/yr CLMaxN.

The results of the assessment are presented in Table 7-4. This shows the contribution to deposition rate as calculated from the annual mean NOx for Phase 1, and as a percentage of the recommended critical loads for nitrogen and acid deposition (the latter using the "CLmaxN") where available from the APIS website.

Table 7-4 - Nitrogen and Acid Deposition Results at Ecological Receptors

Site	PC N dep kg N/ha/yr	PC / C Load,	PC N acid dep kg N/ha/yr	PC / CLMaxN,
Mersey Estuary SPA/ Ramsar	0.01	0.05*	0.001	0.15
Mersey Estuary SSSI	0.01	0.07	0.001	0.15
River Dee and Bala Lake SAC/ SSSI	<0.01	0.01	<0.001	N/A**
Gowy Meadows and Ditches LWS	0.02	0.12	0.002	0.03
Station Road Railway Site	0.03	0.33	0.002	0.14

*0.21% if Raised and blanket bogs habitat is considered (critical load range 5-10 kg N/ha/yr) and assuming AQTAG deposition velocity for woodland

**no CLMaxN available for this feature, which represents a waterbody

The nitrogen and acid deposition results show:

- The PCs at the two European sites are less than 1% of the critical loads, even allowing for potential presence of bog habitat at the Mersey Estuary SPA;
- The maximum nutrient nitrogen and acid deposition rates at an LWS are less than 1% of the respective critical loads.

In light of these very low results at the closest designated sites of interest, the impacts at all other LWS within the relevant distance are considered to be insignificant.

[25] It should be noted that while the APIS website also provides a critical load range for raised and blanket bogs for the Mersey Estuary SPA, the project ecologist has confirmed that saltmarsh is the only habitat present to the north of the HPP where the highest PC is modelled. However, in the absence of an acid critical load for saltmarsh habitat, and to enable a conservative screening assessment, the CLMaxN for bog has been adopted.

8. Conclusions

An air dispersion modelling study, undertaken in support of the Environmental Permit application for the HPP, has estimated the impacts at human health receptors and ecological receptors locations from the concurrent operation of both the Feed Fired Heater and the Steam Boiler.

A stack height sensitivity study showed that a height of 40 m was considered suitable to satisfy the Environment Agency's requirements to represent BAT and incorporated in the design.

The air quality assessment has not identified any likelihood of breaches of long or short-term assessment criteria at human receptors for any pollutant or averaging period including on elevated ground to the east.

The long- and short-term impacts at either statutory or non-statutory sites within the study area were also found to be negligible in terms of critical levels and loads.

On this basis, it is concluded that the impact of the Feed Fired Heater and the Steam Boiler at the HPP on local air quality are not significant.

Appendices

Appendix A.

A.1. Model Input Parameters

Table A-1 - Feed Fire Heater (F101) Flue Characteristics - Phase 1

Stack Parameter	Value
Stack location	344462, 375236
Stack height, m	40
Flue diameter (single flue), m	1
Flue gas discharge temperature, °C	140
Flue gas discharge temperature, K	413.15
Discharge velocity, m/s	11.4
Actual discharge flow rate, am^3/s	8.94
Water content, % (approx.)	30
Oxygen content, dry, % (approx.)	2.3
Normalised flow rate (273 K, 101.3 kPa, 3% O_2 dry basis), Nm^3/s	4.31
Oxides of nitrogen (as NO_2) emission concentration, mg/Nm^3	80
Carbon monoxide emission concentration, mg/Nm^3	100
Oxides of nitrogen (as NO_2) emission rate, g/s	0.345
Carbon monoxide emission rate, g/s	0.431

Table A-2 - Steam Boiler (B101) Flue Characteristics - Phase 1

Stack Parameter	Value
Stack location	344467, 375247
Stack height, m	40
Flue diameter (single flue), m	1
Flue gas discharge temperature, °C	140
Flue gas discharge temperature, K	413.15
Discharge velocity, m/s	16.2
Actual discharge flow rate, am3/s	12.70
Water content, % (approx.)	30
Oxygen content, dry, % (approx.)	1.6
Normalised flow rate (273 K, 101.3 kPa, 3% O_2 dry basis), Nm^3/s	5.90
Oxides of nitrogen (as NO_2) emission concentration, mg/Nm3	80
Carbon monoxide emission concentration, mg/Nm^3	100
Oxides of nitrogen (as NO_2) emission rate, g/s	0.472
Carbon monoxide emission rate, g/s	0.590

Table A-3 - Summary of Other Model Parameters

Model Parameter	Value
Model type, version	AERMOD, 19191
Meteorological data	Speke, 2016-2020 (<1% missing data)
Pollutants	NOx, CO
Sources	2 x point sources
Averaging periods	1h, 8h, 24h, annual
Receptor grid	3.5 x 3.5 km @ 100 m spacing
Discrete receptors	D1 to D26 (human Health), D27 to D37 (Ecological)
Discrete receptor height	1.5 m
Buildings	Included, 3 off
Terrain	Included
Variable emissions	No, continuous
NOx conversion rate	35 / 70 worst case
Sensitivity analysis	Met data – individual years Terrain Data – extra grid to east SO_2 – calculation of max

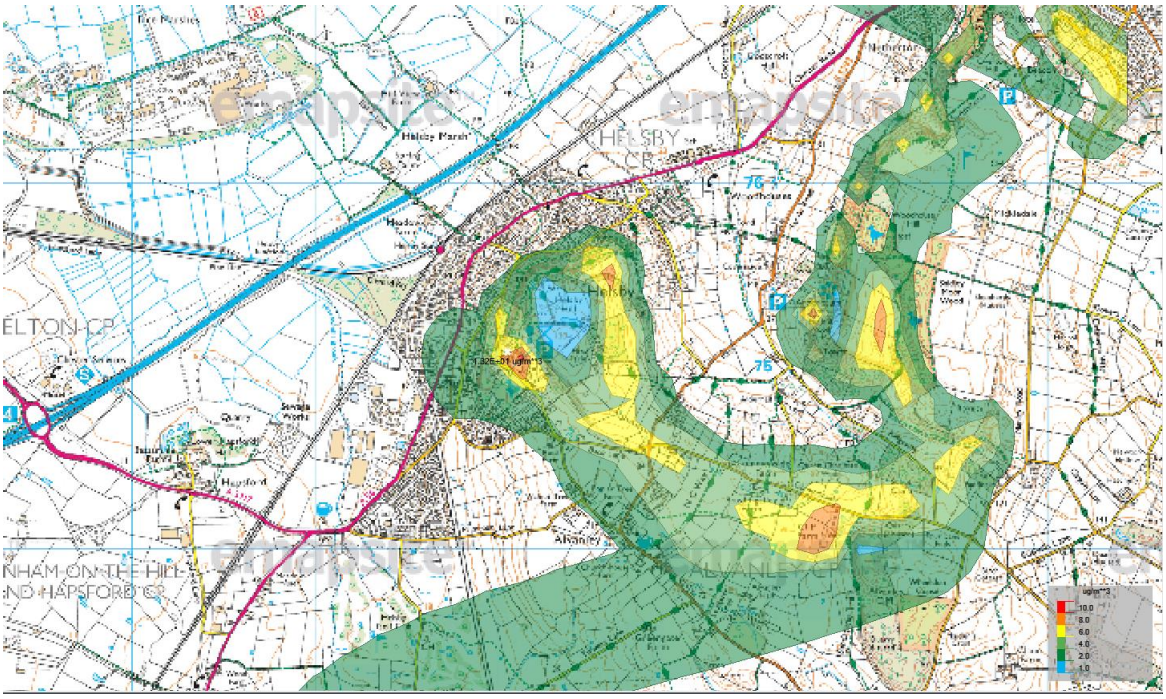
A.2. Terrain Sensitivity

The ground rises steeply to the east of the A56 at Helsby, to a maximum of 140 m above ordinance datum (AoD) at Helsby Fort, compared to just 10 m at the HPP boundary. Although Helsby is around three kilometres east of the HPP, an additional model run was undertaken to identify whether higher concentrations may occur on this elevated ground and thus whether receptors should be included in the main study and if so, where. To check this, concentrations were estimated using a 100 metre resolution grid covering an area of 3.5 by 3 kilometres.

The maximum modelled annual NO_2 PC over a five-year dataset was 0.01 µg/m^3 (i.e. 0.02% of the AAD), while the maximum hourly NO_2 PC was 4.6 µg/m^3, equal to the 2.3% of the AAD limit value. The modelled concentrations at locations with elevated ground would be below the AAD limit value and confirm the findings presented in the main report.

A screenshot of the maximum hourly NOx concentrations across the modelled area in presented in Figure A-1 below. This contour map was used to include additional receptors in the main study (D23 to D26).

Figure A-1 - Maximum Hourly Average NOx Concentrations on elevated ground, µg/m^3



A.3. Annual Emissions

The detailed modelling study has considered the additional emissions from the HPP in isolation from the existing Stanlow refinery. The HPP will be sited in an area of Stanlow Refinery known as “Alcohols”, currently a largely redundant plot of land which was, in part, the location of the previous Alcohols production facility. There has been a reduction in refinery emissions following the closure of Essar’s SHOP and Alcohols Plant in 2019 and the additional emissions from HPP are small in comparison.

The annual emissions due to the operation of the Feed Fired Heater and the Steam Boiler for both Phase 1 in isolation and in combination with the future Phase 2 plant have been estimated. These are provided in the context of the reduction in refinery emissions following the closure of Essar’s SHOP and Alcohols Plant in 2019. The annual NOx emissions for the SHOP and Alcohol Plant and for Phase 1 and Phase 2 of the HPP are shown in Table A-4 and Table A-5 below.

Table A-4 - Annual NOx Emissions from SHOP and Alcohols Plant

Ref	Stack	NOx (tonnes)		
		2016	2017	2018*
ALC-A-1	Alcs F2102	55.2	40.8	32.2
ALC-A-2	Alcs common furnaces	0.0	0.0	0.0
SHO-A-1	SHOP Flare	14.5	14.3	15.3
SHO-A-2	SHOP F9460	1.3	1.3	1.3
SHO-A-3	SHOP F9401	2.6	2.6	2.6
SHO-A-4	SHOP F9801	97.0	91.5	23.6
Total SHOP and ALCOHOLS		**170.6**	**150.4**	**74.9**

**reduced operational hours due to 3 months of maintenance*

Table A-5 - Annual NOx Emissions HPP vs SHOP and Alcohols Plant

Phase	Source	NOx (tonnes)
		2016
Phase 1	F-101	10.9
	B-101	14.9
Total Phase 1		25.8
Total Phase 1 vs 2017 NOx from SHOP and ALCOHOLS		-83%
Phase 2	F-101	21.7
	B-101	29.8
Total Phase 1 + Phase 2		77.2
Total Phase 1 + Phase 2 vs 2016 NOx from SHOP and ALCOHOLS		-55%
Total Phase 1 + Phase 2 vs 2017 NOx from SHOP and ALCOHOLS		-49%

The comparison demonstrates:

- the total annual NOx emissions from the HPP Phase 1 heater and boiler, assuming operation every hour of the year, are 66.5% lower than the Alcohols and SHOP NOx emissions in 2018;
- the total annual NOx emissions from the boilers and for both Phase 1 and Phase 2, assuming the boilers being operational every hour of the year, are 55.8% less than the Alcohols and SHOP NOx emissions in 2016, and 49.9% less than those in 2017;

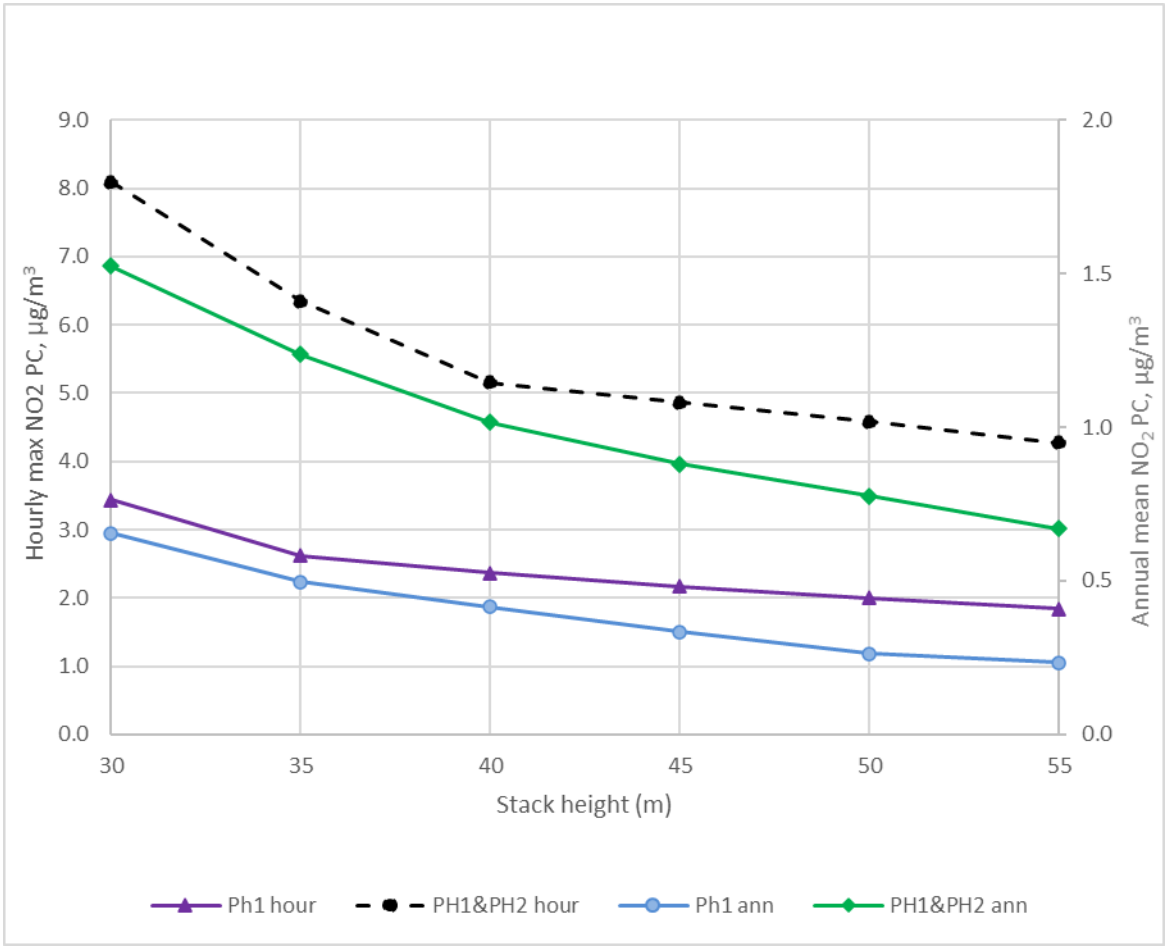
Overall, with the additional Phase 1 NOx emissions from the Feed Fired Heater and Steam Boiler, total annual NOx emissions will still be lower than in previous years with the SHOP and Alcohols plants operational.

A.4. Stack Height Sensitivity Study

The results of the stack height sensitivity study are presented as the modelled process contribution, excluding background. These are the maximum annual and hourly mean NO_2 and NOx concentrations at any of the site boundary or off-site grid receptors from a five-year meteorological dataset.

The results are shown in Figure A-2 for both Phase 1 alone and Phase 1 and Phase 2 combined scenarios. The vertical axis on the left denotes the hourly average concentrations whereas that on the right denotes the annual average concentrations.

Figure A-2 - Phase 1 and Combined Phase 1 and Phase 2 NO_2 Concentrations at Offsite Receptors



The graph of hourly mean NO_2 concentrations for Phase 1 (purple line, triangular markers) shows a clear reduction in the rate of decrease at a stack height of 35 metres. After this point, the decrease in modelled concentrations with each additional 5 metre stack height is less perceptible, demonstrated by the way the slope of the line flattens out. For Phase 1 and Phase 2 combined hourly mean (black dashed line, circular markers) there is a clear change in the rate of decrease at a stack height of 40 m. After this point, the decrease in modelled concentrations with each additional 5 metre stack height is again less perceptible.

At 40 m, the maximum off-site hourly mean NO_2 PC for Phase 1 only and for the combined Phase 1 and Phase 2 emissions are just 1.2% and 2.6% of the AAD limit value of 200 µg/m^3, respectively. For an additional 5 m stack height, the reduction in ground level concentration would be negligible and the PCs would be virtually identical at 1.1% and 2.4% for Phase 1 only and the combined Phase 1 and Phase 2 respectively, as a fraction of the AAD limit value.

The annual average results are proportionately less affected by incremental changes in stack height than the hourly results. There is a steady but small reduction with increasing stack height. There is less benefit in terms of reductions in annual average concentrations with a combined stack, as evidenced by the flatter line.

At 40 m, the maximum off-site annual mean NO_2 concentrations for Phase 1 only and for the combined Phase 1 and Phase 2 emissions are just 1% and 2.5% of the air quality standard of 40 µg/m^3, respectively. For an additional 5 m stack height, there would be a negligible reduction in NO_2 concentrations and the NO_2 PC would be 0.8% and 2.2% for Phase 1 only and the combined Phase 1 and Phase 2 respectively.

The stack height analysis was also undertaken considering the maximum NO_2 concentrations at selected sensitive receptors and the maximum NOx concentrations at the ecological site receptors. This showed a

similar downward trend with the with increase in stack height up to 40 m being more effective. At a height of 40 m, the potential for ground level concentrations exceeding the AQS standard for human health is negligible.

As a result, 40 m was considered the most suitable stack height to ensure that the emissions are effectively dispersed using best available techniques.

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A.3.0 NOISE ASSESSMENT

ATKINS

Member of the SNC-Lavalin Group

HyNet

EA Permitting Noise Assessment

09 June 2021

5194812/EA/Noise

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1. Introduction

Atkins Acoustics, Noise and Vibration has been instructed to prepare a noise impact assessment for the proposed HyNet Hydrogen Production Plant (HPP) in the east of the existing Stanlow Oil refinery site, in Ellesmere Port, for the purposes of an Environmental Permit application.

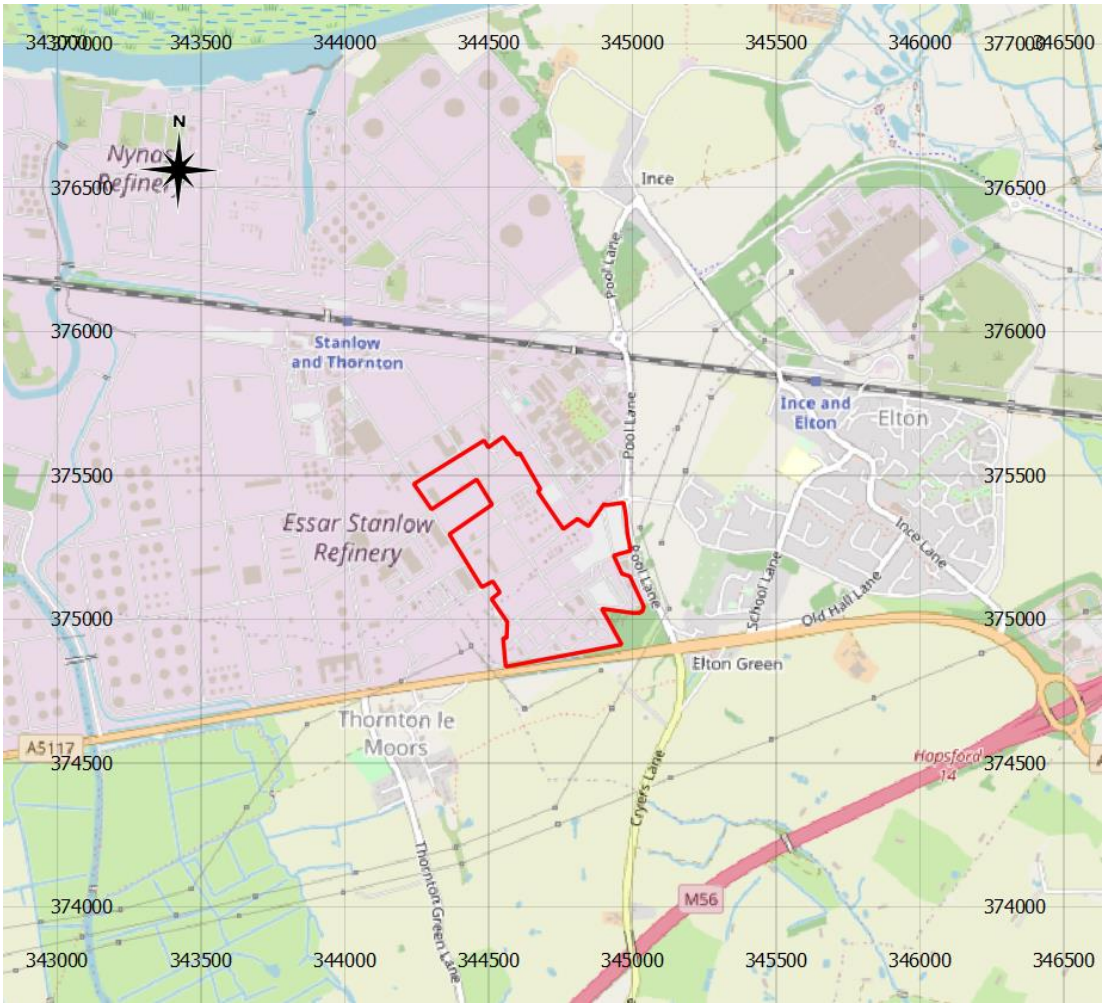
HyNet is a significant clean growth energy opportunity for the UK. Based in the North West it is a low cost, deliverable project which meets the major challenges of reducing carbon emissions from industry, domestic heat and transport and an enabler towards the UK achieving Net Zero CO2 emissions.

HyNet is based on the production of hydrogen from natural gas. It includes the development of a new hydrogen pipeline; and the creation of the UK's first Carbon Capture, and Storage (CCS) infrastructure. CCS is a vital technology to achieve the widespread emissions savings needed to meet the 2050 net zero carbon reduction targets.

HyNet is a complete system of hydrogen production, hydrogen supply, hydrogen utilisation, carbon capture, transportation, and carbon sequestration located in an area of concentrated industry, existing technical skill base, and suitable geology for sequestration. The close proximity of hydrogen production, utilisation, and carbon sequestration means that the HyNet system offers lower capital cost and development risk compared to other potential clusters around the UK.

A site location plan is shown in Figure 1-1.

Figure 1-1 – Site location plan



A glossary of acoustic terminology in provided in Appendix A.

2. Policy and Guidance

2.1. Policy

2.1.1. National Planning Policy Framework

Section 170 of the National Planning Policy Framework (NPPF) indicates that the planning system should contribute to and enhance the natural and local environment by:

"preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans."

Section 180 is specifically related to noise and requires planning policy decisions to:

- "mitigate and reduce to a minimum, potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life"; and
- "identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason".

The terms 'adverse impacts' and 'significant adverse impacts' are defined within the explanatory note of the Noise Policy Statement for England, 2010 (NPSE).

2.1.2. Noise Policy Statement for England

NPSE sets out the long-term vision of Government noise policy: to promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development.

The NPSE outlines three aims for the effective management and control of environmental, neighbour and neighbourhood noise:

- Avoid significant adverse impacts on health and quality of life;
- Mitigate and minimise adverse impacts on health and quality of life; and
- Where possible, contribute to the improvement of health and quality of life.

In its aims, the NPSE uses the key phrases 'significant adverse' and 'adverse'. The NPSE states in its explanatory note that there are two established concepts that are currently being applied to noise impacts, which are:

- NOEL – No Observed Effect Level. This is the level below which no effect can be detected; and
- LOAEL – Lowest Observed Adverse Effect Level. This is the level above which adverse effects on health and quality of life can be detected.

The NPSE then extends this concept to include:

- SOAEL – Significant Observed Adverse Effect Level. This is the level above which significant adverse effects on health and quality of life occur.

The NPSE notes that it is not possible to have a single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations. Consequently, the SOAEL is likely to vary for different noise sources, receptors, and times. Relevant SOAELs have been identified for the Scheme taking account of the sources of exposure and receptors.

Guidance for determining LOAEL and SOAEL levels is provided in Planning Practice Guidance for Noise (PPGN).

2.1.3. Planning Practice Guidance for Noise, 2014

PPGN provides further detail about how the effects of noise can be categorised. The noise exposure hierarchy from PPGN is reproduced in Table 2-1.

Table 2-1 – PPGN Noise exposure hierarchy

Response	Example of outcomes	Increasing effect level	Action
Not present	No effect	No Observed Effect	No specific measures required
Present and not intrusive	Noise can be heard, but does not cause any change in behaviour, attitude or other physiological response.		
Lowest Observed Adverse Effect Level (LOAEL)			
Present and intrusive	Noise can be heard and causes small changes in behaviour, attitude or other physiological response, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a small actual or perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level (SOAEL)			
Present and disruptive	The noise causes a material change in behaviour, attitude or other physiological response, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Present and very disruptive	Extensive and regular changes in behaviour, attitude or other physiological response and/or an inability to mitigate effect of noise leading to psychological stress, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory.	Unacceptable Adverse Effect	Prevent

2.1.4. Environmental Protection Act, 1990

Section 79 of the Environmental Protection Act 1990 places a duty on local authorities to inspect their areas periodically for statutory nuisances and to take such steps as are reasonably practicable to investigate complaints of statutory nuisance. Where a local authority is satisfied that a statutory nuisance exists, or is likely to occur or recur, the local authority is obliged to serve an abatement notice requiring the abatement of the nuisance or prohibiting or restricting its occurrence or recurrence. Section 79 (1(g)) includes “noise emitted from premises so as to be prejudicial to health or nuisance”.

Local authorities can defer serving an abatement notice under Section 80 of the Environmental Protection Act for statutory nuisance from noise for up to seven days in order for the premises to take other appropriate steps to abate the statutory nuisance.

The optional seven-day deferral was introduced by the Clean Neighbourhoods and Environment Act 2005.

2.1.5. Environmental Agency Horizontal Guidance Note IPPC H3 (part 2), 2004

The HPP requires an Environmental Permit to operate. Integrated Pollution Prevention and Control (IPPC) is a regulatory system that employs an integrated approach to control the environmental impacts of certain industrial activities. It involves determining the appropriate controls for industry to protect the environment through a single Permitting process. To gain a Permit, Operators will have to show that they have systematically developed proposals to apply the Best Available Techniques (BAT) and meet certain other requirements, taking account of relevant local factors.

Horizonal Guidance Note IPPC H3 (part 2) describes the principles of noise measurement and prediction and the control of noise by design, by operational and management techniques and abatement technologies

2.2. Guidance

2.2.1. BS 4142:2014+A1:2019 'Methods for rating and assessing industrial and commercial sound'

British Standard 4142:2014+A1:2019 'Methods for rating and assessing industrial and commercial sound' (BS 4142) describes methods for rating and assessing sound of an industrial and/or commercial nature. The methods described in the standard use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident.

The standard is used to determine the rating levels for sources of sound of an industrial and/or commercial nature and the ambient, background and residual sound levels at outdoor locations. These levels could be used for the purposes of investigating complaints; assessing sound from proposed, new, modified or additional source(s) of sound of an industrial and/or commercial nature; and assessing sound at proposed new dwellings or premises used for residential purposes. However, the determination of noise amounting to a nuisance is beyond the scope of the standard.

The procedure contained in BS 4142 assesses the significance of sound which depends upon the margin by which the rating level of the specific sound sources exceeds the background sound level ($L_{A90,T}$) and the context in which the sound occurs.

The reference time interval for the specific sound source 'Tr' is 60 minutes during the daytime and 15 minutes during the night. The reduced reference time at night reflects the increased sensitivity to sound during this period. The relevant time periods for daytime and night-time are as follows:

- Daytime – 07:00 to 23:00 hours; and
- Night-time – 23:00 to 07:00 hours.

Certain acoustic features can increase the significance of impact over that expected from a basic comparison between the specific sound level and the background sound level. Where such features are present at the assessment location, the standard adds a character correction to the specific sound level to obtain the rating level. Character corrections can be included for tonality, impulsivity, other sound characteristics that make it "readily distinctive", and intermittency.

An initial estimate of the impact of the sound source is obtained by subtracting the measured background sound level from the rating level and considering the following:

- Typically, the greater this difference, the greater the magnitude of the impact.
- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.
- A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.
- The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.

For this assessment the impact scale as shown in Table 2-2 has been adopted.

Table 2-2 – Impact assessment scale

Rating level of industrial/commercial sound	Impact	Significance
Up to 1dB above the background sound level	Negligible	Not significant
1 to 5 dB greater than the background sound level	Minor adverse	Not significant
More than 5 dB greater than the background sound level	Moderate adverse	Significant
More than 10 dB greater than the background sound level	Major adverse	Significant

2.2.2. WHO Guidelines

Published by the World Health Organisation in 2000, this document was prepared as a response to a need for action together with a generic need for improvements in legislation at a national level.

The document provides guideline sound levels in specific human environments. There is also information on the likely 'critical heath effects' associated with sound levels exceeding the guideline values. The guideline values for ambient sound levels ($L_{Aeq,T}$) and maximum sound levels (L_{AFmax}) that are relevant in this case are set out in Table 2-3.

Table 2-3 – WHO Community noise guidelines

Specific Environment	Critical Health Effect	L_{Aeq}, dB	Time base	L_{AFmax} dB
Outdoor Living Area	Serious annoyance, daytime and evening	55	16	-
	Moderate annoyance, daytime and evening	50	16	-
Dwelling, indoors	Speech intelligibility and moderate annoyance, daytime and evening	35	16	-
Inside bedrooms	Sleep disturbance night-time	30	8	45*
Outside bedrooms	Sleep disturbance, window open (outdoor values)	45	8	60*

* With regard to the assessment of maximum sound levels, it is suggested in Section 3.4 of the WHO Guidelines that the L_{AFmax} levels shown in this table should not be exceeded more than 10-15 times per night.

3. Baseline and Survey

3.1. Introduction

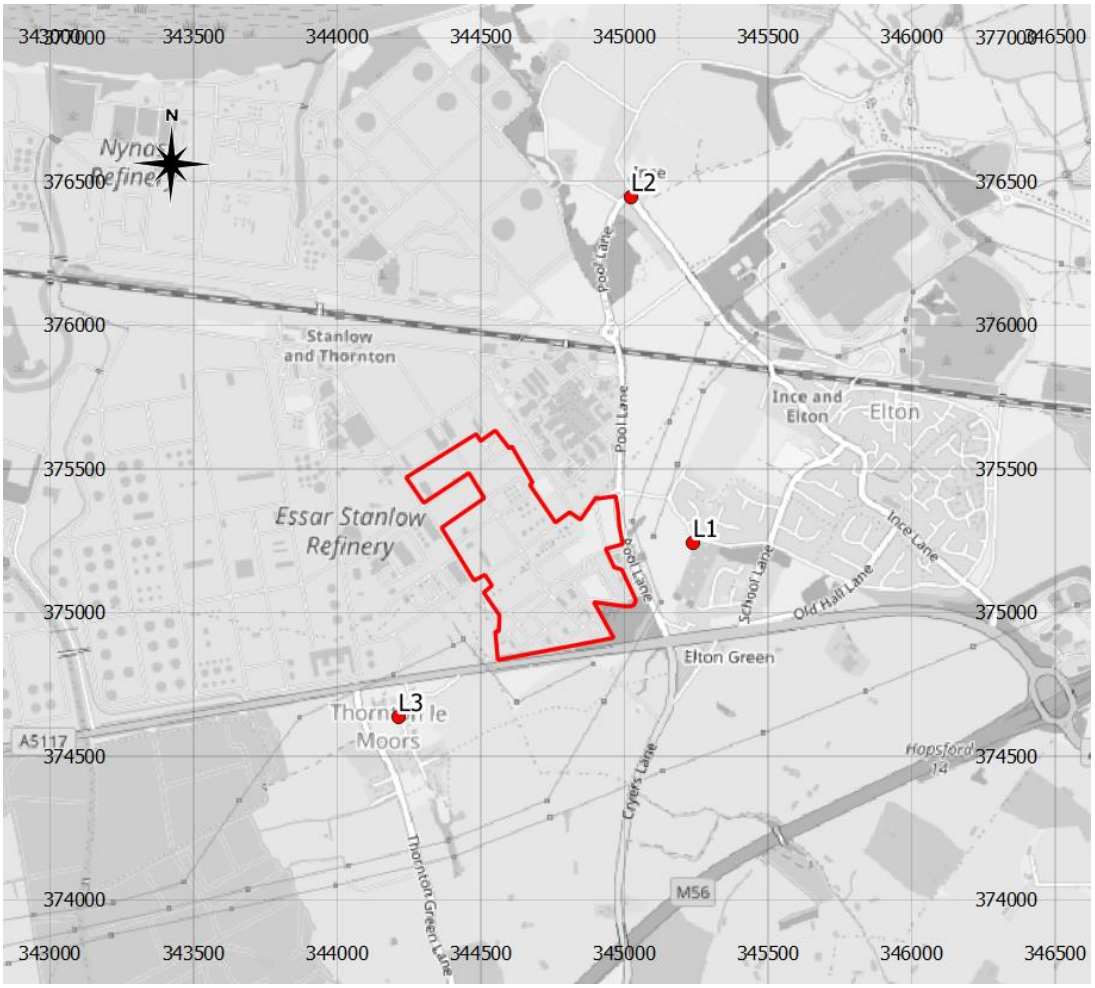
Environmental noise surveys have been conducted in accordance with BS 7445-1:2003 at locations representative of the nearby Noise Sensitive Receptors (NSRs). Additionally, Defra strategic noise maps[1] and existing publicly accessible noise survey data from submitted planning applications for the area have been used to inform baseline ambient noise levels in the wider area surrounding the site. Such data has also been used to corroborate noise surveys conducted as part of the proposed development, taking into account potential variation in noise levels due to the Covid-19 pandemic at the time of the survey and assessment. Noise data has been obtained from the following report:

- Environmental Noise Survey at Essar Oil (UK) Ltd, report ref: EOS2878, Diamond Environmental Ltd, April 2016

3.2. Noise surveys

Environmental noise surveys have been conducted in accordance with BS 7445-1:2003 at locations representative of the nearby NSRs. These have been agreed with the Environmental Health Officer at Cheshire West and Chester Council and shown in Figure 3-1.

Figure 3-1 – Noise monitoring location Plan



Noise surveys have been conducted at three locations, comprising a long duration survey at one location (L1), and short-term attended surveys at two locations. This survey data is supplemented by data from a 2016 noise

[1] https://www.gov.uk/government/publications/open-data-strategic-noise-mapping

survey comprising attended short-term measurements at the same, or comparable, locations. Details of the survey locations are provided in Table 3-1.

Table 3-1 – Details of noise survey location

Location	Description of location	Photograph
L1	Southwest of Parkland Drive, Elton, to the north-west corner of community allotment. Representative of NSR in Elton.	
L2	The Square, Ince. Representative of NSR in Ince	
L3	Poole Lane, Thornton-le-Moors. Representative of NSR to the south of the Site.	

Noise survey data is summarised in Table 3-2. Full data is provided in Appendix B. Data from surveys undertaken in 2016 (denoted by '*') has been used to verify the noise survey data in relation to potential changes in noise climate due to national lock-downs during Covid-19 pandemic which was on-going at the time of the surveys.

Table 3-2 – Summary of Noise Survey Data

Location	Time period	$L_{Aeq,15min}$	Typical $L_{AFmax,15min}$	$L_{A10,15min}$	$L_{A90,15min}$
1 (Meadow View, Elton)	Day	53	74	54	47
	Day*	55	72	57	46
	Night	48	57	49	46
	Night*	52	57	53	51
2 (Ince)	Day	58	73	61	48
	Day*	59	70	61	44
	Night*	49	64	49	47
3 (Thornton le Moors	Day	53	62	54	51
	Day*	55	68	56	52
	Night*	50	60	51	47

*2016 data

The noise climate in the area is typical of a mixed residential and industrial area, and the background sound (L_{A90}) levels at all locations is broadly comparable.

The main sources of noise at location 1 were traffic on Pool Lane and the A5117. Distant traffic on the M56 was also audible, together with some industrial noise from the Stanlow Refinery site.

The main sources of noise at location 2 were traffic on Pool Lane, Marsh Lane, and Station Road. Between nearby vehicle movements, the background sound level predominantly comprised distant traffic on the M56, together with some industrial noise from the Stanlow Refinery site.

The main sources of noise at location 3 were traffic on the A5117 and the M56. Noise from the Stanley Refinery was not perceptible at this location during the monitoring.

The comparison with the 2016 data indicates that noise levels are generally similar, and that background sound levels (L_{A90}) are broadly comparable at all locations, predominantly comprising distant traffic noise from the M56. The modal background sound level obtained from the long-duration survey at Location 1 of 46 dB $L_{A90,15min}$ will therefore be used in the assessment of operational noise at all NSR.

4. Assessment

4.1. Introduction

A noise impact assessment has been prepared to predict the impact of operational noise from the proposed Site.

At this stage, detailed information regarding operational noise source levels is not available as the schemed is at front end engineering design (FEED) stage. The assessment is therefore based on worst case plant specification which is generally set at 85 dBA at 1m from the plant (with the aim to meet compliance with noise at work regulations) although other values have been provided where these are likely to be different. Such noise levels are high with regards to environmental noise and, in practice, noise levels from many plant items would be expected to be lower. The assessment presented is therefore considered to be worst-case.

4.2. Modelling and Assessment Methodology

Noise modelling has been conducted using SoundPlan software in accordance with 'ISO 9613-2 Acoustics – Attenuation of sound during propagation of sound outdoors – Part 2: General methods of calculation' (ISO 9613), taking account of typical worst-case assumptions for sound propagation.

The results of the modelling have been assessed against the background noise level in accordance with BS 4142.

4.3. Plan Noise Data

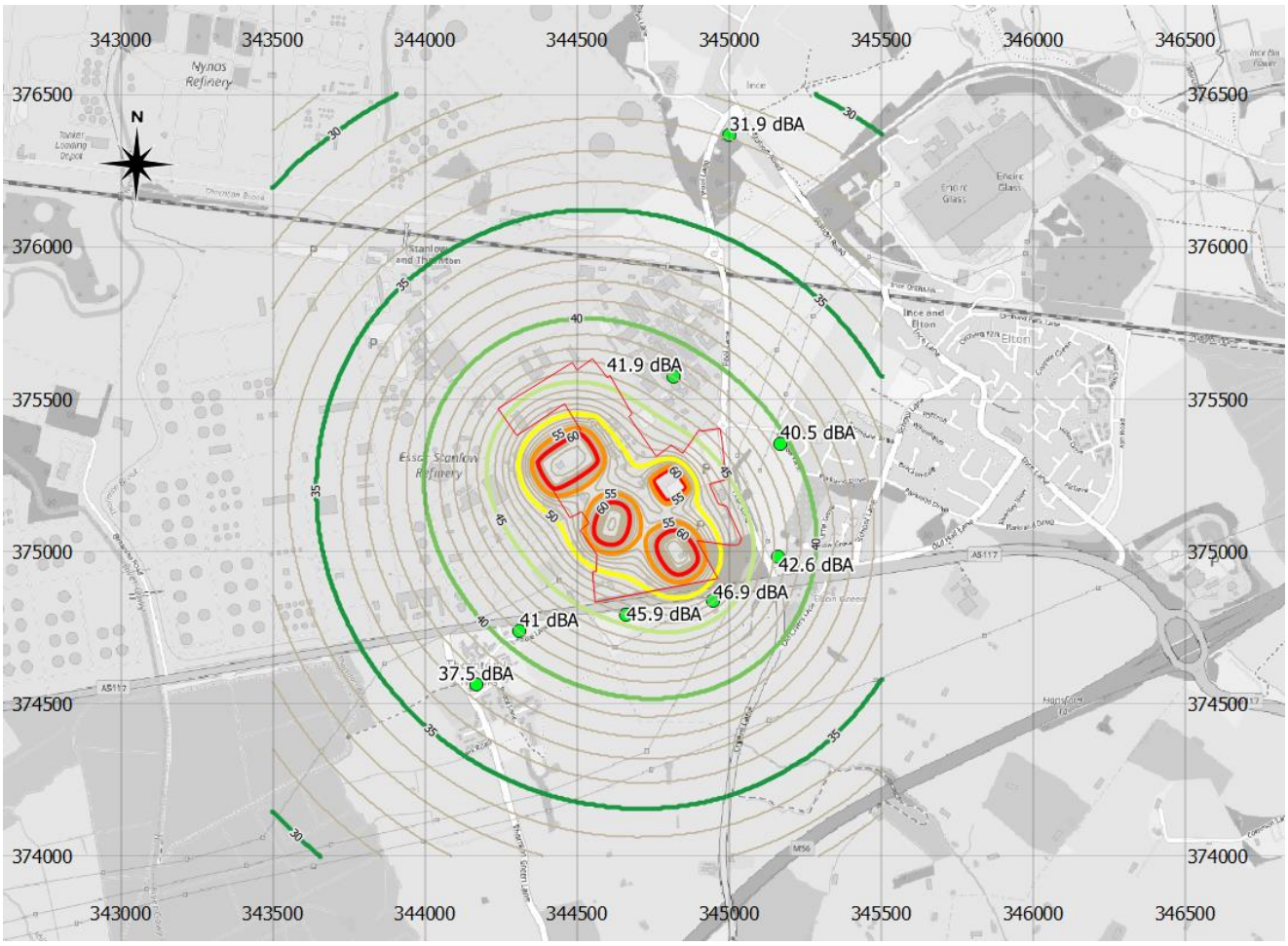
As noted above, detailed information regarding operational noise source levels is not available as the scheme is at FEED stage and the assessment is therefore based on worst case plant specification. Indicative plant noise data has been provided by the client which includes manufacturers noise attenuation measures on the main noise generating plant. This data is provided in Appendix C. Plant that is not expected to generate noise is not included.

The proposals also include a flare which has the potential to generate noise. However, the flare is for emergency use only and would not be expected to operate as part of normal operations. Noise from the flare is therefore not included in the assessment. Similarly, let-down valves may vent on occasion and these are not included in the modelling. However, valves will be designed to reduce noise egress form the site using best available techniques.

4.4. Noise Modelling Results

The results of the noise modelling are shown graphically in Figure 4-1.

Figure 4-1 – Noise Modelling Results



The results of the modelling are shown in Table 4-1.

Table 4-1 – Noise Modelling Results

Receptor Location	Predicted Operational Noise level, dBA
The Stables travellers' site	47
Little Meadow Park travellers' site	46
Elton	43
Thornton Science Park	42
Thornton le Moors	41
St Mary's Church, Thornton le Moors	38
Elton Primary School	35
Ince	32

The results indicate that the highest predicted plant noise level is 47 dBA at the Stables traveller's site to the south of the site.

4.5. BS 4142 Assessment

The BS 4142 assessment is provided in Table 4-2 for the worst-case receptor; namely, the Stables travellers site to the south of the site. This location is sensitive during both daytime and night-times periods. As the night-time background sound level is lower than the daytime, the assessment is based on the night-time period. The impact during daytime, and at other locations, will be lower.

Table 4-2 – BS 4142 Assessment

Parameter	Result	Relevant Clauses of BS 4142	Commentary
Specific sound level	47 dB $L_{Aeq,24h}$	7.3.6	Highest predicted plant sound pressure level at nearby NSR; namely, the Stables travellers' site to the south of the Site.
Background sound level	46 dB $L_{A90,Typ\ night}$	8	Typical night-time background sound level
Acoustic feature correction	0 dB	9.2	Plant assumed to not be tonal, impulsive, or intermittent at NSR. Not expected to be distinctive against the existing noise climate given the industrial nature of the area.
Rating level	47 dB	9.1	Rating level equal to specific sound level with no acoustic features.
Excess of rating level of background sound level	+1 dB	11	Assessment indicates low impact, depending on context.
Context	-	11	Context of the area is an existing mixed industrial and residential area.
Uncertainty of assessment	-	10	Main uncertainty is the plant noise data being indicative, based on the FEED stage and is therefore expected to be worst case. Additionally, no additional mitigation has been considered.

The assessment indicates the noise from the operation of the Site is likely to cause, at worst, a low impact at nearby NSR. However, the assessment is based on worst-case FEED stage plant noise data and, although some plant items are to be installed in enclosures, does not take account of additional mitigation. Best available techniques will be employed to reduce noise egress from the site.

5. Mitigation

BAT will be implemented to reduce noise egress from the site. Noise management and reduction will include:

- Preparation and implementation of a noise management plan;
- Plant selection will consider noise and lower noise alternatives will be selected where feasible;
- Plant design will consider noise mitigation at source, including manufacturers attenuation measures (e.g. silencers);
- Plant design to consider enclosures for noisy equipment and operations;
- Plant design to the consider the location of noisy equipment and operations; and
- Plant design to consider the use of screening.

6. Conclusion

Atkins Acoustics, Noise and Vibration has been instructed to prepare a noise impact assessment for the proposed HyNet Hydrogen Production Plant in the east of the existing Stanlow Oil refinery site, at Ellesmere Port, for the purposes of an environmental permit application.

A BS 4142 assessment has been undertaken, with reference to baseline conditions at the nearby sensitive receptors and precited operational noise levels from the site.

Detailed information regarding operational noise source levels is not available as the schemed is at FEED stage and the assessment is therefore based on worst case plant specification. Indicative plant noise data has been provided by the engineering design team which includes manufacturers noise attenuation measures on the main noise generating plant.

Minor adverse impacts are predicted at the nearest noise sensitive receptor, the Stables travellers' site, to the south of the site. Noise impacts at all other receptors are predicted to be negligible. The minor adverse impacts at the Stabes travellers' site are expected to be successfully mitigated further to a negligible impact as part of the detailed design process through the further application of noise mitigation measures, including equipment selection, noise abatement and screening.

The overall noise impact from the site is not considered to be significant during operation.

Appendices

Appendix A. Glossary

Decibel (dB)

The unit of measurement used for sound pressure levels. The scale is logarithmic rather than linear. The threshold of hearing is 0 dB and the threshold of pain is 120 dB. In practical terms these limits are seldom experienced and typical levels lie within the range 30 dB (a quiet night-time level in a bedroom) to 90 dB (at the kerbside of a busy city street).

A-weighting:

An electrical frequency weighting used to represent the response of the human hearing mechanism to sound. A-weighted sound level is indicated either by placing the capital letter A after the letters dB to get dB(A) or it may be added as a subscript to the sound level parameter as in $L_{Aeq,T}$.

Percentile Level (Statistical Sound Level Indices, L_{AN}, L_{A10}, L_{A90})

L_{AN} is the dB(A) level exceeded N% of the time measured on a sound level meter with Fast(F) time weighting, e.g. L_{A90} the dB(A) level exceeded for 90% of the time, is commonly used to estimate background sound level. L_{A10}, the level exceeded for 10% of the time, is commonly used in the assessment of road traffic noise.

Research has shown that the arithmetic average of the 18, 1-hour L_{A10} levels (depicted as $L_{A10,18h}$) between 0600 and 2400 hours shows a reasonably good correlation with community responses to traffic noise. This unit is used in the UK for the assessment of road traffic noise.

Equivalent Continuous A-Weighted Sound Pressure Level ($L_{Aeq,T}$):

Equivalent continuous A-weighted sound pressure level is the steady sound level that has the same sound energy as the fluctuating A-weighted sound pressure level occurring over the same time period and at the same location.

Ambient Sound Level ($L_{Aeq,T}$):

Totally encompassing sound in a given situation at a given time usually composed of sound from many sources near and far.

Background Sound level ($L_{AF90,T}$):

The A-weighted sound pressure level of the existing ambient sound level that is exceed for 90% of a given time period, T, measured using time weighting 'Fast'.

Free-Field (acoustical):

Free-field means a position far away from any reflecting surfaces other than the ground. Several standards and guidelines recommend that to achieve free-field conditions the microphone should be positioned at least 3.5 metres from any reflecting surfaces.

Appendix B. Acoustic survey details and data

B.1. Survey details

B.1.1. Survey Instrumentation

Table B-1 – Survey instrumentation

Item	Manufacturer	Type	Serial Number
	L1		
Sound Level Meter	Rion	NL-52	921176
Microphone	Rion	UC-59	04208
Calibrator	Rion	NC-75	35292145
	L2		
Sound Level Meter	01dB	Fusion	12079
Microphone	GRAS	40CD	367009
Calibrator	01dB	CAL31	82830
	L3		
Sound Level Meter	01dB	Fusion	12083
Microphone	GRAS	40CD	331886
Calibrator	01dB	CAL31	82830

Sound level meters had been laboratory calibrated within two years of the surveys, and the acoustic calibrator had been laboratory calibrated within one year of the survey, in line with good practice and manufacturers recommendations. On site calibration checks were undertaken before and after each measurement period with no significant drift in calibration level observed (i.e. below 0.3 dB).

B.1.2. Weather Conditions

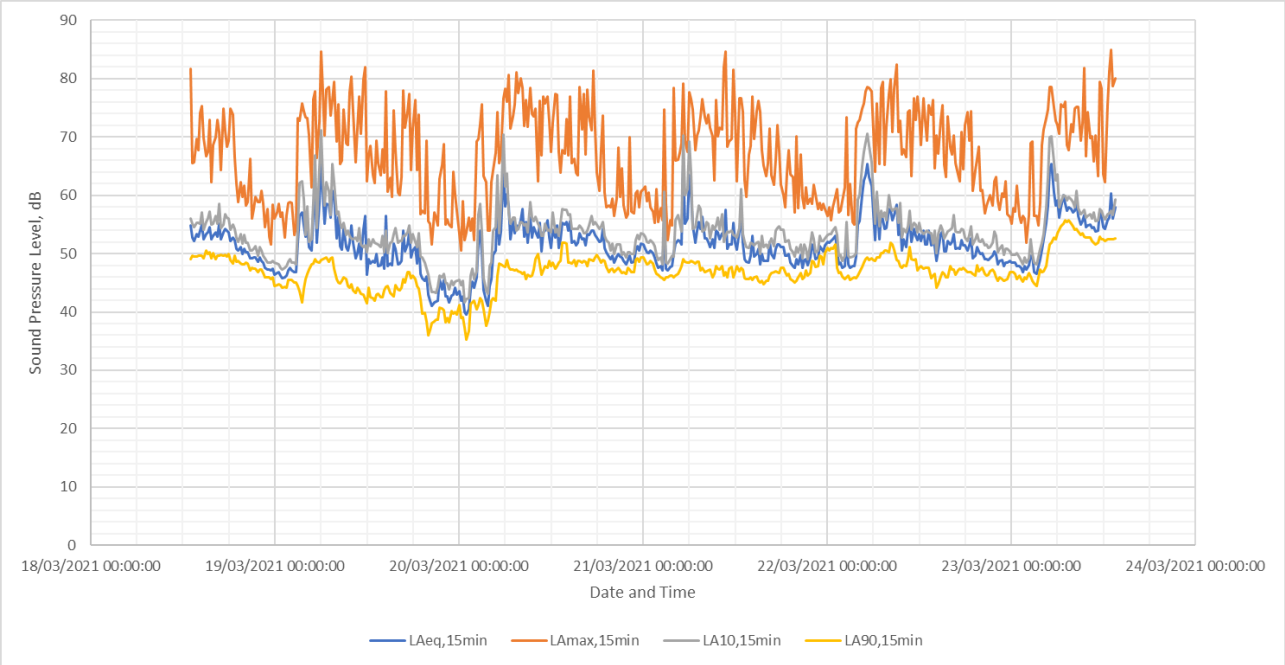
Weather conditions were favourable during the survey period. Conditions were generally calm with winds speeds below 5m/s from a south-westerly direction. There was no precipitation. Temperatures ranged between 4 and 13°C and atmospheric pressure ranged between 1018 and 1030 mbar.

B.2. Survey Results

B.2.1. Location 1 (Elton

The temporal results of the long-duration unattended survey at L1 are shown in Figure B-1.

Figure B-1 Temporal Noise Survey Results – L1



The statistical distribution of sound levels during daytime periods is shown in Figure B-2. The statistical distribution of sound levels during night-time periods is shown in Figure B-3.

Figure B-2 Statistical Distribution of Noise Levels – L1 – Daytime

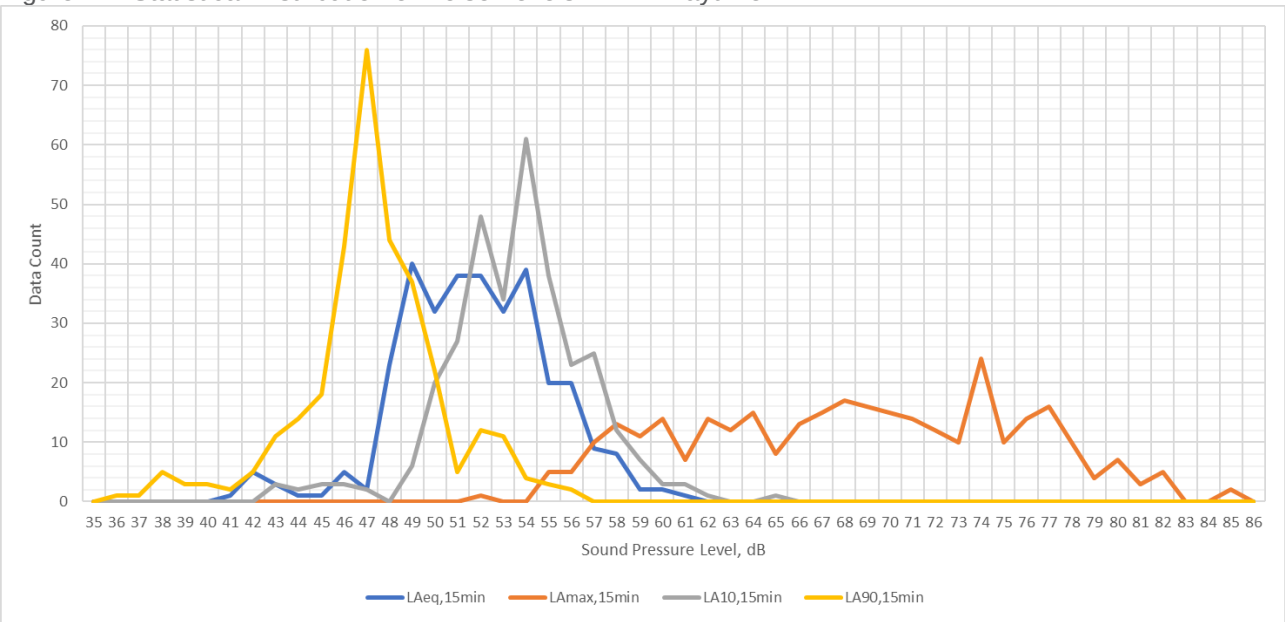
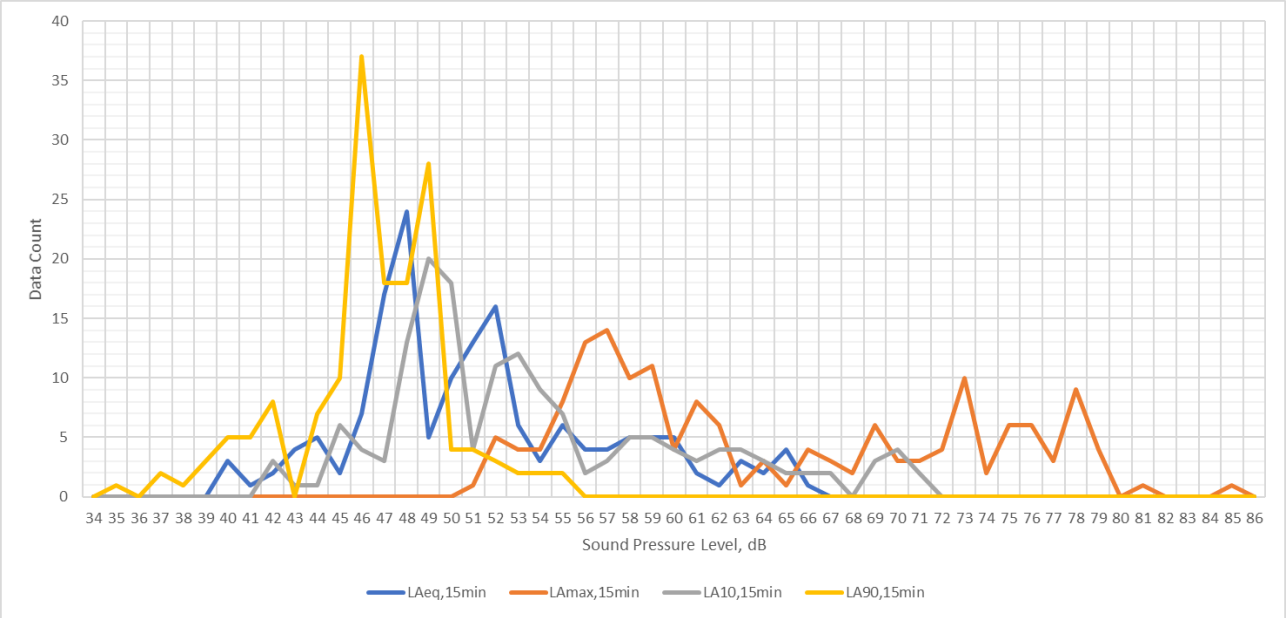


Figure B-3 Statistical Distribution of Noise Levels – L1 – Night-time



B.2.2. Location 2 (Ince)

The measured sound levels from the attended survey at L2 are provided in Table B-2.

Table B-2 – Measured Sound Levels – L2 (Ince)

Period Start	$L_{Aeq,15min}$	$L_{Amax,F,15min}$	$L_{A10,15min}$	$L_{A90,15min}$
23/03/21 11:40	59.9	76.7	63.3	47.7
23/03/21 11:55	56.8	71.9	60.9	47.2
23/03/21 12:10	58.1	75.9	59.9	47.9
23/03/21 12:25	54.4	70.4	55.4	47.5
23/03/21 12:40	58.3	73.9	61.8	47.7
23/03/21 12:55	56.4	73.1	59.1	46.3
23/03/21 13:10	59.0	77.8	61.0	46.0

B.2.3. Location 2 (Ince)

The measured sound levels from the attended survey at L3 are provided in Table B-3.

Table B-3 – Measured Sound Levels – L3 (Thornton le Moors)

Period Start	$L_{Aeq,15min}$	$L_{Amax,F,15min}$	$L_{A10,15min}$	$L_{A90,15min}$
23/03/21 12:00	54.0	63.0	56.1	51.5
23/03/21 12:15	53.3	60.9	54.2	51.4
23/03/21 12:30	53.7	64.7	55.6	51.5
23/03/21 12:45	53.1	62.4	54.1	51.4
23/03/21 13:00	52.7	61.7	53.6	51.3

Appendix C. Plant noise data

Table C-1 Plant Noise Data (FEED stage)

Plant Item	Project TAG Number	FEED Stage Indicative Sound Pressure Level at 1m, dBA
Natural Gas Compressor A Reciprocating Type (Oil Free)	10-AAJ-P-02	87
Flash Gas Recycle Compressor A	10-BAF-U-006	85
Membrane Bioreactor (MBR)	10-FAA-P-111	85
H2 Compressor A Reciprocating Type (Oil Free)	10-FAA-P-105	84
ROG Compressor Package A Reciprocating Type (Oil Free)	10-FAA-U-104	84
Process Condensate Pump	10-FAA-U-105	83.6
Saturator Water Pump	10-FAA-U-106	83.6
Demin Water Pump	10-FAA-U-107	83.6
Water Demineralisation Plant	10-BAF-P-005	83.6
CO2 Absorber Feed Pump	10-AAJ-U-105	81.2
CO2 Stripper Feed Pump	10-AFF-U-101	81.2
MP BFW Pump	10-BAF-U-002	81.2
Cooling Medium Pump	10-BAG-P-009	81.2
Lean Amine Cooler	10-FAA-P-110	80.1
LP Flash Column Condenser	10-AAJ-C-103	80.1
Cooling Medium Air Cooler	10-FAA-XJ-101	80.1
CO2 Compressor Integrally Geared Centrifugal Type (Noise level external to enclosure)	10-FAA-P-108	80
CO2 Ejector	10-FAA-E-119	80
Air Separation Unit, Main Air Compressor A, Integrally Geared Centrifugal Type (Noise level external to enclosure)	10-BAA-E-001	80
TEG Contactor (note pump noise)	10-BAA-P-001	78.8
Filtered Water Supply Pump	10-BAG-V-001	78.8
Firewater Jockey Pump	10-BAG-P-006	78.8
Raw Water Booster Pump	10-BAB-P-001	78.8
Raw Water Transfer Pump	10-BAG-P-005	78.8
Unthickened Sludge Mixing Pump	10-BAG-P-012	78.8
Waste Water Pump	10-BAG-U-002	78.8
Feed Fired Heater Combustion Air Fan	10-BAF-U-007	77
Steam Boiler Combustion Air Fan	10-BAF-U-005	77

Plant Item	Project TAG Number	FEED Stage Indicative Sound Pressure Level at 1m, dBA
Corrugated Plate Interceptor (CPI)	10-BAG-P-004	67.8
Waste Water Mixing Pump	10-BAF-U-003	67.8
Compressor Suction Cooler	10-AAJ-F-101	65
Amine Drain Drum Pump	10-AAJ-K-102	65
Amine Make-Up Pump	10-BAF-P-003	65
BFW Dosing Package	10-BAC-P-001	60.3
Anti-Foam Injection Package	10-FAA-C124	60.3
Anti-Foam Injection Package	10-AAJ-C-102	60.3
Anti-Foam Injection Package	10-ADD-U-101	60.3
Anti-Foam Injection Package	10-ADD-U-104	60.3
Aluminium Sulphate Dosing Package Plant	10-FAA-E-119	60.3
Dewatering Centrifuge Polymer Dosing Package	10-FAA-E-117	60.3
Dewatering Centrifuge Polymer Make-Up Plant	10-FAA-P-109	60.3
N Supplement & Micro-Nutrient Solution Dosing Package	10-BAG-U-001	60.3
Phosphoric Acid Dosing Package	10-AAJ-P-104	60.3
Raw Water Polymer Dosing Package	10-BAG-U-005	60.3
Raw Water Polymer Make-Up Plant	10-AAF-C-001	60.3
Sodium Bisulphite Dosing Package	10-AFF-U-101	60.3
Sodium Hydroxide Dosing Package	10-BAG-U-004	60.3
Sodium Hypochlorite Dosing Package	10-AAJ-P-102	60.3
Sulphuric Acid Dosing Package Plant	10-BAF-P-002	60.3
Closed Drains Pump	10-BAF-U-001	57.9
LP Flash Column Reflux Pump	10-BAF-U-005	57.9
TEG Return Pump	10-BAF-U-004	57.9
Backwash Supernatant Pump	10-BAF-P-001	57.9
CPI Sludge Pump	10-AAI-U-002	57.9
Dewatered Sludge Mixing Pump	10-AAI-U-001	57.9
Dewatered Sludge Pump	10-AAJ-P-101	57.9
Dewatering Liquors Sump Pump	10-BAF-P-004	57.9
Sludge Transfer Pump	10-BAB-U-005	57.9
Unthickened Sludge Pump	10-BAB-U-004	57.9
Wastewater Sump Pump	10-BAF-U-010	57.9
Carbon Dioxide Metering Package	10-AAJ-B-101	50
Hydrogen Export Metering Package 1	10-AAJ-K-101	50
Hydrogen Export Metering Package 4	10-BAF-U-009	50

Plant Item	Project TAG Number	FEED Stage Indicative Sound Pressure Level at 1m, dBA
Natural Gas Metering Package	10-FAB-U-101	50
ROG Metering Package	10-FAB-U-102	50
TEG Regeneration Skid	10-FAB-P-101	50
Clarification Plant	10-BAG-P-003	50
Dewatering Centrifuge Plant	10-BAG-P-002	50
Dual Media Filtration Plant	10-BAG-P-011	50
Raw Water Metering Package	10-BAG-P-001	50

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A.4.0 ACCIDENT RISK ASSESSMENT

HPP ACCIDENT RISK ASSESSMENT

No.	ENVID Ref	Event	Consequence	Risk Severity	Mitigation Measures	Actions in Event of Incident
RELEASE OF HAZARDOUS MATERIAL – LOSS OF CONTAINMENT						
1.1	1.5.1	Equipment or pipework failure leading to major loss of containment.	• Hydrocarbon release to atmosphere e.g. NG or ROG. • Release of GHG to atmosphere. • Contribution to global warming and climate change. • Serious permit breach, prohibited activity.	3	• Pressure relief valves. • Anti-surge valve. • Control valves on feed to compressor. • Double seal arrangement, labyrinth seal. • Valve and material choices to mitigate fugitive emissions. • SOPs, DB&Bs, isolation points (relevant to maintenance). • Design pressure of pipework and compressor casing. • Flare. • Inspection regime.	• Plant trips (on plant failure).
1.2	1.5.2		• Release of syngas. • Potential to impact on wildlife and human receptors.	3	• Pressure relief valves. • Design pressure of pipework. • Valve and material choices to mitigate fugitive emissions. • SOPs, DB&Bs, isolation points (relevant to maintenance). • Flare. • Inspection regime.	• Plant trips (on plant failure).

No.	ENVID Ref	Event	Consequence	Risk Severity	Mitigation Measures	Actions in Event of Incident
1.3	1.5.3		• Release of CO_2 contributing to global warming and climate change. • Serious permit breach due to breach point. Note. CO_2 discharge to atmosphere is planned during plant start-up and shutdown.	3	• Pressure relief valves. • Anti surge valve on CO_2 compressor. • Control valves on feed to compressor. • Design pressure of pipework and compressor casing. • Metallurgy selection caters for potential corrosion. • Easily identified leaks (visible and audibly). • Inspection regime.	• Plant trips (on plant failure).
1.4	1.5.4		• Release of hydrogen. • Permit breach. • Hydrogen is an indirect GHG(1).	1	• Monitoring of the heat sensitive paint (a means of identifying refractory lining failures in process vessels prior to loss of containment occurring). • Valve and material choices to mitigate fugitive emissions. • Periodic IR surveys. • Inspection procedure. • Pressure relief valves. • Design pressure of pipework. • Flare. • Inspection regime.	• Plant trips (on plant failure).
1.5	1.5.5		• Release of amines. • Toxic to aquatic life at 10s of mg/litre. 10s of days for degradation in freshwater, potential to be discharged to the sea via the Mersey, subsequently slower degradation in sea water.	3	• Bunding. • Collection in “potentially contaminated” drainage system and returned to process. • Collection in surface water sumps.	

No.	ENVID Ref	Event	Consequence	Risk Severity	Mitigation Measures	Actions in Event of Incident
1.6	1.5.8		• Release of diesel from emergency generator or fire water pump. Inventory circa 5,000 - 10,000 litres. • Potential to contaminate the land on site.	3	• Small inventories (day tanks). • Double skinned tanks. • Bunding. • Base plate rims with drainage connections or wider package baseplate.	
1.7	1.5.9		• Firewater run off due to requirement to fight major incident.	3	• Storm drainage system designed for firewater. Design intent includes a requirement to contain firewater.	
1.8	1.5.10		• Firefighting foam associated with lube oil fires has the potential to contaminate water.	3	• Effluent treatment of fire water (either at UU Effluent treatment Plant or tankered off site to alternative treatment works). • Selection criteria for firefighting foam will be incorporated into the design at the next phase of the project.	• Localized lined concrete pits around process areas to contain fire water and foam.
1.9	1.5.11		• Propylene glycol release. Cooling medium tank 30% glycol, 4200 m^3, potential for 100 m^3 + release. • Potential for spill to be released to water course. Hazardous to aquatic life.	3	• Bunding.	
1.10	1.5.12		• Release of TEG. • Potential for release into water course. • Relatively low ecotoxicity.	3	• Bunding.	
1.11	1.5.13		• Catalyst in fixed bed released (nickel and molybdenum, zinc oxide and copper). • Metals contamination of water and/ or land. Toxic to aquatic life. • Significant and localised contamination.	3	• Approved contractor for catalyst loading/ unloading. • Area on hardstanding.	

No.	ENVID Ref	Event	Consequence	Risk Severity	Mitigation Measures	Actions in Event of Incident
1.12	1.5.14		• Release of water treatment chemicals i.e. sodium hypochlorite, sodium hydroxide and sulphuric acid (25%). • Typically stored in 1 m^3 IBCs.	2	• Bunding. • Drainage system. • Inventory control. • COSHH controls and operation procedures.	
1.13	1.5.15		• Combustion products produced from a major fire on site. e.g. heavy metals, smoke, particulates.	4	• Flare system. • Equipment design conditions. • Impact protection. • Site layout. • Inventory Control.	• Firefighting and emergency response plans in place will be extended to include the HPP.
1.14	1.13.4	Major hazardous event on refinery south site (from nearby activities).	• Impairment of control room, impacting ongoing operation of plant. • Loss of control of plant could lead to loss of containment event. • See other entries 1.1 – 1.13 for environmental impact of loss of containment events.	4	• Fail safe equipment.	• Automatic shutdown of plant. • Site alarms and emergency procedures in place.
1.15	1.18.1	Leak from fractured drain pipe.	• Leak of waste water to the ground. • Breach of permit.	2	• Corrosion allowance of pipework. • Wrapped or coated for buried pipelines. • Inspection regime.	
1.16	1.7.11	Requirement to unload hydrogen from road tanker for start-up operations.	• Potential for hydrogen release e.g. from hose failure/ connection or operator error.	1	• Certified hoses inspected before use. • Small flowrate during delivery. • Piping layout around tanker offloading.	
1.17	1.7.14	Human error - potential for mixing of chemicals.	• Incorrect water chemistry leading to increased corrosion and failures of pipework, pipework leaks.	3	• Procedures and signage/ labels. • Chemical loading area with Armco barrier.	

No.	ENVID Ref	Event	Consequence	Risk Severity	Mitigation Measures	Actions in Event of Incident
SPILLS						
2.1	1.2.5	Transportation, delivery of TEG, amine. Tankers and forklift truck IBCs.	• Spills during loading and unloading operations.	2	• Unloading procedures. • Bunding.	
2.2	1.2.6	Transportation, delivery of catalyst. Tankers and forklift truck IBCs.	• Spills during loading and unloading operations. Potential for small spillage. • Heavy metal contamination of water and/ or land. Toxic to aquatic life. • Significant and localised contamination.	2	• Unloading procedures. • Bunding. • Process areas surrounded by hardstanding.	
2.3	-	Transportation, delivery of diesel. Tankers and tanks.	• Spills during loading and unloading operations.	2	• Unloading procedures. • Bunding.	
FIRE / EXPLOSION						
3.1	1.9.1.	Fire in surrounding perimeter of site.	• Thermal radiation on site due to vegetation fire or increased congestion if flammable cloud released. • Explosion (Buncefield). • See 1.13 for environmental impact of major fires/ explosions.	4	• Site wide housekeeping and maintenance.	• Firefighting and emergency response.
3.2	1.13.1	Fire event involving storage tanks e.g. crude oil storage. Boil over (from nearby activities).	• Potential for thermal radiation and fire impact.	4	• Spacing at Stanlow between plant and tanks. • Global Asset Protection document. • Tanks secondary containment. • Emergency access. • Tank farm upgrade project consistent with Buncefield recommendations.	• Firefighting and emergency response.

No.	ENVID Ref	Event	Consequence	Risk Severity	Mitigation Measures	Actions in Event of Incident
3.3	1.14.1	HV supply to the site.	• Electrical energy release, transformer explosions. • Oil releases. • See 1.1 - 1.13 for environmental impact of loss of containment and the impact of subsequent fires.	4	• Transformer location is outside with transformer bays to segregate.	• Firefighting and emergency response.
COLLISION / DROPPED OBJECTS						
4.1	1.2.1	Plane crash.	• Major damage to equipment, plant and site. • Potential for major loss of containment event. • See 1.1 - 1.13 for environmental impact of major loss of containment events.	4	• CAA guidance to be followed. • Aircraft warning lights on flare and ASU. • Potential for warning lights on stack heaters.	• Firefighting and emergency response.
4.2	1.2.4	Dropped objects from lifting operations while plant online e.g. PSV maintenance, changeout of guard beds and compressor maintenance.	• Damaged equipment. • Potential for pipe rupture, release of hydrocarbons. • Fire. • See release of hazardous material section for environmental impact of major loss of containment events.	4	• Operational risk assessment for lifting.	• Firefighting and emergency response.
SECURITY BREACH						
5.1	1.2.11	Terrorism.	• Significant unit damage. Assessed as catastrophic plant damage and multiple onsite personnel fatalities. • See 1.1 - 1.13 for environmental impact of major loss of containment events.	4	• Entry gates designed perpendicular to road. Prevents build-up of acceleration to gate. • Security gate, as second defence.	

No.	ENVID Ref	Event	Consequence	Risk Severity	Mitigation Measures	Actions in Event of Incident
5.2	1.2.12	Cyber attacks.	• Loss of control of the plant. • Potential to override safety systems remotely (if unmitigated). Severity assessed as similar to terrorism, potential for catastrophic plant damage and multiple on site fatalities. • See 1.1 - 1.13 for environmental impact of major loss of containment events.	4	• Cyber security measures to be extended to include HHP.	
ADVERSE WEATHER AND CLIMATE CHANGE EFFECTS						
6.1	1.1.1	Flooding due to extreme weather.	• Washing contaminants such as spilt lube oils into the drainage system. • Potential for discharge into receiving watercourses.	2	• Site drainage. • Localised drainage collection from rotating equipment, drain drum and appropriate bunding of chemicals. [Note. Awaiting HPP drainage plan] • Spill kits and spill response in place. • Refinery flood protection scheme. • Layout (locating equipment as far as possible away from flood zone)	• Site emergency procedures for flood will be extended to include the HPP.
6.2	1.1.3	Lightning.	• Damage to equipment with potential to cause fire and damage to monitoring and burner management equipment meaning unable to monitor emissions / potential for permit breaches.	2	• Equipment earthed. Bonded. • Project standard for lightening control.	• Firefighting and emergency response.
PROCESS UPSET/ EQUIPMENT FAILURE						
7.1	1.3.1	Low flow through feed fired heater coil e.g. due to blockage.	• Overheating of tube, tube rupture. • Release of process fluid into heater, inefficient burning, resulting in equipment damage. • Smoke production, breach of permit conditions. • Feed purification coil failure, untreated natural gas, potential for SOx release.	2	• Control loops.	• Low flow trip.

No.	ENVID Ref	Event	Consequence	Risk Severity	Mitigation Measures	Actions in Event of Incident
7.2	1.3.4	Exothermic reaction in Isothermic Shift Converter.	• Increase in temperature beyond design temperature leading to vessel damage and potential for loss of containment of syngas or catalyst. • See 1.2 and 1.11 for environmental impact of major loss of containment of syngas or catalyst events.	3	• Temperature control (TI in tubes) and steam drum level control. • Operating regime includes large safety margin in temperatures. • Lower levels of contaminant metal species.	
7.3	1.3.5	Emergency trip resulting in depressurisation and flaring of inventory.	• Short term increased flaring with potential for noise and light pollution. • Combustion of plant inventory.	2	• Abnormal flaring included in permit.	• Gas flaring is used to control inventories of depressurised gas.
7.4	1.3.6	Operational trip resulting depressurisation and flaring of inventory.	• Increased flaring and more CO_2 released.	2	• Inventory control. • Potential to recover plant without depressurisation.	• Gas flaring is used to control inventories of depressurised gas.
7.5	1.3.7	O_2 Vaporiser failure e.g. level control failure leading to liquid O_2 in transfer line to process.	• Potential for low temperature failures, brittle fracture. • Loss of containment of O_2 leading to oxygen-enriched fire (if heat sources nearby). • See 1.7, 1.8 and 1.13 for the environmental impact of major fires resulting from loss of containment events.	4	• ASU low temperature cut off. • Open air. • Visibly readily detectable. • Material selection of vaporiser.	• Firefighting and emergency response.
7.6	1.3.10	Unignited gas cloud from flare.	• Unignited gas cloud from flare. Potential emission of natural gas, syngas, ROG, or hydrogen. Some of these are GHG.	3	• Flare ignition package. • Flare tip height leading to dispersion.	
7.7	1.3.12	Bursting discs on heat exchanger for CO_2 plant, HPP, capture.	• Initial release of steam/ water followed by syngas (including toxic CO), CO_2 or hydrogen.	2	• Located far west of plant to maximise distance from population.	• Plant shutdown.
7.8	1.6.1	Vibration from compressors and air-cooled exchangers and other operational noise sources.	• Nuisance noise.	1	• Anti-vibration, well designed foundations, well designed interface between foundations and machinery i.e. baseplate. • Good pipework and support steelwork design.	
MISLABELLING OF MATERIALS OR WASTE						

No.	ENVID Ref	Event	Consequence	Risk Severity	Mitigation Measures	Actions in Event of Incident
8.1	1.19.1	Wrong categorisation of catalyst waste.	• Disposal of catalyst rather than reusing/ recycling, lost opportunity. • Breach of environmental regulations.	2	• Site EMS. • Operating procedures. • Approved contractor for catalyst and absorbents loading/ unloading.	
8.2	1.19.2	Formation of nickel or iron carbonyl on reforming catalysts and HTS catalysts.	• Incorrect disposal of waste and breach of permit and regulations.	2	• Site EMS. • Operating and shutdown procedures (including purging requirements). • ACTION: Investigate disposal methods and waste disposal contractors to safely dispose of catalyst and absorbents waste.	
8.3	1.19.3	Disposal of mercury filter.	• Incorrect disposal of waste and breach of permit and regulations.	2	• Site EMS. • Operating procedures. • Approved contractor for mercury filter treatment/ disposal.	
8.4	1.22.1	Radioactive Sludge removed during pigging operations (from NORM in gas).	• Environmental impact of improper disposal of sludge from pipeline i.e. natural gas pipeline. • Potential for waste to be radioactive. • Breach of permit.	2	• Site EMS. • Operating procedures and characterisation of waste.	

Notes.

1. Hydrogen reacts with tropospheric hydroxyl radicals. For this reason emissions of hydrogen to the atmosphere perturb the distributions of methane and ozone, the second and third most important greenhouse gases after CO_2. Hydrogen is therefore an indirect greenhouse gas with a global warming potential GWP of 5.8 over a 100-year time horizon.

A.5.0 PRE-APPLICATION DISCUSSIONS AND ADVICE

[redacted]

Essar Oil UK Limited

Stanlow Refinery, Oil Sites Road,
Ellesmere Port, CH65 4HB

Our reference: EPR/FP3139FN/V012*

(*NB the advice has been logged under this application number, but the application will be logged under the actual sequential reference at the time of receiving it)

Date: 16/06/2021

Dear [redacted],

OFFICIAL SENSITIVE - Pre application advice – Enhanced service

I am pleased to provide you with your enhanced level of pre-application advice for Stanlow Manufacturing Complex as requested on 19/01/2021.

Our advice is based on the information provided on your pre application advice form and conversations / emails recorded on the following dates:

- Minutes of meeting on pre-application EPR/WP3809SG/A001 (01/06/2020).
- Pre-application request form submitted on 19/01/2021;
- Additional information on combustion equipment in the Hynet plant, email from [redacted] dated 11/02/2021;
- Meeting (call conference) on 23/02/2021;
- Request for clarification on aerial emissions and additional information received by email from [redacted] on 08/03/2021.
- Request for additional advice received from [redacted] on 10/05/2021, including attachment titled 'HYNet EA Preapp queries May 21'.
- Email from [redacted] received on 21/05/2021 describing the configuration of the water / waste water treatment facilities.
- Email from [redacted] received on 15/06/2021, including additional queries on application charges for hazardous waste water and sludge treatment activities and noise management plan charges.

What enhanced pre application covers

Further information on the enhanced pre-application service is detailed on section 2 of the Environmental permitting charges guidance on GOV.UK.

As part of this service we have provided you with the following information:

Application reference number	**EPR/FP3139FN/V012** Note: since we understand other applications will be submitted prior to this variation application, this may differ

	from the actual application number that will be sequentially assigned at the point of submitting your application
Habitats screening	Not requested in the scope of the pre-application, there are ecological sites within screening distance that will require assessment. Applicant to obtain habitat screening from external sources and assess all the relevant habitat and ecological sites within relevant screening distance.
Documents attached	• Attachment 1 – Guidance: 'Review of Best Available Techniques (BAT) for Hydrogen Production from Methane and Refinery Fuel Gas with Carbon Capture'. • Attachment 2 – Email from [redacted] dated 10/03/2021 with additional advice on risk assessment of aerial emissions. • Attachment 3 – 'Installations basic generic pre-application advice'. Refer to this document for a complete list of information that might be required for this type of application, although not all the documents listed may be applicable. • Attachment 4 - Monitoring Facilities M1 Summary
Application charge required	**£67,160** Refer to item 12. and 16. below for details and assumptions.
Forms required to be submitted	For variations applications: Application for an environmental permit: part A about you Application for an environmental permit: part C2 varying a bespoke permit

	Application for an environmental permit Part C3 - Variation to a bespoke installation permit Application for an environmental permit (charges and declarations): part F1
Additional documents required	Not requested / Not applicable Refer to attachment 3 for a complete list of information that might be required for this type of application, although not all the documents listed may be applicable.
Additional information	Refer to minutes of meeting and post meeting advice below.

Minutes of meeting of 23/02/2021

Attendees:	Organisation
[redacted]	Environment Agency
[redacted]	Environment Agency
[redacted]	Environment Agency
[redacted]	Essar Oil UK Limited (EOUKL)*
[redacted]	Essar Oil UK Limited (EOUKL)*
[redacted]	Essar Oil UK Limited (EOUKL)*
[redacted]	Essar Oil UK Limited (EOUKL)*
[redacted]	Essar Oil UK Limited (EOUKL)*
[redacted]	Atkins*
[redacted]	Atkins*
[redacted]	Atkins*
[redacted]	Atkins*
[redacted]	Progressive Energy*
[redacted]	Progressive Energy*
[redacted]	Progressive Energy*

*collectively referred as 'the Applicant'.

1. It was confirmed that the draft 'Guidance for Establishing Best Available Techniques for Hydrogen Production from Methane and Refinery Fuel Gas with Carbon Capture' has been circulated to industry stakeholders for comments and emailed to [redacted] in advance of the meeting. Comments on the draft guidance should be sent to Costain, who have authored that document for the Environment Agency / UK environmental regulators, although specific questions on its application to the Hynet project might be raised as part of future engagement within the scope of this pre-application service.

   The draft 'Guidance for Establishing Best Available Techniques for Hydrogen Production from Methane and Refinery Fuel Gas with Carbon Capture' refers to another document under development: 'BAT Review for New-Build and Retrofit Post-Combustion Carbon Dioxide Capture Using Amine-Based Technologies for Power and CHP Plants Fuelled by Gas and Biomass as an Emerging Technology under the IED for the UK'. **ACTION:** [redacted] to send copy of this document [Post meeting note: actioned on 24/02/2021].

2. The Feed Fired Heater pre-heats the incoming natural gas upstream of the reforming process. The unit has a net thermal input of 20.2 MWth. On start-up and shutdown it is fired on natural gas. During normal operation it is fired on PSA tail gas, which is hydrogen rich.

   The Applicant proposed emission limits from the new feed heater at 80mg/Nm^3 for NOx and 100 mg/Nm^3 for CO at 3% O_2. Subject to the findings of the environmental risk assessment and air dispersion model, the Environment Agency confirmed that these emission limits look adequate when compared against the BAT-AELs set out in the Refinery BAT conclusions and the emission levels set out in the LVIC (Ammonia) BREF.

   The Steam Boiler generates the steam required in the reforming process. It has a net rated thermal input of 27.6 MWth and burns the same fuel as the Feed Fired Heater. **ACTION:** [redacted] to advise on the Environment Agency's interpretation of the applicability of the NOx emission level associated with BAT (20 mg/m^3) set out in the LVIC (Ammonia) BREF for boilers in heat exchange autothermal reforming process configuration.

   [Post meeting update of 19/04/2021 closing out the outstanding action of 23 02/2021:

   The Environment Agency has reviewed further the matter of which emission limits would be considered applicable to the NOx emissions from the Steam Boiler fired on hydrogen rich tail gas.

   Due to the differences in the process between the LVIC-Ammonia BREF and the process at the proposed Hynet hydrogen plant, the non-binding nature of emission limits set out in pre-IED BREFs (such as the LVIC-Ammonia BREF), the lack of adequate references and description of techniques supporting the 20 mg/m^3 emission level stated in the LVIC-Ammonia BREF and the industrial sector of the permit for the Stanlow Manufacturing Complex, the Environment Agency is minded to consider applicable to this emission point the BAT-AEL for new equipment firing gaseous fuels set out in Table 10 of the Refining of Mineral Oil and Gas BAT Conclusions (2014/738/EU).
   The new Steam Boiler will therefore need to comply with the refinery BAT-AEL range of 30-100 mg/m^3 at 3% oxygen for NOx for combustion of gaseous fuels. For this and any other combustion units proposed, the application shall provide a justification that the primary and/or secondary measures proposed to control and minimise NOx emissions are BAT and appropriate according to the results of the environmental risk assessment. The ELV will be set out in the permit according to emission level that is achievable with the proposed BAT measures, for example the Environment Agency would expect the lower end of the range (i.e. 30 mg/m^3) to be achievable if Selective Catalytic Reduction is required to meet the BAT-AEL range and therefore considered BAT for this application.

The same considerations and advice also apply to the emissions from the Feed Fired Heater, therefore this post-meeting note should be taken to supplement the advice given above for that combustion unit].

The Applicant queried whether the guidance 'Review of Best Available Techniques (BAT) for Hydrogen Production from Methane and Refinery Fuel Gas with Carbon Capture' will specify emission limits in its final version. The Environment Agency explained that this guidance does not have the same status as a BREF or BAT conclusions at this stage. Further information from operating plant would need to be available in order to set BAT-AELs specific to this sector where necessary. At the moment, emission limits are expected to be specified looking at other existing BREF documents and BAT conclusions whose scope could be considered to apply to the proposed plant. This approach will be confirmed as the work to finalise the draft guidance progresses.

The Applicant explained that there are no Large Combustion Plants (LCP), i.e. combustion plants aggregating to >50 MWth per stack, in the scope of the Hynet project. The Environment Agency confirmed that therefore IED Chapter III and the LCP BAT conclusions won't apply.

3. EOUKL queried the option of providing certain information that isn't available at FEED stage through pre-operational conditions.
   The Environment Agency confirmed that, in principle, they acknowledge that certain detailed information may become available as the design progresses, therefore it accepts that pre-operational conditions may be used to seek approval. However, as a general principle, any changes significantly affecting the environmental risk profile of the installation, beyond the environmental risk envelope addressed and presented with the application, will need to be assessed in a permit variation, as opposed to pre-operational conditions.

   The Environment Agency expects that all the key process design information is available at FEED design stage and that this information is made available when relevant to the permit application (example: the Environment Agency expects that the key energy integration proposals are made and energy balance is available at FEED stage). This option will therefore need to be assessed on a case by case basis and the applicant should flag in the application key information that is subject to change because deemed preliminary and propose a way for validating that information (such as proposing specific pre-operational conditions). If the potential changes affect the environmental risk of the installation, the applicant may attempt to address the uncertainties with a sensitivity analysis in the application.

4. EOUK confirmed that the Hynet plant will be installed within the current permit boundary (subject to varying the permit to remove alcohol production activities that have been decommissioned in the area).

The Environment Agency advised that, if the variation does not entail expanding the permit boundaries, there is no requirement for an updated Site Condition Report to be submitted with the variation application for the Hynet plant.
The ongoing work to establish the retrospective pollution baseline shall continue under the improvement conditions currently set out in the permit. Although the previous activities (i.e. alcohol production) will be removed from the permit through a permit variation, reference to them will remain in the permit status log to ensure that they are taken into account at the eventual permit surrender (or partial surrender of the activities and land carried out in this area) and the operator will remain liable for pollution of the area until then.
The Environment Agency advised that the environmental risk assessment submitted with the variation application for the Hynet project activities will need to cover risk of pollution to soil and groundwater from the new hydrogen + carbon capture plant, taking into account the inventory of hazardous pollutants, and the measures proposed to prevent minimise and manage the risk (e.g. design of drainage systems, containment, etc.).
The Applicant shall demonstrate in the application that the proposed measures and operating techniques for soil and groundwater pollution prevention and containment comply with BAT.

5. EOUKL queried the scope of the air dispersion model for the Hynet project in relation to other emission sources in the current refinery permit and possible changes to emissions due to the future use of hydrogen fuel produced in the Hynet plant and future CHP plant run on hydrogen.
The Environment Agency advised that the application should model emissions from the new Hynet plant both in isolation and with the other emissions sources in the refinery permit in order to make the relevant assessment on the significance of impacts from the new and combined activities, taking into account the background air quality in the area. If applicable, the application should explain how the existing activities might be contributing already to the background, however this is dependent on the source of data used to establish the background for the air quality assessment. This approach is consistent with the Environment Agency requirements for assessment of impacts from the regulated facility as a whole.

   The Environment Agency explained that the risk assessment submitted with the application will need to reflect the proposed operations of the installation after granting that specific permit variation. If the application covers the new Hynet plant, but does not cover the combustion of hydrogen in the refinery combustion units, in this case the risk assessment should be based on the emissions from the new Hynet plant, plus the current emissions from the refinery. The combustion of hydrogen in the refinery combustion units will need to be covered in a subsequent application specifically addressing that scope. The Environment Agency remarked that permission for the future use of hydrogen as a fuel in refinery combustion plant shall not be implied from permitting the Hynet plant activities.

6. EOUKL queried about the timing and sequencing of the Hynet and CD4 variation applications: the current strategy is to submit CD4 and Hynet as two separate permit variations. The Hynet application is expected in June 2021 and the CD4 variation would be submitted sometime after that but while the Hynet is still being processed.
   The Environment Agency confirmed that in principle they don't have objections to keeping the CD4 and Hynet applications separate, however they advised that, if the timeline overlaps, the applicant should work out a mechanism for ensuring that the second application does not invalidate the air quality risk assessment submitted for the first application, whilst this is still being determined (for example modelling the emissions from the revised CD4 operations as sensitivity case in the first application).

7. The Applicant explained that the flare will be used for non-routine flaring only, including emergency depressurisation, process upsets, during start-up/shut-down and proposed not to include the flare operation in the air dispersion model.
   The Environment Agency commented that they expect the level of assessment to be proportionate to the risk of the flare operations. If the Applicant is not able to adequately justify that the risk is low, the Environment Agency would expect a precautionary scenario to be modelled. For example, if the flare is expected to be used up to 10% of the time, as anticipated by email prior to the meeting, then it should be included in the air dispersion model. It was commented that this figure might be too high for non-routine flaring operation only and that the Applicant should review the expected flaring frequency/duration as part of the application. Other elements should be considered when assessing the risk of the flare operation are the composition of the gas flared, the configuration of the flare system and its compliance with BAT, operating techniques to prevent and minimise other than normal operating conditions (OTNOC) potentially leading to flaring.

8. The Applicant explained that it is proposed to discharge RO effluent within existing permitted discharge limits. The Environment Agency commented that, although this is acceptable in principle, it would expect the application to include an assessment of the discharge in terms of capability and readiness of the existing facilities to process it.

9. Changes to charging advice. The Environment Agency commented that the charging estimate given as part of previous pre-application services was preliminary and aimed at explaining the charging mechanism rather providing a precise figure. In particular, aspects that remain to be defined to work out the application charge are: the configuration of new waste water treatment activities; the interactions of the new plant with existing activities in the permit.
   From the information received at this stage of pre-application advice service, it is understood that the new combustion equipment proposed in the scope of the Hynet project might exceed aggregated 50 MWth when the new standby generators are included. Therefore, since the aggregated thermal input exceed the threshold set out for the S1.1 Part A1 (a) activity, this should be charged as a substantial

variation to the S1.1 Part A1 (a) activity currently included in the permit (note: this charge element was considered as the charge for a minor variation in the estimate provided in January 2021).

10. Some additional budget has been allocated for future advice under this pre-application service. This service will remain open, pending further update between EOUKL and the Environment Agency at the end of March 2021.

Additional advice (May 2021) in response to request received on 10/05/2021

We refer to the email received from [redacted] on 10/05/2021, including attachment titled 'HYNet EA Preapp queries May 21'.

11. **Confirmation of listed activities to inform the charge**
    We have the following comments to the activity list you have identified:

a. The waste water treatment activity will need further clarification as we receive a full application. You have currently identified the following:

Section 5.4, Part A(1)(b) as a process for "Recovery or a mix of recovery and disposal of non-hazardous waste with a capacity exceeding 75 tonnes per day, by biological treatment"	From receipt of site drainage and process effluents, pre-treatment dosing and treatment in the Membrane Bioreactor (MBR), transfer of treated effluent to the Clarified Water Tank and then filtration in the Dual Media Filtration Plant to storage of filtered water in the Filtered Water Tank. Including separation and dewatering of sludges, re-use of supernatant and off-site disposal of sludge.

i. You will need to explain/justify why the waste water should be considered non-hazardous in the application;

ii. You will need to clearly explain which effluent / waste streams are recovered and which ones are disposed in the application;

iii. The scheduled activity for the biological process is not correctly identified, it should be:

Section 5.4 Part A(1) (b) (i) - Recovery or a mix of recovery and disposal of non-hazardous waste with a capacity exceeding 75 tonnes per day, by biological treatment".

iv. We note that an activity for sludge treatment for disposal is included in the description you have provided. This consists of physico-chemical processing for disposal and it may either constitute a scheduled activity Section 5.4 Part A(1) (a) (ii) on its own if the capacity of the equipment installed (e.g. dewatering tanks, filter press, etc.) exceed the threshold of 50 tonnes per day or be considered as a DAA to the biological treatment plant. We will only be able to make a definitive call on this point once we receive all the details with your application. We have therefore provisionally included an additional Section 5.4 Part A(1) (a) (ii) activity in the updated charging estimate.

b. We think you have shown the combustion activities twice: once as 'Schedule 25A Medium Combustion Plant' and also as aggregation to the existing S1.1

PartA(1)(a) activity. According to the aggregation guidance set out in RGN2 Appendix 1 and 2 we would only consider them in the aggregation to the existing S1.1 Part A(1)(a).

c. We will review the DAA list at the point of receiving a complete application. These should not make any material difference to establish the charge for the application.

12. **Updated application charge**

We provide below an updated estimate of the application charge, based on the activities you have stated in the document titled 'HYNet EA Preapp queries May 21' and our current understanding of your application and interpretation of the charging scheme.

The application charge will need to be confirmed upon receiving a complete application.

Since you are introducing new activities to the permit, these are charged as new bespoke activities as stated by our charging guidance:

3.8 Add an activity to an existing permit

If you want to add an activity to your permit, you must pay the charge for a new permit application for that type of activity.

The charging mechanism for new permits is summarised in the following excerpt of our charging guidance:

Using the tables of charges, you need to calculate the sum of:

- 100% of the relevant application charge in the tables of charges for the largest application fee
- 50% of the relevant application charge for any secondary activities that can reasonably be considered to be part of the same operation -- to reflect the time saved during the determination period, for example, by only needing one consultation or one set of operator competence checks
- 10% of the relevant application charge for the same activity carried out multiple times on the same site

The new activities being introduced and charged according to the above mechanism are:

- New hydrogen plant – Section 4.2 Part A(1) (a) (i)
- New carbon capture plant for geological storage – Section 6.10 Part A(1) (a)

- New non-hazardous biological effluent treatment plant – Section 5.4 Part A(1) (b) (i)
- New non-hazardous physico-chemical treatment (sludge) – Section 5.4 Part A(1) (a) (ii) [refer to item 11.a.iv. above]

We have included the charge for a substantial variation to the combustion activity S1.1 Part A(1) (a) as discussed in item 9. above.

We have also included the charge for two minor technical variations needed to remove from the permit the decommissioned alcohol and SHOP chemical activities located where the new Hynet plant will be built as explained by you in a previous pre-application discussions (EPRFP3139FN/V011).
There is no reduction to the charging for variations of activities in the charging scheme.

We have also included the charge for habitat assessment and a noise management plan. Should other environmental management plans be required, you will need to add the relevant charge component.

The application charge worked out according to the above principles is therefore worked out in the following table:

TOTAL APPLICATION CHARGE **£64,330**

View full Table of Charges

Percentage Charge Breakdown		100%	90%	60%	50%	50%	30%	20%	15%	10%		
Select an activity ref...	*And select a description....*	Baseline Charge	Sub Variation	Surrender Permit	Secondary Activity	Normal Variation	Minor Variation	Low-Risk Surrender	Transfer Permit	Repeat Activity	*Select a charge type...*	Charge
1.4.4	Section 4.2 - production of a single inorganic chemical.	£13,209	£11,888	£7,925	£6,604	£6,604	£3,963	£2,642	£2,459	£1,320	Secondary Activity	£6,604
1.10.4	Carbon capture and storage.	£14,915	£13,423	£8,949	£7,457	£7,458	£4,474	£2,983	£2,459	£1,491	Baseline Charge	£14,915
1.16.2.2	Section 5.4 (a)(ii) - non-hazardous waste installation – physico-chemical treatment for disposal.	£13,443	£12,099	£8,066	£6,721	£6,722	£4,033	£2,689	£2,016	£1,344	Secondary Activity	£6,721
1.16.2.1	Section 5.4 (a)(i) and (b)(i) - non-hazardous waste installation – biological treatment.	£13,984	£12,586	£8,390	£6,992	£6,992	£4,195	£2,797	£2,098	£1,398	Secondary Activity	£6,992
1.10.1	Section 1.1 - combustion plant - rated thermal input of 50MWth or more.	£19,103	£17,193	£11,462	£9,551	£9,552	£5,731	£3,821	£2,459	£1,910	Sub Variation	£17,193
1.4.2	Section 4.1 - production of more than one organic chemical.	£16,466	£14,819	£9,880	£8,233	£8,233	£4,940	£3,293	£2,459	£1,646	Minor Variation	£4,940
1.4.2	Section 4.1 - production of more than one organic chemical.	£16,466	£14,819	£9,880	£8,233	£8,233	£4,940	£3,293	£2,459	£1,646	Minor Variation	£4,940
											TOTAL A	**£62,305**

Charges for plans and assessments

Activity Reference	Plan or assessment	Charge	*Enter the number of plans...*	
1.19.1	Waste recovery plan	£1,231		
1.19.2	Habitats assessment	£779	1	£779
1.19.3	Fire prevention plan	£1,241		
1.19.4	Pest management plan	£1,241		
1.19.5	Dust management plan	£1,241		
1.19.6	Odour management plan	£1,246		
1.19.7	Noise and vibration management plan	£1,246	1	£1,246
1.19.8	Ammonia emissions risk assessment	£620		
1.19.9	Dust and bio-aerosol management plan	£620		
	Advertising	£500		
			TOTAL B	**£2,025**

The total application charge is therefore estimated as **£64,330**. You will need to provide detailed description of the proposed activities, supported by process flow diagrams, to validate the charging estimate at the point of receiving a complete application.

Refer to our charging guidance for further details.

We consider that there is a possibility that this application might draw high level of interest from members of the public. If this happens, after the initial budget corresponding to the charge worked out according to the scheme outlined above is utilised, the charging will become based on time and materials, see https://www.gov.uk/government/publications/environmental-permitting-charges-guidance/environmental-permitting-charges-guidance#publicinterest. In this case, you may also be required to pay additional £500 to advertise your application on a newspaper (note this component of the charge has not been included at the moment, but it may become required at a later stage by the Permitting Officer duly making or determining your application).

13. **Energy efficiency**

The Environment Agency expects that a complete application should address in detail the proposed energy integration and energy efficiency measures included in the design.
In general, you should refer to the relevant guidance in the latest available version of the guidance document titled 'Review of Best Available Techniques (BAT) for Hydrogen Production from Methane and Refinery Fuel Gas with Carbon Capture'.

The key energy sources and energy users of the proposed process should be identified, along with an explanation of how any excess heat would be reused among the available thermal levels of the process and waste heat is minimised.

A simplified heat balance should be provided, showing the energy integration of the process and energy transfer from higher to lower energy levels in a clear way, for example in the form of a Sankey diagram.

The overall energy efficiency of the plant should be calculated and presented, along with a description of the key assumptions made to work that out and the proposed validation methods at the commissioning stage of the plant. The Process / Energy Efficiency Key Performance Parameters figures presented in the guidance 'Review of Best Available Techniques (BAT) for Hydrogen Production from Methane and Refinery Fuel Gas with Carbon Capture' should be calculated and presented in the application.

Particular consideration should be given to the energy efficiency measures and heat integration of combustion equipment (boilers, fired heaters), reactors and gas compressors (for example air compressor in the ASU, CO_2 compressor, hydrogen compressor if applicable) and selection of cooling system.

An explanation should be given of the energy efficiency options considered in the design, even if it is proposed not to take some of them forward. If less efficient process options are proposed, these should be justified on a technical or cost-benefit basis against more efficient options discarded.

We understand there is no electric power generation proposed as part of the proposal (other than small sized standby diesel generators that would be used for limited hours in the case of loss of power supply from the grid). The rationale for the proposed configuration, entailing the import of outsourced electric power, as opposed to its on-site production in a combined heat and power (CHP) plant fully integrated within the process, should be explained and justified. CHP readiness requirements do not apply to installations that do not include power generation, however, as the proposed combustion units exceed 20 MW thermal input, the requirements of Article 14 of the Energy Efficiency Directive are applicable. You should therefore submit a cost-benefit analysis following with our draft guidance ('Draft guidance on completing cost-benefit assessments for installations under Article 14 of the Energy Efficiency Directive') or provide a justification that any waste heat generated by the proposed plant is not available at a useful temperature. Even low grade energy might be efficiently utilised if lower temperature users are identified, for example in other refinery processes, and we would expect you to provide evidence in the application that you have explored all the available options to minimise waste heat.

14. **Confidentiality**

The Environment Agency is not able to enter into a non-disclosure agreement as part of a permit application. All the provisions for industrial and commercial confidentiality for permit applications are governed by the Environmental Permitting Regulations.

You should therefore refer to the relevant Environmental Permitting Regulations (regulations 48 to 56) for details.

Our confidentiality assessment process follows the requirements of the Environmental Permitting Regulations, including the following key elements:

- We will only be able to assess confidentiality of certain information after we receive it, along with a confidentiality objection notice with adequate justification;
- We have a duty to determine confidentiality, and we will make a confidentiality determination if we receive a confidentiality objection notice from you or if we identify information in your application that we consider might be confidential. We may accept or refuse (in full or in part) the confidentiality objection notice;
- You will have a right of appeal to our decision;
- We will consider in our assessment the representations made in the confidentiality objection notice to assess whether the information is commercial or industrial information, the confidentiality claim is to protect a legitimate economic interest and whether the public interest in keeping the information confidential outbalance the public interest in disclosing it.

The law requires us to apply a presumption in favour of including the information on the public register.

- Any confidentiality decision is time limited, maximum time limit of 4 years is set out in the Environmental Permitting Regulations;
- We have a legal obligation to disclose information that relates to emissions.

The general assumption should be that any information sent to us might become of public domain if the confidentiality claim is refused, or after the time limited confidentiality decision expires (unless another confidentiality claim is requested by the operator and accepted by us).
We might also receive a request to disclose information under the Environmental Information Regulations, in which case would need to carry out a separate assessment to decide whether to disclose the information in response to the request.

15. **Additional information – water treatment and discharge**
You have provide additional information on the configuration of the proposed water waste water processing facilities. Expanding on item 8 above, you should either:
    - Reassess the environmental risks of the discharge to surface water through emission point W3, taking into account any changes to the composition and flow rate of the discharged effluent arising from the new activities; or
    - Provide a technical justification / demonstration that the risk is unchanged compared to the currently permitted discharge.

    If you need to assess the risk of hazardous pollutants to surface water, you need to follow the surface water pollution risk assessment guidance.
    If you need to assess the risk from sanitary determinands you should follow the assessment of sanitary and other pollutants in surface water discharges methodology.

Additional advice (June 2021) in response to request received on 15/06/2021

16. **Updated application charge estimate for hazardous waste water treatment**

As requested, we provide an updated charging estimate in the scenario that the waste water treatment and sludge dewatering activities are for hazardous waste:

- S5.3 Part A(1) (a) (i) Disposal or recovery of hazardous waste with a capacity exceeding 10 tonnes per day by biological treatment;
- S5.3 Part A(1) (a) (ii) Disposal or recovery of hazardous waste with a capacity exceeding 10 tonnes per day by physio-chemical treatment (sludge dewatering over 10 t/day).

The charging mechanism explained in item 12. remains the same, but please note the activity with the largest application charge to be charged at 100% (baseline charge) is now the S5.3 Part A(1) (a) (ii) activity.

Refer to item 17. below for additional considerations on the requirement for the Noise and Vibration Management Plan fee, which has been provisionally included in the estimate.

TOTAL APPLICATION CHARGE **£67,160**

View full Table of Charges

Percentage Charge Breakdown		100%	90%	60%	50%	50%	30%	20%	15%	10%
Select an activity ref...	*And select a description....*	Baseline Charge	Sub Variation	Surrender Permit	Secondary Activity	Normal Variation	Minor Variation	Low-Risk Surrender	Transfer Permit	Repeat Activity
1.4.4	Section 4.2 - production of a single inorganic chemical.	£13,209	£11,888	£7,925	£6,604	£6,604	£3,963	£2,642	£2,459	£1,320
1.10.4	Carbon capture and storage.	£14,915	£13,423	£8,949	£7,457	£7,458	£4,474	£2,983	£2,459	£1,491
1.16.1.2	Section 5.3 (a)(ii) - hazardous waste installation – physico-chemical treatment.	£16,001	£14,401	£9,601	£8,000	£8,000	£4,800	£3,200	£2,459	£1,600
1.16.1.1	Section 5.3 (a)(i) - hazardous waste installation – biological treatment.	£16,001	£14,401	£9,601	£8,000	£8,000	£4,800	£3,200	£2,459	£1,600
1.10.1	Section 1.1 - combustion plant - rated thermal input of 50MWth or more.	£19,103	£17,193	£11,462	£9,551	£9,552	£5,731	£3,821	£2,459	£1,910
1.4.2	Section 4.1 - production of more than one organic chemical.	£16,466	£14,819	£9,880	£8,233	£8,233	£4,940	£3,293	£2,459	£1,646
1.4.2	Section 4.1 - production of more than one organic chemical.	£16,466	£14,819	£9,880	£8,233	£8,233	£4,940	£3,293	£2,459	£1,646

Select a charge type...	Charge
Secondary Activity	£6,604
Secondary Activity	£7,457
Baseline Charge	£16,001
Secondary Activity	£8,000
Sub Variation	£17,193
Minor Variation	£4,940
Minor Variation Repeat Activity	£4,940
TOTAL A	**£65,135**

Charges for plans and assessments

Activity Reference	Plan or assessment	Charge
1.19.1	Waste recovery plan	£1,231
1.19.2	Habitats assessment	£779
1.19.3	Fire prevention plan	£1,241
1.19.4	Pest management plan	£1,241
1.19.5	Dust management plan	£1,241
1.19.6	Odour management plan	£1,246
1.19.7	Noise and vibration management plan	£1,246
1.19.8	Ammonia emissions risk assessment	£620
1.19.9	Dust and bio-aerosol management plan	£620
	Advertising	£500

Enter the number of plans...	
1	£779
1	£1,246
TOTAL B	**£2,025**

17. **Charge for Noise and Vibration Management Plan**

If the noise impact assessment submitted with your application confirms that the risk associated with noise generated from the new and varied activities is insignificant, for example the noise levels at the receptors are substantially unchanged, you may provide a justification that a Noise and Vibration Management Plan is not required. In this case the relevant charge would not apply.
However, we may require a Noise and Vibration Management Plan and the associated charge before duly making your application or at a later stage, including during the determination of the permit variation, if we disagree with the conclusions of your noise impact assessment.
In any case, even if you don't submit a Noise and Vibration Management Plan, you should address how the noise mitigation measures specified in the design will comply with BAT.

A complete application must contain the following information below:

Declaration	Please ensure the declaration section is completed by each relevant person. For a limited company, this must be a director/company secretary as listed on Companies House.
Site Plan	Site plan must be clearly marked with the full site boundary (refer to specific advice in Attachment 4 for site plans to be provided for multi-operator installations)
Payment	Please note your application will not be processed until we receive the full payment.

What happens next?

If you submit an environmental permit application then please quote this pre-application reference number: EPR/FP3139FN/V012 (even if future applications will be allocated a different reference number according to the actual sequence of submitting them, check with [redacted] if in doubt).

If the advice above details using the online digital application form, your application can be submitted using this method. If not, please send your completed application documents via email to:

[redacted]

Or by post to:

Environment Agency, Permitting Support Centre, Quadrant 2, 99 Parkway Avenue, Sheffield, S9 4WF

Dealing with the impact of COVID-19

We are following Government advice to manage the risks of Coronavirus to our organisation, to protect the health, safety and wellbeing of our staff and sustain our critical operations.

We are doing all we can to maintain our service, however it may take us longer than usual to respond to you. It is important that you inform us of any applications that are critical to maintain national resilience, national infrastructure and critical environmental protection.

Our current queues are large and we are taking longer than usual to allocate work for duly made checks. Please refer to myself or your area officers to be updated on progress made with allocating your application(s).

Disclaimer

The advice given is based on the information you have provided, and does not constitute a formal response or decision of the Environment Agency with regard to future permit

applications. Any views or opinions expressed are without prejudice to the Environment Agency's formal consideration of any application. Please note that any application is subject to duly making and then full technical checks during determination, and additional information may be required based on your detailed submission and site specific requirements and the advice given is to address the specific pre-application request.

This advice covers installations only. Other permissions from the Environment Agency and/or other bodies may be required for associated or other activities.

Enhanced pre application cost estimate

At this stage the pre-application advice is expected to cost up to £3,000 plus VAT. An invoice will be sent separately at a later date.

Application Timescales

Our current queues are large and we are taking longer than usual to allocate work for initial assessment, known as duly making. The table below shows our estimated queue times by application type. Please note, this is based on our average times and some applications may be picked up before or after the timescales listed below.

Application type	Estimated time to allocation
New standard rules	14-18 weeks
New bespoke	16-20 weeks
Admin variation	2-4 weeks
Minor variation	13-17 weeks
Normal variation	17-19 weeks
Substantial variation	14-18 weeks
Transfer	7-11 weeks
Surrender	17-21 weeks
Intensive Farming new bespoke	14-18 weeks
Intensive Farming admin variation	12-16 weeks
Intensive Farming normal variation	15-19 weeks
Intensive Farming substantial variation	18-22 weeks
Intensive Farming transfer	22-26 weeks
Intensive Farming surrender	6-10 weeks

Once an application is duly made, the amount of time taken to determine your application will vary. It will be impacted by factors such as:

- The quality of the application
- The complexity of the application
- Whether an application is of high public interest
- Whether the application includes novel technologies or techniques
- Whether the determination requires input from others, both internal and external to the Environment Agency
- Whether modelling and/or monitoring and assessment is required, for example Air Quality modelling and assessment

The Permitting Officer determining your application will be able to keep you updated with the progress of your application.

This pre-application request is now closed.

We consider this pre application request is now closed however if you have any questions regarding this letter please contact [redacted] If you require additional enhanced pre-application advice please complete our online form.

We look forward to working with you on this project.

If you have any questions please call [redacted]

Yours sincerely

[redacted] CEng MIchemE

Senior Permitting Officer, National Permitting Service

[redacted]

HyNet North West

Minutes of Meeting - 5194812-000-30MN-4-0006

Project:	Hynet Low Carbon Hydrogen (LCH™) Plant		
Subject:	Environment Agency Pre-application Meeting (EPR/WP3809SG/A001)		
Meeting place:	Skype call		
Date and time:	1st June 2020, 1.00 – 2:45	**Note of Actions by:**	CG & PJN
Attendees:	[redacted]	**Representing:**	Atkins SNC-L Atkins SNC-L Atkins SNC-L Atkins SNC-L Essar PEL PEL EA EA EA EA

Note. The Environment Agency has read these minutes and has confirmed that they represent an accurate record of the meeting. The EA's post-meeting clarifications to various matters arising are given below in blue font.

Item	Description	Deadline	Action
1.	**Introductions, key objectives of the meeting, background to the overall HyNet project, and overview of HyNet LCH™ plant project.** See embedded MS PowerPoint presentation		
2.	**Definition of the LCH™ Plant under Environmental Permitting (England and Wales) Regulations 2016** The EA stated that the HyNet LCH™ plant falls under EPR Schedule 1, Part 2, Chapter 4, Section 4.2, Part A(1)(i) as a process for "*Producing inorganic chemicals such as gases (for example ammonia, hydrogen chloride, hydrogen fluoride, hydrogen cyanide, hydrogen sulphide, oxides of carbon, sulphur compounds, oxides of nitrogen, **hydrogen**, oxides of sulphur, phosgene)*". This definition reflects the plant's primary objective of hydrogen production, and is consistent with the EA regulation of other hydrogen plants in the UK. However, the EA believes that an application would also be necessary under Chapter 6, Section 6.10, Part A(1)(a) as a process for the "*Capture of carbon dioxide streams from an installation for the purposes of geological storage pursuant to Directive 2009/31/EC of the European Parliament and of the Council on the geological storage of carbon dioxide*". This will be confirmed. The EA confirmed post meeting that as the purpose of the capture of the carbon dioxide is for geological storage any capture activity on the installation will be a Section 6.10 A(1)(a) scheduled activity. This can either be included in the initial application or added later in a variation before commissioning depending on the phasing of the project (also see point 21 fees).		EA

Item	Description	Deadline	Action
	There may also need to be a waste treatment scheduled activity for effluent treatment on the HyNet LCH™ installation. This will depend on the volume capacity of the treatment, whether it is for disposal or recovery, the nature of the effluent (hazardous vs non-hazardous) and the nature of the treatment (biological vs physical).		
3.	**Applicable Regulatory Guidance** The EA stated that the following environmental regulatory guidance is applicable: • Reference Document on Best Available Techniques for the Manufacture of Large Volume Inorganic Chemicals – Ammonia, Acids and Fertilisers (recognizing that this document is now quite old) • Best Available Techniques (BAT) Reference Document for the Refining of Mineral Oil and Gas • (BAT) conclusions for the refining of mineral oil and gas (2014/738/EU) • Best Available Techniques (BAT) Reference Document for Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector • (BAT) conclusions for common waste water and waste gas treatment/management systems in the chemical sector JBD asked whether we should also refer to old EA sector guidance notes. The EA's advice was that there is no particular need to review these documents. Focus should be on the above BRef notes.		
4.	JBD asked whether there are any permit applications which might help inform the HyNet LCH™ application and therefore be worth reviewing. The EA were of the opinion that there are currently none.		
5.	**Best Available Techniques** The EA acknowledged that the combination of hydrogen production and CO_2 removal is relatively new, and that the agency is still trying to establish BAT for the process. It highlighted that further clarification on BAT could be sought if necessary. This approach is consistent with Article 14(6) of IED that allows the competent authority to set permit conditions on the basis of the best available techniques that it has determined for the activities or processes concerned, by giving special consideration to the criteria listed in Annex III. The EA stated as a general point that if specific elements of BAT (as set out in the above references) are considered not to apply to the HyNet LCH™ plant then this should be made clear within the application. Also, an explanation should be provided regarding why the proposed Gas Heated Reformer (GHR) / Autothermal Reformer (ATR) combination is BAT for the H_2 production and CO_2 capture process. In response to this point TC noted that the benefit of the process (over more conventional steam reforming technology) is that it operates at pressure hence maximising capture and removal of the CO_2.		Atkins SNC-L
6.	JD stated that within the application the EA will be looking for evidence that CO_2 removed by the LCH™ plant would be effectively stored. TC noted that this is a function of the wider HyNet system described in the		

Item	Description	Deadline	Action
	meeting introduction and highlighted that the purpose of the plant is to provide a decarbonized energy stream.		
7.	JBD observed that the net thermal input of combustion plant installed under Phase 1 of the HyNet LCH™ project is likely to be under 50 MW but that future phases would likely result in an increase in thermal input above this figure, bringing the plant under IED Ch II or Ch III controls. Would Phase 2/3 of the project therefore necessitate the upgrade of the Phase 1 combustion plant had it not been designed to meet IED Ch II or Ch III controls? The EA to confirm. The EA confirmed post meeting that if combustion plant installed as part of Phase I was part of an aggregation calculation for the increase in combustion capacity under Phase2/3 bringing the total above 50MWth input then upgrading of the monitoring/controls would be necessary to either Ch II or Ch III as necessary depending on factors such as common windshielding.		EA
8.	JBD asked whether the HyNet LCH™ Plant fired heater and steam boiler are likely to aggregate as part of the wider refinery site. The EA noted that this would depend upon the type of permit applied: • Option 1: Were the LCH™ Plant subject to a standalone permit then it would be considered as separate, under which circumstance aggregation would not apply. • Option 2. The LCH™ Plant could be permitted as a variation to the existing Stanlow permit. In this instance it would be considered as part of the refinery, and aggregation would then apply. JBD asked for clarification: were the Phase 1 HyNet LCH™ combustion plant to be aggregated with existing refinery combustion sources (Option 2) to give a net thermal input above the IED Ch II or Ch III thresholds, would ELVs, monitoring requirements and the BAT measures applicable to aggregated plant of this scale be applicable to the additional LCH™ combustion plant? The EA to confirm. The EA confirmed post meeting that as the HyNet LCH™ Plant is very unlikely to share a common windshield with any Stanlow Plant we do not believe it will be aggregated as an LCP Ch III activity with existing Stanlow plant under Option 2. Aggregation under Option 2 as part of the Stanlow 1.1A(a) activity to Ch II would lead to control and monitoring requirements as necessary being applied to the HyNet LCH™ Plant but there is no appreciable difference to the requirements for new plant under the MCPD if using Option 1 for Phase 1. Option 1 status as a separate permit in a multi-operator installation would not lead to aggregation in this case.		EA
9.	**Permitting approach** The EA stated that it did not have a particular preference with regard to the HyNet LCH™ Plant permitting approach – i.e. the options in the above item – but noted that a substantial variation to the existing Stanlow permit could make regulation complex. The choice, however, is one for the Consortium.		
10.	The EA highlighted that for a standalone permit to be issued for the HyNet LCH™ Plant it would be necessary to surrender Area 4 from the		

Item	Description	Deadline	Action
	existing Stanlow permit. This would prevent future regulatory "overlap" issues which should be avoided if at all possible. CG stated that the majority of Area 4 is outside the refinery permit boundary, that the area is not used for permitted activities. The EA noted that if the area has not previously been used under the existing permit then a partial surrender is a fairly straightforward process. JBD asked whether the partial surrender should be carried out first or whether the HyNet LCH™ Plant permit application and Area 4 surrender could be twin-tracked. The EA also confirmed that the partial surrender of the land cannot be part of a variation of the Essar Stanlow permit that will be required to accept RO concentrate from HyNet LCH™ for treatment (as well as any infrastructure or operational changes for the export of refinery gas to the new plant). However, all the necessary applications can be parallel tracked in determination provided they are issued in the correct order.		
11.	KR noted that a standalone permit for the HyNet LCH™ Plant would necessitate a variation to the existing Stanlow permit to account for: i) the transfer of a waste water stream from the LCH™ Plant to the refinery, and ii) potential changes in fuel gas usage within the refinery.		
12.	The EA asked whether Essar will be the long-term operator of the HyNet LCH™ Plant (and hence owner of the environmental permit). KR advised that this issue is still under discussion. The EA commented that the operator is a key point for them. The operator must meet the Legal Operator and Competence Requirements (https://www.gov.uk/guidance/legal-operator-and-competence-requirements-environmental-permits) and whilst Essar are likely to be suitable it is much less likely to be so for the Special Purpose Vehicle if it is essentially a holding company with no operational staff of its own.		
13.	**Combustion Plant** Putting aside the issue of aggregation (item 8), the LCH™ Phase 1 combustion plant would come under the MCPD (Medium Combustion Plant Directive) due to the net thermal input being above 1 MW but below 50 MW. The requirements of IED Chapter II and III would therefore not apply. The EA was in agreement with JBD's suggestion that it would be prudent to anticipate/design for the tightening of environmental regulation associated with the applicability of IED at Phases 2 and 3. It would also be wise to investigate the impact of three trains through air dispersion modelling. However, the EA noted that if the application were to cover Phase 1 only, then the application environmental risk assessment should be confined to Phase 1 only (i.e. regulation under MCPD) and not include impacts associated with all three phases because it is only Phase 1 for which a permit is sought.		
14.	JBG raised the issue of a software interlock which is described within the existing Stanlow permit and whether this could impose restrictions in terms of the maximum thermal capacity of the LCH™ combustion plant. The EA believes that the issue is specifically linked to the Stanlow High Pressure Boiler House and is not relevant to the HyNet LCH™ Plant. This will be confirmed.		EA

Item	Description	Deadline	Action
	The EA confirmed post meeting that this interlock limits the capacity of the LCP140 regulated High Pressure Boiler House only and would not apply to the LCH™ combustion plant.		
15.	The EA stated that it does not believe that the HyNet LCH™ Plant would fall within the "refinery bubble", the concept/mechanism through which emissions are regulated. It would probably only apply were the HyNet LCH™ Plant to be included as a variation to the Stanlow permit (Option 2). The EA will confirm the applicability. The EA clarified post meeting that a technically linked but separately permitted activity on a multi-operator installation could be included in the main refinery bubble (and has been in another case) for emissions regulation (i.e. it is possible under options 1 or 2). However, they do not believe there would be any advantage to doing this considering the nature of the likely emissions, the spare capacity within the Stanlow bubble and the rules governing its use.		EA
16.	**Other Issues** It is not proposed to model the LCH™ Plant flare for the permit application as it is a safety device which will be infrequently used. The EA is satisfied with this approach provided that the likely infrequency of flare operation is established in the application. The application should also establish the likely presence of sulphur compounds within the flared gas.		Atkins SNC-L
17.	It is not proposed to model odour from the HyNet LCH™ Plant, as there are no direct discharge points on the plant. However, the EA asked that the potential for thermal degradation of amine (present in the CO_2 removal plant) be considered, highlighting some draft BAT guidance. JG requested that a reference be provided so that we can address this issue. The EA confirmed post meeting that it is working on Carbon Capture and Storage with the CCSA trade association and guidance is currently being revised. The 2012 (latest) version of the UK position on Carbon Capture Technology and Carbon Capture Ready Criteria will be supplied separately. It contains some details about amine scrubbing for post combustion capture although they may be different to conditions proposed in the HyNet LCH™ Plant.		EA
18.	**Energy Efficiency** JBD noted that the HyNet LCH™ Plant already incorporates energy recovery and asked what further analysis might be required for the purposes of the application. The EA noted that it should be sufficient to explain within the application why CHP readiness or further energy efficiency measures are not required. TC confirmed that there are currently no plans to integrate energy recovery between the ASU and plant in the Phase 1 process area.		
19.	JBD asked if there was a requirement to assess the waste water discharge transferred from the HyNet LCH™ demin plant to the Essar site. The EA stated that it would expect the application to include an assessment of the discharge in terms of Essar's capability and readiness to accept it. However, it was noted that Essar discharges its effluent to a United Utilities effluent treatment plant, so any assessment is likely to be around waste water volumes.		

Item	Description	Deadline	Action
20.	**Programme** JBD advised an application submission date of mid December 2020. The EA stated that it is currently experiencing an end-to-end queue of between 6 to 8 months. A satisfactory application in December 2020 (i.e. one not requiring substantial further work) would probably not therefore receive a permit until around September 2021.		
21.	**Application Fees** The basic application fee for the HyNet LCH™ Plant as a stand-alone application is around £13k, noting that additional scheduled activities and assessments requirements will increase this fee. The EA will provide an estimate of fees for a stand-alone new application and a variation application. The EA stresses that all fees are confirmed at the time of application depending on the charging scheme current at the time and the detail of the submitted application. Current guidance and fees are available at https://www.gov.uk/government/publications/environmental-permitting-charges-guidance However, the following is an estimate of fee options as an illustration. We believe the main activity is production of hydrogen under scheduled activity 4.2A(1)(a)(i) Production of hydrogen charged for application as 1.4.4 Production of a single inorganic chemical at a baseline £13,209. There will also be a plant to treat the waste water, largely for recovery and reuse. Any disposal would go to sewer. Assumed to have a capacity larger than the scheduled activity thresholds. If the effluent is hazardous then the treatment would be 5.3A(1)(a)(i) for biological or 5.3A(1)(a)(ii) for physic-chemical treatment incurring a baseline charge under 1.16.1.1 or 1.16.1.2 respectively of £16,001. If, as you have said is more likely, the effluent is non-hazardous, then biological treatment for recovery falls under 5.4A(1)(b)(i) with a baseline charge under 1.16.2.1 of £13,984. Physico-chemical treatment of non-hazardous waste for recovery is not a scheduled activity but would be considered a Directly Associated Activity to the main production rather than a standalone waste operation, and so would not incur an application charge. Carbon dioxide capture for the purposes of geological storage is a 6.10 A(1)(a) Scheduled Activity charged under 1.10.4 Carbon Capture and Storage as a baseline £14,915 A 1.1A(a) Large Combustion activity has a baseline charge under 1.10.1 of £19,103 Although Medium Combustion Plant must meet relevant BAT and any relevant emission limits, where the equipment is to provide heat to the main production process we consider it a Directly Associated Activity without a separate application charge. In keeping with previous decisions we are likely to consider the feed gas desulphurisation as part of the overall hydrogen generation process but if the submitted detail shows it to be sufficiently separate it might be a separate 1.2A(1)(a) or 1.2A(2) refining gas activity depending on scale. If these components are applied for separately or as part of a variation then they are charged at the new activity baseline amounts shown		EA

Item	Description	Deadline	Action
	(Guidance section 3.8). This would include a variation (likely substantial) to add the Hynet LCH process to the Essar Stanlow Permit. If components are applied for at the same time under a new bespoke application then Guidance section 2.12 describes some aggregation. 100% of the baseline fee for the largest component and 50% of the baseline fee for linked secondary components (all the above components are linked). The one exception would be a non-hazardous biological effluent treatment plant which would be charged at 10% of its baseline fee. If there are multiple production lines each extra one would be 10% of the baseline fee. In addition to the fee based on scheduled activities, the table 1.19 also lists charges for plans and assessments that must be added to the total. Example: Phase 1 application for single line hydrogen production with a biological non-hazardous effluent treatment plant for recovery >75 tpd but no carbon capture activity yet. Combustion facilities >15MW each but aggregate <50MW. European Habitats sites within 10km and noise impact assessment and management plan required 100% of 1.4.4 at £13,209 + 10% of £13,984 + £779 for Habitats and £1,246 for Noise = £16,632		
22.	**Future Contact** The principal EA contact for future discussion about BAT development is [redacted] (Environment and Business). Once this pre-application case is closed further advice about the HyNet LCH™ Plant permit application can be obtained by making another pre-application advice request (either Basic or Enhanced) to the National Permitting Service through our website.		
23.	The pre-application meeting was terminated after 1 hour and 45 minutes.		

HyNet North West

A.6.0 COMPANY INFORMATION

A.6.1 ENVIRONMENTAL MANAGEMENT SYSTEM ISO14001:2015 CERTIFICATION

DNV·GL

MANAGEMENT SYSTEM CERTIFICATE

Certificate No:
189212-2015-AE-GBR-UKAS

Initial certification date:
05 December 2011

Valid:
13 September 2018 - 13 September 2021

This is to certify that the management system of

ESSAR OIL (UK) LIMITED

Stanlow Manufacturing Complex, Stanlow Refinery, Ellesmere Port, Cheshire, CH65 4HB, United Kingdom

has been found to conform to the Environmental Management System standard:

ISO 14001:2015

This certificate is valid for the following scope:

The production of refined petroleum products from crude oil and gas.

Place and date:
London, 14 September 2018

UKAS MANAGEMENT SYSTEMS
0013

For the issuing office:
DNV GL – Business Assurance
4th Floor, Vivo Building, 30 Stamford Street, London, SE1 9LQ, United Kingdom

Doug Milne
Management Representative

Lack of fulfilment of conditions as set out in the Certification Agreement may render this Certificate invalid.
ACCREDITED UNIT: DNV GL Business Assurance UK Limited, 4th Floor, Vivo Building, 30 Stamford Street, London, SE1 9LQ, United Kingdom.
TEL: +44(0) 203 816 4000. www.dnvgl.co.uk

A.7.0 MATERIALS SAFETY DATA SHEETS

SAFETY DATA SHEET
ALUMINIUM SULPHATE SOLID

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

Product name ALUMINIUM SULPHATE SOLID

Product number 11986

Synonyms; trade names GOLDIFLOC FILTER AID TABLETS, BRISWIM FLOC, ALUMINIUM SULPHATE 0-2 MM 17-18%, ALUMINIUM SULPHATE 2-8 MM 17/18%, FILTER AID TAB, FLOC GRANULES, ALUMINIUM SULPHATE 15% SLAB, ALUM SULPHATE HG 17%, AQUAEASY GOLDIFLOC TAB

1.2. Relevant identified uses of the substance or mixture and uses advised against

Identified uses Water Treatment ADDITIVE Adhesive. Resin.

Uses advised against No specific uses advised against are identified.

1.3. Details of the supplier of the safety data sheet

Supplier

Univar
Aquarius House
6 Mid Point Business Park
Bradford
BD3 7AY
+44 1274 267300
sds@univar.com
+44 1274 267306

1.4. Emergency telephone number

Emergency telephone SGS - +32 (0)3 575 55 55 (24h)

Sds No. 11986

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

Classification (EC 1272/2008)

Physical hazards Not Classified

Health hazards Eye Dam. 1 - H318

Environmental hazards Not Classified

Classification (67/548/EEC or 1999/45/EC) Xi;R41.

2.2. Label elements

ALUMINIUM SULPHATE SOLID

Pictogram

Signal word	Danger
Hazard statements	H318 Causes serious eye damage.
Precautionary statements	P280 Wear protective gloves/ protective clothing/ eye protection/ face protection. P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
Contains	ALUMINIUM SULPHATE

2.3. Other hazards

This substance is not classified as PBT or vPvB according to current EU criteria.

SECTION 3: Composition/information on ingredients

3.2. Mixtures

ALUMINIUM SULPHATE		**> 15**
CAS number: 10043-01-3	EC number: 233-135-0	REACH registration number: 01-2119531538-36

Classification	**Classification (67/548/EEC or 1999/45/EC)**
Met. Corr. 1 - H290 Eye Dam. 1 - H318	Xi;R41.

The Full Text for all R-Phrases and Hazard Statements are Displayed in Section 16.

SECTION 4: First aid measures

4.1. Description of first aid measures

Inhalation	Move affected person to fresh air at once. Get medical attention if any discomfort continues.
Ingestion	Move affected person to fresh air and keep warm and at rest in a position comfortable for breathing. Rinse mouth thoroughly with water. Give plenty of water to drink. Do not induce vomiting. Get medical attention.
Skin contact	Remove contaminated clothing immediately and wash skin with soap and water. Get medical attention if any discomfort continues.
Eye contact	Rinse immediately with plenty of water. Remove any contact lenses and open eyelids wide apart. Continue to rinse for at least 15 minutes. Get medical attention immediately. Continue to rinse.

4.2. Most important symptoms and effects, both acute and delayed

Eye contact	Risk of serious damage to eyes. May cause permanent damage if eye is not immediately irrigated.

4.3. Indication of any immediate medical attention and special treatment needed

Notes for the doctor	Treat symptomatically.

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable extinguishing media	Use fire-extinguishing media suitable for the surrounding fire.

ALUMINIUM SULPHATE SOLID

Unsuitable extinguishing media Do not use water jet as an extinguisher, as this will spread the fire.

5.2. Special hazards arising from the substance or mixture

Hazardous combustion products Oxides of carbon. Thermal decomposition or combustion may liberate carbon oxides and other toxic gases or vapours. Sulphurous gases (SOx).

5.3. Advice for firefighters

Special protective equipment for firefighters Wear positive-pressure self-contained breathing apparatus (SCBA) and appropriate protective clothing.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Personal precautions Follow precautions for safe handling described in this safety data sheet. Avoid inhalation of dust. Avoid contact with eyes. Provide adequate ventilation.

6.2. Environmental precautions

Environmental precautions Spillages or uncontrolled discharges into watercourses must be reported immediately to the Environmental Agency or other appropriate regulatory body.

6.3. Methods and material for containment and cleaning up

Methods for cleaning up Collect powder using special dust vacuum cleaner with particle filter or carefully sweep into suitable waste disposal containers and seal securely. Flush contaminated area with plenty of water. Collect and place in suitable waste disposal containers and seal securely. For waste disposal, see Section 13.

6.4. Reference to other sections

Reference to other sections For personal protection, see Section 8.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Usage precautions Provide adequate ventilation. Avoid handling which leads to dust formation. Avoid contact with skin and eyes.

7.2. Conditions for safe storage, including any incompatibilities

Storage precautions Store in tightly-closed, original container in a dry, cool and well-ventilated place. Store away from the following materials: Acids. Oxidising materials. Metals The substance is hygroscopic and will absorb water by contact with the moisture in the air.

7.3. Specific end use(s)

Specific end use(s) The identified uses for this product are detailed in Section 1.2.

SECTION 8: Exposure Controls/personal protection

8.1. Control parameters

DNEL Industry - Inhalation; Long term systemic effects: 20.2 mg/m³
Consumer - Oral; Long term systemic effects: 3.4 mg/kg/day

PNEC - STP; 20 mg/l

ALUMINIUM SULPHATE (CAS: 10043-01-3)

Ingredient comments WEL = Workplace Exposure Limits

ALUMINIUM SULPHATE SOLID

DNEL	Consumer - Oral; : 3700 mg/kg/day Industry - Oral; : 5700 mg/kg/day
PNEC	Not available.

8.2. Exposure controls

Protective equipment

Eye/face protection	The following protection should be worn: Chemical splash goggles.
Hand protection	The most suitable glove should be chosen in consultation with the glove supplier/manufacturer, who can provide information about the breakthrough time of the glove material. Chemical-resistant, impervious gloves complying with an approved standard should be worn if a risk assessment indicates skin contact is possible. Rubber (natural, latex). Neoprene. Polyvinyl chloride (PVC). To protect hands from chemicals, gloves should comply with European Standard EN374.
Other skin and body protection	Wear appropriate clothing to prevent repeated or prolonged skin contact.
Respiratory protection	If ventilation is inadequate, suitable respiratory protection must be worn. If ventilation is inadequate, suitable respiratory protection must be worn. Wear a respirator fitted with the following cartridge: Particulate filter, type P2.

SECTION 9: Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Appearance	Solid
Colour	White.
Odour	Slight.
Odour threshold	No information available.
pH	pH (diluted solution): ~ 3 1 %
Melting point	>300°C
Initial boiling point and range	No information available.
Flash point	Scientifically unjustified.
Evaporation rate	Not applicable.
Evaporation factor	No information available.
Flammability (solid, gas)	No information available.
Upper/lower flammability or explosive limits	No information available.
Other flammability	No information available.
Vapour pressure	Not applicable.
Vapour density	Not applicable.
Relative density	No information available.
Bulk density	1690 kg/m³

ALUMINIUM SULPHATE SOLID

Solubility(ies)	Soluble in water.
Partition coefficient	No information available.
Auto-ignition temperature	No information available.
Decomposition Temperature	Not available.
Viscosity	Not applicable.
Explosive properties	Not considered to be explosive.
Explosive under the influence of a flame	No information available.
Oxidising properties	Does not meet the criteria for classification as oxidising.

9.2. Other information

Other information	No information required.
Refractive index	No information available.
Particle size	No information available.
Molecular weight	No information available.
Volatility	No information available.
Saturation concentration	No information available.
Critical temperature	No information available.
Volatile organic compound	No information available.

SECTION 10: Stability and reactivity

10.1. Reactivity

Reactivity There are no known reactivity hazards associated with this product.

10.2. Chemical stability

Stability Stable at normal ambient temperatures and when used as recommended.

10.3. Possibility of hazardous reactions

Possibility of hazardous reactions Not available.

10.4. Conditions to avoid

Conditions to avoid Avoid excessive heat for prolonged periods of time. Water, moisture.

10.5. Incompatible materials

Materials to avoid Strong alkalis. Metals Strong oxidising agents.

10.6. Hazardous decomposition products

Hazardous decomposition products Oxides of carbon. Thermal decomposition or combustion may liberate carbon oxides and other toxic gases or vapours. Sulphurous gases (SOx).

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Acute toxicity - oral

ALUMINIUM SULPHATE SOLID

Acute toxicity oral (LD_{50} mg/kg)	2,000.0
Species	Rat

Acute toxicity - dermal

Acute toxicity dermal (LD_{50} mg/kg)	5,000.0
Species	Rabbit

Skin corrosion/irritation

Animal data	Not irritating.

Serious eye damage/irritation

Serious eye damage/irritation	Moderately irritating.

Respiratory sensitisation

Respiratory sensitisation	No information available.

Skin sensitisation

Skin sensitisation	Not sensitising.

Germ cell mutagenicity

Genotoxicity - in vitro	This substance has no evidence of mutagenic properties.

Carcinogenicity

Carcinogenicity	There is no evidence that the product can cause cancer.

Reproductive toxicity

Reproductive toxicity - development	This substance has no evidence of toxicity to reproduction.

Specific target organ toxicity - single exposure

STOT - single exposure	No information available.

Specific target organ toxicity - repeated exposure

STOT - repeated exposure	No information available.

Aspiration hazard

Aspiration hazard	Not applicable.

Inhalation	Dust may irritate the respiratory system.
Ingestion	Gastrointestinal symptoms, including upset stomach.
Skin contact	Skin irritation should not occur when used as recommended.
Eye contact	Risk of serious damage to eyes.

ALUMINIUM SULPHATE

Inhalation	Dust in high concentrations may irritate the respiratory system.
Ingestion	May cause discomfort if swallowed.
Skin contact	Powder may irritate skin.

ALUMINIUM SULPHATE SOLID

Eye contact Irritating to eyes.

SECTION 12: Ecological Information

Ecotoxicity The product components are not classified as environmentally hazardous. However, large or frequent spills may have hazardous effects on the environment.

ALUMINIUM SULPHATE

Ecotoxicity The product components are not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.

12.1. Toxicity

Acute toxicity - fish LC50, 96 hours: 142 mg/l,

Acute toxicity - aquatic invertebrates EC_{50}, 48 hours: 38 mg/l,

ALUMINIUM SULPHATE

Toxicity Not considered toxic to fish.

12.2. Persistence and degradability

Persistence and degradability The product contains only inorganic substances which are not biodegradable.

Biodegradation Scientifically unjustified.

ALUMINIUM SULPHATE

Persistence and degradability There are no data on the degradability of this product.

12.3. Bioaccumulative potential

Partition coefficient No information available.

ALUMINIUM SULPHATE

Bioaccumulative potential No data available on bioaccumulation.

12.4. Mobility in soil

Mobility The product is soluble in water.

ALUMINIUM SULPHATE

Mobility Not determined.

12.5. Results of PBT and vPvB assessment

Results of PBT and vPvB assessment This substance is not classified as PBT or vPvB according to current EU criteria.

ALUMINIUM SULPHATE

Results of PBT and vPvB assessment This substance is not classified as PBT or vPvB according to current EU criteria.

ALUMINIUM SULPHATE SOLID

12.6. Other adverse effects

Other adverse effects None known.

ALUMINIUM SULPHATE

Other adverse effects No information available.

SECTION 13: Disposal considerations

13.1. Waste treatment methods

General information Waste should be treated as controlled waste.

Disposal methods Dispose of waste to licensed waste disposal site in accordance with the requirements of the local Waste Disposal Authority.

SECTION 14: Transport information

General The product is not covered by international regulations on the transport of dangerous goods (IMDG, IATA, ADR/RID).

14.1. UN number

Not applicable.

14.2. UN proper shipping name

Not applicable.

14.3. Transport hazard class(es)

Not applicable.

14.4. Packing group

Not applicable.

14.5. Environmental hazards

Environmentally hazardous substance/marine pollutant
No.

14.6. Special precautions for user

Not applicable.

14.7. Transport in bulk according to Annex II of MARPOL and the IBC Code

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code Not applicable.

SECTION 15: Regulatory information

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

EU legislation Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) (as amended).
Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures (as amended).
Commission Regulation (EU) No 2015/830 of 28 May 2015.

15.2. Chemical safety assessment

ALUMINIUM SULPHATE SOLID

No chemical safety assessment has been carried out.

SECTION 16: Other information

Abbreviations and acronyms used in the safety data sheet

ATE: Acute Toxicity Estimate.
ADR: European Agreement concerning the International Carriage of Dangerous Goods by Road.
ADN: European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways.
CAS: Chemical Abstracts Service.
DNEL: Derived No Effect Level.
IATA: International Air Transport Association.
IMDG: International Maritime Dangerous Goods.
Kow: Octanol-water partition coefficient.
LC_{50}: Lethal Concentration to 50 % of a test population.
LD_{50}: Lethal Dose to 50% of a test population (Median Lethal Dose).
PBT: Persistent, Bioaccumulative and Toxic substance.
PNEC: Predicted No Effect Concentration.
REACH: Registration, Evaluation, Authorisation and Restriction of Chemicals Regulation (EC) No 1907/2006.
RID: European Agreement concerning the International Carriage of Dangerous Goods by Rail.
vPvB: Very Persistent and Very Bioaccumulative.
IARC: International Agency for Research on Cancer.
MARPOL 73/78: International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978.
cATpE: Converted Acute Toxicity Point Estimate.
BCF: Bioconcentration Factor.
BOD: Biochemical Oxygen Demand.
EC_{50}: 50% of maximal Effective Concentration.
LOAEC: Lowest Observed Adverse Effect Concentration.
LOAEL: Lowest Observed Adverse Effect Level.
NOAEC: No Observed Adverse Effect Concentration.
NOAEL: No Observed Adverse Effect Level.
NOEC: No Observed Effect Concentration.
LOEC: Lowest Observed Effect Concentration.
DMEL: Derived Minimal Effect Level.
EL50: Exposure Limit 50
hPa: Hectopascal
LL50: Lethal Loading fifty
OECD: Organisation for Economic Co-operation and Development
POW: Octanol-water partition coefficient
SCBA: self-contained breathing apparatus
STP: Sewage Treatment Plant
VOC: Volatile Organic Compounds

Classification abbreviations and acronyms

Acute Tox. = Acute toxicity
Aquatic Acute = Hazardous to the aquatic environment (acute)
Aquatic Chronic = Hazardous to the aquatic environment (chronic)

Key literature references and sources for data

Supplier's information.

Revision comments

NOTE: Lines within the margin indicate significant changes from the previous revision.

Revision date

18/04/2017

ALUMINIUM SULPHATE SOLID

Revision	05
Supersedes date	02/09/2016
SDS number	11986
Version number	1.003
SDS status	Approved.
Signature	Lisa Bland
Risk phrases in full	R41 Risk of serious damage to eyes.
Hazard statements in full	H290 May be corrosive to metals. H318 Causes serious eye damage.

Johnson Matthey

KATALCO$_{JM}$™ 23-4HQ

Katalco Activate your potential

SAFETY DATA SHEET

Version	:	4
Date of issue/ Date of revision	:	22/01/2016
Date of previous issue	:	09/12/2013
Prepared by	:	Johnson Matthey Process Technologies Regulatory Affairs Department

SECTION 1: Identification of the substance/mixture and of the company/ undertaking

1.1 Product identifier

Product name	:	KATALCO$_{JM}$ 23-4HQ
Product type	:	Solid.
Product definition	:	Mixture Classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]

1.2 Relevant identified uses of the substance or mixture and uses advised against

Specific uses	:	Catalyst for steam reforming of hydrocarbons

1.3 Details of the supplier of the safety data sheet

Supplier	:	Johnson Matthey Process Technologies PO Box No 1, Billingham Stockton on Tees, TS23 1LB UNITED KINGDOM +44 (0) 1642 523343
e-mail address of person responsible for this SDS	:	protechsds.enquiries@matthey.com

1.4 Emergency telephone number

For Chemical Emergency ONLY (spill, leak, fire, exposure or accident) call :

Emergency telephone number (with hours of operation)	:	+44 (0) 870 8200418 CHEMTREC UK (London)	(24 hours)
		+(1) 703-527-3887 CHEMTREC International	(24 hours)
Country information	:	000-800-100-7141 CHEMTREC India (local)	(24 hours)
Information limitations	:	For emergency calls only. Non-emergency calls cannot be serviced at this number.	
CHEMTREC Customer Number (CCN)	:	CCN12026	

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

By analogy with similar preparations this material is unlikely to be a skin sensitiser.

Product definition : Mixture

Classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]

Carc. 1A, H350i (inhalation)
STOT RE 1, H372 (lungs) (inhalation)

See Section 16 for the full text of the H statements declared above.

See Section 11 for more detailed information on health effects and symptoms.

SECTION 2: Hazards identification

2.2 Label elements

Hazard pictograms :

Signal word : Danger

Hazard statements : May cause cancer if inhaled.
Causes damage to organs through prolonged or repeated exposure if inhaled. (lungs)

Precautionary statements

Prevention : Obtain special instructions before use. Do not breathe dust. Use personal protective equipment as required. In case of inadequate ventilation wear respiratory protection. Wear protective gloves/clothing and eye/face protection.

Response : Get medical attention if you feel unwell. IF exposed or concerned: Get medical attention.

Storage : Not applicable.

Disposal : Dispose of contents and container in accordance with all local, regional, national and international regulations.

Supplemental label elements : Contains nickel monoxide. May produce an allergic reaction.

Annex XVII - Restrictions on the manufacture, placing on the market and use of certain dangerous substances, mixtures and articles : Restricted to professional users.

Special packaging requirements

Containers to be fitted with child-resistant fastenings : Not applicable.

Tactile warning of danger : Not applicable.

2.3 Other hazards

Other hazards which do not result in classification : None known.

SECTION 3: Composition/information on ingredients

3.2 Mixtures

Substance/mixture : Mixture

Product/ingredient name	Identifiers	%	Classification Regulation (EC) No. 1272/2008 [CLP]	Type
aluminium oxide	REACH #: 01-2119529248-35 EC: 215-691-6 CAS: 1344-28-1	≥75 - <90	Not classified.	[2]
nickel monoxide	REACH #: 01-2119467172-41 EC: 215-215-7 CAS: 1313-99-1 Index: 028-003-00-2	≥10 - <24	Skin Sens. 1, H317 Carc. 1A, H350i (inhalation) STOT RE 1, H372 (lungs) (inhalation) Aquatic Chronic 4, H413 **See Section 16 for the full text of the H statements declared above.**	[1] [2]

SECTION 3: Composition/information on ingredients

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment, are PBTs or vPvBs or have been assigned a workplace exposure limit and hence require reporting in this section.

Type

[1] Substance classified with a health or environmental hazard
[2] Substance with a workplace exposure limit
[3] Substance meets the criteria for PBT according to Regulation (EC) No. 1907/2006, Annex XIII
[4] Substance meets the criteria for vPvB according to Regulation (EC) No. 1907/2006, Annex XIII
[5] Substance of equivalent concern

Occupational exposure limits, if available, are listed in Section 8.

SECTION 4: First aid measures

4.1 Description of first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Continue to rinse for at least 10 minutes. Get medical attention.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Get medical attention. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Skin contact : Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Wash contaminated clothing thoroughly with water before removing it, or wear gloves. Continue to rinse for at least 10 minutes. Get medical attention. Wash clothing before reuse. Clean shoes thoroughly before reuse.

Ingestion : Wash out mouth with water. Remove dentures if any. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. Stop if the exposed person feels sick as vomiting may be dangerous. Do not induce vomiting unless directed to do so by medical personnel. If vomiting occurs, the head should be kept low so that vomit does not enter the lungs. Get medical attention. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Wash contaminated clothing thoroughly with water before removing it, or wear gloves.

4.2 Most important symptoms and effects, both acute and delayed

Potential acute health effects

Inhalation : Unlikely to be hazardous by inhalation unless present as a dust. High concentrations of dust may be irritant to the upper respiratory tract. Dust may enter the lung and be slow to clear.

Ingestion : Ingestion may cause irritation of the gastrointestinal tract.

Skin contact : Repeated or prolonged skin contact may cause irritation. May cause physical abrasion in contact with skin.

Eye contact : Dust may cause irritation to eyes.

Over-exposure signs/symptoms

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Ingestion : No specific data.

SECTION 4: First aid measures

4.3 Indication of any immediate medical attention and special treatment needed

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

SECTION 5: Firefighting measures

5.1 Extinguishing media

Suitable extinguishing media : Use an extinguishing agent suitable for the surrounding fire.

Unsuitable extinguishing media : None known.

5.2 Special hazards arising from the substance or mixture

Hazards from the substance or mixture : No specific fire or explosion hazard.

Hazardous combustion products : Decomposition products may include the following materials:
metal oxide/oxides

5.3 Advice for firefighters

Special precautions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode. Clothing for fire-fighters (including helmets, protective boots and gloves) conforming to European standard EN 469 will provide a basic level of protection for chemical incidents.

Additional information : Discharged material may be pyrophoric (see Process Hazards).

SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilt material. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

For emergency responders : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

6.2 Environmental precautions : Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

6.3 Methods and material for containment and cleaning up

Small spill : Move containers from spill area. Avoid dust generation. Do not dry sweep. Vacuum dust with equipment fitted with a HEPA filter and place in a closed, labeled waste container. Dispose of via a licensed waste disposal contractor.

Large spill : Move containers from spill area. Approach the release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Avoid dust generation. Do not dry sweep. Vacuum dust with equipment fitted with a HEPA filter and place in a closed, labeled waste container. Dispose of via a licensed waste disposal contractor.

SECTION 6: Accidental release measures

6.4 Reference to other sections : See Section 1 for emergency contact information.
See Section 8 for information on appropriate personal protective equipment.
See Section 13 for additional waste treatment information.

SECTION 7: Handling and storage

7.1 Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8). Avoid exposure - obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Do not get in eyes or on skin or clothing. Do not ingest. If during normal use the material presents a respiratory hazard, use only with adequate ventilation or wear appropriate respirator. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Empty containers retain product residue and can be hazardous. Do not reuse container.

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Process hazards : Following activation in a reducing environment the material should be regarded as pyrophoric. Pyrophoric and self-heating materials can act as sources of ignition and should be kept away from combustible materials. As a minimum, water hoses should be available to cool the material. The action of water on the material may result in the evolution of small quantities of hydrogen. The material should not be exposed to gases containing carbon monoxide at temperatures between 50 deg C and 200 deg C because of the danger of formation of nickel carbonyl under these conditions.

7.2 Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a dry place. Keep only in the original container. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabelled containers. Use appropriate containment to avoid environmental contamination. Store away from incompatible materials (see Section 10).

Additional information : Further advice given in the Johnson Matthey publication 'Catalyst Handling'.

7.3 Specific end use(s)

Recommendations : Not available.

Industrial sector specific solutions : Not available.

SECTION 8: Exposure controls/personal protection

8.1 Control parameters

Occupational exposure limits

Product/ingredient name	Exposure limit values
aluminium oxide	**EH40/2005 WELs (United Kingdom (UK), 12/2011).** TWA: 10 mg/m³ 8 hours. Form: inhalable dust
nickel monoxide	**EH40/2005 WELs (United Kingdom (UK), 12/2011). Absorbed through skin. Skin sensitiser.** TWA: 0.5 mg/m³, (as Ni) 8 hours.
Inhalable fraction	***[Air contaminant]*** **EH40/2005 WELs (United Kingdom (UK)).** TWA: 10 mg/m³ 8 hours.
Respirable dust	***[Air contaminant]*** **EH40/2005 WELs (United Kingdom (UK)).** TWA: 4 mg/m³ 8 hours.

SECTION 8: Exposure controls/personal protection

Recommended monitoring procedures : If this product contains ingredients with exposure limits, personal, workplace atmosphere or biological monitoring may be required to determine the effectiveness of the ventilation or other control measures and/or the necessity to use respiratory protective equipment. Reference should be made to monitoring standards, such as the following: European Standard EN 689 (Workplace atmospheres - Guidance for the assessment of exposure by inhalation to chemical agents for comparison with limit values and measurement strategy) European Standard EN 14042 (Workplace atmospheres - Guide for the application and use of procedures for the assessment of exposure to chemical and biological agents) European Standard EN 482 (Workplace atmospheres - General requirements for the performance of procedures for the measurement of chemical agents) Reference to national guidance documents for methods for the determination of hazardous substances will also be required.

DNELs/DMELs

Product/ingredient name	Type	Exposure	Value	Population	Effects
nickel monoxide	DNEL	Long term Dermal	0.012 mg/cm²	Workers	Local
	DNEL	Long term Inhalation	0.05 mg/m³	Workers	Systemic

PNECs

Product/ingredient name	Type	Compartment Detail	Value	Method Detail
nickel monoxide	-	Fresh water	0.0071 mg/l	Assessment Factors
	-	Marine water	0.0086 mg/l	Assessment Factors
	-	Soil	29.9 mg/kg	Assessment Factors
	-	Sewage Treatment Plant	0.033 mg/l	Assessment Factors

8.2 Exposure controls

Appropriate engineering controls : If user operations generate dust, fumes, gas, vapour or mist, use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

General information : All personal protective equipment (PPE) should be selected and used under the direction of a trained health and safety professional. PPE should be in compliance with any relevant local or national standard. Where no local or national standards apply, compliance with the relevant EU standard is recommended.
It remains the responsibility of the user to ensure that this product is used safely within the context of their site conditions.

Eye/face protection : Safety eyewear complying with an approved standard (EN 166 or local equivalent) is required during loading and unloading of reactors, cleaning and maintenance operations, and sampling, where exposure to dust, powder or liquid splashes is possible.

Skin protection

Hand protection : Chemical/bio-chemical resistant, impervious gloves complying with an approved chemical standard (EN 374 or local equivalent) should be worn at all times when handling chemical products. For tasks involving physical or mechanical hazards, gloves should also comply with an approved physical standard (EN 388 or local equivalent).
Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties.
In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

SECTION 8: Exposure controls/personal protection

Body protection : Safety shoes complying with an approved standard (EN 20346 or equivalent) and a hard hat complying with an approved standard (EN 297 or equivalent) is required during loading and unloading of reactors, cleaning and maintenance operations and sampling.

Other skin protection : A protective suit complying with an approved standard (EN 13982-1 Type 5 or equivalent) should be worn during loading and unloading or reactors, sampling and cleaning and maintenance operations where dermal contact is possible.

Respiratory protection : Use of Respiratory Protective Equipment (RPE) (Particle filter with high efficiency for solid particles (EN 143 or 149, Type P3 or FFP3, Associated Protection Factor (APF) = 20) or local equivalent as a minimum) is required during loading and unloading of reactors, cleaning and maintenance operations, and sampling, where exposure to dust or powder is possible. Air-fed Respiratory Protective Equipment may be used if entry to the reactor is required.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

SECTION 9: Physical and chemical properties

9.1 Information on basic physical and chemical properties

Appearance

Physical state : Solid. [4-hole pellets]

Colour : Grey. Green. [Light]

Odour : Odourless.

Odour threshold : Not applicable.

pH : Not applicable.

Melting point/freezing point : Not determined.

Initial boiling point and boiling range : Not applicable.

Flash point : Not applicable.

Evaporation rate (butyl acetate = 1) : Not applicable.

Flammability (solid, gas) : Not classified.

Upper/lower flammability or explosive limits : Not applicable.

Vapour pressure (mm Hg) : Not applicable.

Vapour density : Not applicable.

Relative density : Not applicable.

Bulk Density (g/ml) : 1.1

Solubility(ies) : Soluble in the following materials: strong acids

Solubility - Water : insoluble in water.

Partition coefficient: n-octanol/ water : Not applicable.

Auto-ignition temperature : Not applicable.

Decomposition temperature : Not available.

Viscosity (m.Pa.s) : Not applicable.

Explosive properties : Not available.

Oxidising properties : Not available.

9.2 Other information

No additional information.

SECTION 10: Stability and reactivity

10.1 Reactivity : No specific test data related to reactivity available for this product or its ingredients.

10.2 Chemical stability : The product is stable.

10.3 Possibility of hazardous reactions : Under normal conditions of storage and use, hazardous reactions will not occur.

See Process Hazards section for hazards associated with the discharged material resulting from its intended use.

10.4 Conditions to avoid : No specific data.

10.5 Incompatible materials : No specific data.

10.6 Hazardous decomposition products : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

SECTION 11: Toxicological information

11.1 Information on toxicological effects

Acute toxicity

Conclusion/Summary : Not classified.

Acute toxicity estimates

Route	ATE value
Not available.	

Irritation/Corrosion

Conclusion/Summary

Skin : Not classified.

Eyes : Not classified.

Respiratory : Not classified.

Sensitiser

Conclusion/Summary

Skin : By analogy with similar mixtures this material is unlikely to be a skin sensitiser. May cause an allergic skin reaction. (ANSI / OSHA Classification)

Respiratory : Not classified.

Mutagenicity

Conclusion/Summary : Not classified.

Carcinogenicity

Conclusion/Summary : May cause cancer if inhaled.

Reproductive toxicity

Conclusion/Summary : Not classified.

Teratogenicity

Conclusion/Summary : Not classified.

Specific target organ toxicity (single exposure)

Not available.

Specific target organ toxicity (repeated exposure)

Product/ingredient name	Category	Route of exposure	Target organs
nickel monoxide	Category 1	Inhalation	lungs

Aspiration hazard

SECTION 11: Toxicological information

Not available.

Information on the likely routes of exposure : Routes of entry anticipated: Dermal, Inhalation.

Potential acute health effects

Inhalation : Unlikely to be hazardous by inhalation unless present as a dust. High concentrations of dust may be irritant to the upper respiratory tract. Dust may enter the lung and be slow to clear.

Ingestion : Ingestion may cause irritation of the gastrointestinal tract.

Skin contact : Repeated or prolonged skin contact may cause irritation. May cause physical abrasion in contact with skin.

Eye contact : Dust may cause irritation to eyes.

Symptoms related to the physical, chemical and toxicological characteristics

Inhalation : No specific data.

Ingestion : No specific data.

Skin contact : No specific data.

Eye contact : No specific data.

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Conclusion/Summary : Causes damage to organs through prolonged or repeated exposure if inhaled.

General : Causes damage to organs through prolonged or repeated exposure if inhaled.

Carcinogenicity : May cause cancer if inhaled. Risk of cancer depends on duration and level of exposure.

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Other information : Not available.

SECTION 12: Ecological information

12.1 Toxicity

Conclusion/Summary : Not classified.

12.2 Persistence and degradability

Conclusion/Summary : The bioaccumulative criteria are not applicable to essential metals.

12.3 Bioaccumulative potential

Product/ingredient name	$LogP_{ow}$	BCF	Potential
nickel monoxide	-	270	low

12.4 Mobility in soil

SECTION 12: Ecological information

Soil/water partition coefficient (K_{OC}) : Not available.

Mobility : Not available.

12.5 Results of PBT and vPvB assessment

PBT : Not applicable.

vPvB : Not applicable.

12.6 Other adverse effects : No known significant effects or critical hazards.

SECTION 13: Disposal considerations

Used material may have different hazards or properties from the new material. This safety data sheet does not apply to the used material.

In all cases where a EWC code is given, this applies to the material under normal conditions of use and may not be appropriate for used material where the properties may have changed. It is the responsibility of the user to check that any waste code recommendation is appropriate to their material in accordance with the recommendation of the European Waste Catalogue.

13.1 Waste treatment methods

Product

Methods of disposal : The generation of waste should be avoided or minimised wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction.

Dispose of through the metal recovery industry.

Container information: : Since the emptied container retains product residue, follow label warnings even after it has been emptied.

Hazardous waste : The classification of the product may meet the criteria for a hazardous waste.

European waste catalogue (EWC) : The user should assign a waste code to the material in accordance with the recommendations of the European Waste Catalogue.

Packaging

Methods of disposal : The generation of waste should be avoided or minimised wherever possible. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible.

Special precautions : This material and its container must be disposed of in a safe way. Care should be taken when handling emptied containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers.

SECTION 14: Transport information

	ADR/RID	ADN	IMDG	IATA
14.1 UN number	Not regulated.	Not regulated.	Not regulated.	Not regulated.
14.2 UN proper shipping name	-	-	-	-
14.3 Transport hazard class(es)	-	-	-	-
14.4 Packing group	-	-	-	-

SECTION 14: Transport information

14.5 Environmental hazards	No.	No.	No.	No.
Additional information	-	-	-	-

14.6 Special precautions for user : Not applicable.

14.7 Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code : Not available.

SECTION 15: Regulatory information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

EU Regulation (EC) No. 1907/2006 (REACH)

Annex XIV - List of substances subject to authorisation

Substances of very high concern

None of the components are listed.

Annex XVII - Restrictions on the manufacture, placing on the market and use of certain dangerous substances, mixtures and articles : Restricted to professional users.

Other EU regulations

Europe inventory : All components are listed or exempted.

Black List Chemicals (76/464/EEC) : Not listed

Priority List Chemicals (793/93/EEC) : Not listed

Product/ingredient name	Carcinogenic effects	Mutagenic effects	Developmental effects	Fertility effects
nickel monoxide	Carc. 1A, H350i (inhalation)	-	-	-

National regulations

Product/ingredient name	List name	Name on list	Classification	Notes
nickel monoxide	UK Occupational Exposure Limits EH40 - WEL	inorganic nickel compounds Insoluble in water Except nickel carbonyl	Carc.	-

International regulations

Chemical Weapon Convention List Schedules I, II & III Chemicals

Not listed.

Montreal Protocol (Annexes A, B, C, E)

Not listed.

Stockholm Convention on Persistent Organic Pollutants

Not listed.

Rotterdam Convention on Prior Inform Consent (PIC)

Not listed.

SECTION 15: Regulatory information

UNECE Aarhus Protocol on POPs and Heavy Metals

Not listed.

15.2 Chemical Safety Assessment : This product contains substances for which Chemical Safety Assessments are still required.

SECTION 16: Other information

Indicates information that has changed from previously issued version.

Abbreviations and acronyms : ATE = Acute Toxicity Estimate
CLP = Classification, Labelling and Packaging Regulation [Regulation (EC) No. 1272/2008]
DNEL = Derived No Effect Level
EUH statement = CLP-specific Hazard statement
PNEC = Predicted No Effect Concentration
RRN = REACH Registration Number

Procedure used to derive the classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]

Classification	Justification
Carc. 1A, H350i (inhalation) STOT RE 1, H372 (lungs) (inhalation)	According to package According to package

Full text of abbreviated H statements :

H317	May cause an allergic skin reaction.
H350i (inhalation)	May cause cancer if inhaled.
H372 (lungs) (inhalation)	Causes damage to organs through prolonged or repeated exposure if inhaled. (lungs)
H413	May cause long lasting harmful effects to aquatic life.

Full text of classifications [CLP/GHS] :

Aquatic Chronic 4, H413	LONG-TERM AQUATIC HAZARD - Category 4
Carc. 1A, H350i (inhalation)	CARCINOGENICITY (inhalation) - Category 1A
Skin Sens. 1, H317	SKIN SENSITIZATION - Category 1
STOT RE 1, H372 (lungs) (inhalation)	SPECIFIC TARGET ORGAN TOXICITY (REPEATED EXPOSURE) (lungs) (inhalation) - Category 1

Notice to reader

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Inspiring science, enhancing life

SAFETY DATA SHEET

Conforms to Regulation (EC) No. 1907/2006 (REACH), Annex II (including amendments) - United Kingdom (UK)

KATALCO 23-4HQR

Version	:	1
Date of issue/ Date of revision	:	31/05/2018
Date of previous issue	:	No previous validation

SECTION 1: Identification of the substance/mixture and of the company/ undertaking

1.1 Product identifier

Product identifier	:	**KATALCO™** 23-4HQR
Product type	:	Solid.
Product definition	:	Mixture Classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]

1.2 Relevant identified uses of the substance or mixture and uses advised against

Specific uses	:	Catalyst for steam reforming of natural gas

1.3 Details of the supplier of the safety data sheet

Supplier	:	Johnson Matthey PO Box No 1,Belasis Avenue, Billingham, Stockton on Tees, TS23 1LB, UK +44 (0) 1642 523343
e-mail address of person responsible for this SDS	:	jmsds1@matthey.com

1.4 Emergency telephone number

For Chemical Emergency ONLY (spill, leak, fire, exposure or accident) call :

Emergency telephone number (with hours of operation)	:	+44 (0) 870 8200418 CHEMTREC UK (London)	(24 hours)
		+(1) 703-527-3887 CHEMTREC International	(24 hours)
Country information	:	000-800-100-7141 CHEMTREC India (local)	(24 hours)
Information limitations	:	For emergency calls only. Non-emergency calls cannot be serviced at this number.	
CHEMTREC Customer Number (CCN)	:	CCN12026	

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

By analogy with similar preparations this material is unlikely to be a skin sensitiser.

Product definition : Mixture

Classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]

Carc. 1A, H350i (inhalation)
STOT RE 1, H372 (lungs, respiratory tract) (inhalation)

The product is classified as hazardous according to Regulation (EC) 1272/2008 as amended.

See Section 16 for the full text of the H statements declared above.

See Section 11 for more detailed information on health effects and symptoms.

2.2 Label elements

Hazard pictograms :

Signal word : Danger

Hazard statements : May cause cancer by inhalation.
Causes damage to organs through prolonged or repeated exposure if inhaled. (lungs, respiratory tract)

Precautionary statements

Prevention : Obtain special instructions before use. Do not breathe dust. Wear protective gloves/clothing and eye/face protection.

Response : Get medical attention if you feel unwell. IF exposed or concerned: Get medical attention.

Storage : Not applicable.

Disposal : Dispose of contents and container in accordance with all local, regional, national and international regulations.

Supplemental label elements : Contains nickel monoxide and nickel. May produce an allergic reaction.

Annex XVII - Restrictions on the manufacture, placing on the market and use of certain dangerous substances, mixtures and articles : Restricted to professional users.

Special packaging requirements

Containers to be fitted with child-resistant fastenings : Not applicable.

Tactile warning of danger : Not applicable.

2.3 Other hazards

Other hazards which do not result in classification : None known.

SECTION 3: Composition/information on ingredients

3.2 Mixtures

Substance/mixture : Mixture

Product/ ingredient name	Identifiers	%	Regulation (EC) No. 1272/2008 [CLP]	Type
aluminium oxide	REACH #: 01-2119529248-35 EC: 215-691-6 CAS: 1344-28-1	≥75 - ≤90	Not classified.	[2]
nickel	REACH #: 01-2119438727-29 EC: 231-111-4 CAS: 7440-02-0 Index: 028-002-01-4	≥10 - ≤18	Skin Sens. 1, H317 Carc. 2, H351 (inhalation) STOT RE 1, H372 (respiratory tract) (inhalation) Aquatic Chronic 3, H412	[1] [2]
nickel monoxide	REACH #: 01-2119467172-41 EC: 215-215-7 CAS: 1313-99-1 Index: 028-003-00-2	≤6.2	Skin Sens. 1, H317 Carc. 1A, H350i (inhalation) STOT RE 1, H372 (lungs) (inhalation) Aquatic Chronic 4, H413 **See Section 16 for the full text of the H statements declared above.**	[1] [2]

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment, are PBTs or vPvBs or have been assigned a workplace exposure limit and hence require reporting in this section.

Type

[1] Substance classified with a health or environmental hazard
[2] Substance with a workplace exposure limit
[3] Substance meets the criteria for PBT according to Regulation (EC) No. 1907/2006, Annex XIII
[4] Substance meets the criteria for vPvB according to Regulation (EC) No. 1907/2006, Annex XIII
[5] Substance of equivalent concern
[6] Additional disclosure due to company policy

Occupational exposure limits, if available, are listed in Section 8.

SECTION 4: First aid measures

4.1 Description of first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Continue to rinse for at least 10 minutes. Get medical attention.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Get medical attention. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

SECTION 4: First aid measures

Skin contact : Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Wash contaminated clothing thoroughly with water before removing it, or wear gloves. Continue to rinse for at least 10 minutes. Get medical attention. Wash clothing before reuse. Clean shoes thoroughly before reuse.

Ingestion : Wash out mouth with water. Remove dentures if any. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. Stop if the exposed person feels sick as vomiting may be dangerous. Do not induce vomiting unless directed to do so by medical personnel. If vomiting occurs, the head should be kept low so that vomit does not enter the lungs. Get medical attention. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Wash contaminated clothing thoroughly with water before removing it, or wear gloves.

4.2 Most important symptoms and effects, both acute and delayed

Potential acute health effects

Inhalation : Unlikely to be hazardous by inhalation unless present as a dust. High concentrations of dust may be irritant to the upper respiratory tract. Dust may enter the lung and be slow to clear.

Ingestion : Ingestion may cause irritation of the gastrointestinal tract.

Skin contact : Repeated or prolonged skin contact may cause irritation. May cause physical abrasion in contact with skin.

Eye contact : Dust may cause irritation to eyes.

Over-exposure signs/symptoms

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Ingestion : No specific data.

4.3 Indication of any immediate medical attention and special treatment needed

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

SECTION 5: Firefighting measures

5.1 Extinguishing media

Suitable extinguishing media : Use an extinguishing agent suitable for the surrounding fire.

Unsuitable extinguishing media : None known.

5.2 Special hazards arising from the substance or mixture

SECTION 5: Firefighting measures

Hazards from the substance or mixture : In case of fire toxic nickel carbonyl can be formed.

Hazardous combustion products : Decomposition products may include the following materials: metal oxide/oxides

5.3 Advice for firefighters

Special precautions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode. Clothing for fire-fighters (including helmets, protective boots and gloves) conforming to European standard EN 469 will provide a basic level of protection for chemical incidents.

Additional information : Discharged material may be pyrophoric (see Process Hazards).

SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilt material. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

For emergency responders : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

6.2 Environmental precautions

Environmental precautions : Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

6.3 Methods and material for containment and cleaning up

Small spill : Move containers from spill area. Avoid dust generation. Do not dry sweep. Vacuum dust with equipment fitted with a HEPA filter and place in a closed, labelled waste container. Dispose of via a licensed waste disposal contractor.

Large spill : Move containers from spill area. Approach the release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Avoid dust generation. Do not dry sweep. Vacuum dust with equipment fitted with a HEPA filter and place in a closed, labelled waste container. Dispose of via a licensed waste disposal contractor.

6.4 Reference to other sections

See Section 1 for emergency contact information.
See Section 8 for information on appropriate personal protective equipment.
See Section 13 for additional waste treatment information.

SECTION 7: Handling and storage

7.1 Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8). Avoid exposure - obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Do not get in eyes or on skin or clothing. Do not ingest. If during normal use the material presents a respiratory hazard, use only with adequate ventilation or wear appropriate respirator. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Empty containers retain product residue and can be hazardous. Do not reuse container.

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Process hazards : Nitrogen blanketing is recommended when reactors have been loaded. The charging of pre-reduced materials requires particular care. Charging should be done quickly and if possible controlled from outside the vessel. Excessive vibration or disturbances should be avoided since this could cause dust to form. The material can remove oxygen from air causing a severe hazard in enclosed or confined spaces. In case of insufficient ventilation, wear suitable respiratory equipment. Following activation in a reducing environment the material should be regarded as pyrophoric. Pyrophoric and self-heating materials can act as sources of ignition and should be kept away from combustible materials. As a minimum, water sprays should be available to cool the material. The action of water on the reduced material may result in the evolution of small quantities of hydrogen. The reduced material should not be exposed to gases containing carbon monoxide at temperatures between 50 deg C and 200 deg C because of the danger of formation of nickel carbonyl under these conditions.

7.2 Conditions for safe storage, including any incompatibilities

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a dry place. Keep only in the original container. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabelled containers. Use appropriate containment to avoid environmental contamination. Store away from incompatible materials (see Section 10). See Section 10 for incompatible materials before handling or use.

Additional information : Further advice given in the Johnson Matthey publication 'Catalyst Handling'.

7.3 Specific end use(s)

Recommendations : Not available.

Industrial sector specific solutions : Not available.

SECTION 8: Exposure controls/personal protection

The information in this section contains generic advice and guidance. Information is provided based on typical anticipated uses of the product. Additional measures might be required for bulk handling or other uses that could significantly increase worker exposure or environmental releases.

8.1 Control parameters

Occupational exposure limits

Product/ingredient name	Exposure limit values
aluminium oxide	**EH40/2005 WELs (United Kingdom (UK), 12/2011).** TWA: 10 mg/m³ 8 hours. Form: inhalable dust
nickel	**EH40/2005 WELs (United Kingdom (UK), 12/2011). Absorbed through skin.** TWA: 0.5 mg/m³, (as Ni) 8 hours.
nickel monoxide	**EH40/2005 WELs (United Kingdom (UK), 12/2011). Absorbed through skin. Inhalation sensitiser.** TWA: 0.5 mg/m³, (as Ni) 8 hours.
Inhalable fraction	***[Air contaminant]*** **EH40/2005 WELs (United Kingdom (UK)).** TWA: 10 mg/m³ 8 hours.
Respirable dust	***[Air contaminant]*** **EH40/2005 WELs (United Kingdom (UK)).** TWA: 4 mg/m³ 8 hours.

Recommended monitoring procedures : If this product contains ingredients with exposure limits, personal, workplace atmosphere or biological monitoring may be required to determine the effectiveness of the ventilation or other control measures and/or the necessity to use respiratory protective equipment. Reference should be made to monitoring standards, such as the following: European Standard EN 689 (Workplace atmospheres - Guidance for the assessment of exposure by inhalation to chemical agents for comparison with limit values and measurement strategy) European Standard EN 14042 (Workplace atmospheres - Guide for the application and use of procedures for the assessment of exposure to chemical and biological agents) European Standard EN 482 (Workplace atmospheres - General requirements for the performance of procedures for the measurement of chemical agents) Reference to national guidance documents for methods for the determination of hazardous substances will also be required.

DNELs/DMELs

Product/ingredient name	Type	Exposure	Value	Population	Effects
nickel	DNEL	Long term Dermal	0.035 mg/cm²	Workers	Local
	DNEL	Long term Inhalation	0.05 mg/m³	Workers	Systemic
nickel monoxide	DNEL	Long term Dermal	0.012 mg/cm²	Workers	Local
	DNEL	Long term Inhalation	0.05 mg/m³	Workers	Systemic

PNECs

SECTION 8: Exposure controls/personal protection

Product/ingredient name	Type	Compartment Detail	Value	Method Detail
nickel	-	Fresh water	0.0071 mg/l	Assessment Factors
	-	Marine water	0.0086 mg/l	Assessment Factors
	-	Soil	29.9 mg/kg	Assessment Factors
	-	Sewage Treatment Plant	0.033 mg/l	Assessment Factors
nickel monoxide	-	Fresh water	7.1 µg/l	Assessment Factors
	-	Marine water	8.6 µg/l	Assessment Factors
	-	Soil	29.9 mg/kg dwt	Assessment Factors
	-	Sewage Treatment Plant	0.33 mg/l	Assessment Factors
	-	Fresh water sediment	109 mg/kg dwt	Assessment Factors
	-	Marine water sediment	109 mg/kg dwt	Assessment Factors

8.2 Exposure controls

Appropriate engineering controls : If user operations generate dust, fumes, gas, vapour or mist, use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

General information : All personal protective equipment (PPE) should be selected and used under the direction of a trained health and safety professional. PPE should be in compliance with any relevant local or national standard. Where no local or national standards apply, compliance with the relevant EU standard is recommended.
It remains the responsibility of the user to ensure that this product is used safely within the context of their site conditions.

Eye/face protection : Safety eyewear complying with an approved standard (EN 166 or local equivalent) is required during loading and unloading of reactors, cleaning and maintenance operations, and sampling, where exposure to dust, powder or liquid splashes is possible.

Skin protection

Hand protection : Chemical/bio-chemical resistant, impervious gloves complying with an approved chemical standard (EN 374 or local equivalent) should be worn at all times when handling chemical products. For tasks involving physical or mechanical hazards, gloves should also comply with an approved physical standard (EN 388 or local equivalent).
Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties.
In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Safety shoes complying with an approved standard (EN 20346 or equivalent) and a hard hat complying with an approved standard (EN 297 or equivalent) is required during loading and unloading of reactors, cleaning and maintenance operations and sampling.

SECTION 8: Exposure controls/personal protection

Other skin protection : A protective suit complying with an approved standard (EN 13982-1 Type 5 or equivalent) should be worn during loading and unloading or reactors, sampling and cleaning and maintenance operations where dermal contact is possible.

Respiratory protection : Use of Respiratory Protective Equipment (RPE) (Particle filter with high efficiency for solid particles (EN 143 or 149, Type P3 or FFP3, Associated Protection Factor (APF) = 20) or local equivalent as a minimum) is required during loading and unloading of reactors, cleaning and maintenance operations, and sampling, where exposure to dust or powder is possible. Air-fed Respiratory Protective Equipment may be used if entry to the reactor is required.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

SECTION 9: Physical and chemical properties

9.1 Information on basic physical and chemical properties

Appearance	
Physical state	: Solid. [4-hole pellets]
Colour	: Dark grey.
Odour	: Odourless.
Odour threshold	: Not applicable.
pH	: Not applicable.
Melting point/freezing point	: Not determined.
Initial boiling point and boiling range	: Not applicable.
Flash point	: Not applicable.
Evaporation rate (butyl acetate = 1)	: Not applicable.
Flammability (solid, gas)	: Not classified.
Upper/lower flammability or explosive limits	: Not applicable.
Vapour pressure (mm Hg)	: Not applicable.
Vapour density	: Not applicable.
Relative density	: Not applicable.
Bulk Density (g/ml)	: 1.1
Solubility(ies)	: Soluble in the following materials: strong acids
Solubility - Water	: insoluble in water.
Partition coefficient: n-octanol/water	: Not applicable.
Auto-ignition temperature	: Not applicable.
Decomposition temperature	: Not available.
Viscosity (m.Pa.s)	: Not applicable.
Explosive properties	: Not available.

SECTION 9: Physical and chemical properties

Oxidising properties : Not available.

9.2 Other information

No additional information.

SECTION 10: Stability and reactivity

10.1 Reactivity

No specific test data related to reactivity available for this product or its ingredients.

10.2 Chemical stability

The product is stable.

10.3 Possibility of hazardous reactions

Under normal conditions of storage and use, hazardous reactions will not occur.

See Process Hazards section for hazards associated with the discharged material resulting from its intended use.

10.4 Conditions to avoid

In case of fire, or under certain conditions of low temperature and high pressure in the presence of carbon monoxide, metallic nickel can form nickel carbonyl.

10.5 Incompatible materials

No specific data.

10.6 Hazardous decomposition products

Under normal conditions of storage and use, hazardous decomposition products should not be produced.

SECTION 11: Toxicological information

11.1 Information on toxicological effects

Acute toxicity

Conclusion/Summary : Not classified.

Acute toxicity estimates

Route	ATE value
Not available.	

Irritation/Corrosion

Conclusion/Summary

Skin : Not classified.
Eyes : Not classified.
Respiratory : Not classified.

Sensitiser

SECTION 11: Toxicological information

Product/ingredient name	Route of exposure	Species	Result
KATALCO 23-4HQR	skin	Guinea pig	Not sensitizing

Conclusion/Summary

Skin : By analogy with similar preparations this material is unlikely to be a skin sensitiser.

Respiratory : Not classified.

Mutagenicity

Conclusion/Summary : Not classified.

Carcinogenicity

Conclusion/Summary : May cause cancer by inhalation.

Reproductive toxicity

Conclusion/Summary : Not classified.

Teratogenicity

Conclusion/Summary : Not classified.

Specific target organ toxicity (single exposure)

Not available.

Specific target organ toxicity (repeated exposure)

Product/ingredient name	Category	Route of exposure	Target organs
KATALCO 23-4HQR	Category 1	Inhalation	lungs and respiratory tract
nickel	Category 1	Inhalation	respiratory tract
nickel monoxide	Category 1	Inhalation	lungs

Aspiration hazard

Not applicable.

Information on likely routes of exposure : Routes of entry anticipated: Dermal, Inhalation.

Potential acute health effects

Inhalation : Unlikely to be hazardous by inhalation unless present as a dust. High concentrations of dust may be irritant to the upper respiratory tract. Dust may enter the lung and be slow to clear.

Ingestion : Ingestion may cause irritation of the gastrointestinal tract.

Skin contact : Repeated or prolonged skin contact may cause irritation. May cause physical abrasion in contact with skin.

Eye contact : Dust may cause irritation to eyes.

Symptoms related to the physical, chemical and toxicological characteristics

Inhalation : No specific data.

Ingestion : No specific data.

Skin contact : No specific data.

Eye contact : No specific data.

SECTION 11: Toxicological information

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Conclusion/Summary : Causes damage to organs through prolonged or repeated exposure if inhaled.

General : Causes damage to organs through prolonged or repeated exposure if inhaled.

Carcinogenicity : May cause cancer by inhalation. Risk of cancer depends on duration and level of exposure.

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Other information : Not available.

SECTION 12: Ecological information

12.1 Toxicity

Conclusion/Summary : Not classified.

12.2 Persistence and degradability

Conclusion/Summary : The bioaccumulative criteria are not applicable to essential metals.

12.3 Bioaccumulative potential

Not available.

12.4 Mobility in soil

Soil/water partition coefficient (K_{OC}) : Not available.

Mobility : Not available.

12.5 Results of PBT and vPvB assessment

PBT : Not applicable.

vPvB : Not applicable.

12.6 Other adverse effects

SECTION 12: Ecological information

No known significant effects or critical hazards.

SECTION 13: Disposal considerations

Used material may have different hazards or properties from the new material. This safety data sheet does not apply to the used material.

In all cases where a EWC code is given, this applies to the material under normal conditions of use and may not be appropriate for used material where the properties may have changed. It is the responsibility of the user to check that any waste code recommendation is appropriate to their material in accordance with the recommendation of the European Waste Catalogue.

13.1 Waste treatment methods

Product

Methods of disposal : The generation of waste should be avoided or minimised wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction.

Dispose of through the metal recovery industry.

Container information: : Since the emptied container retains product residue, follow label warnings even after it has been emptied.

Hazardous waste : The classification of the product may meet the criteria for a hazardous waste.

European waste catalogue (EWC) : The user should assign a waste code to the material in accordance with the recommendations of the European Waste Catalogue.

Packaging

Methods of disposal : The generation of waste should be avoided or minimised wherever possible. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible.

Special precautions : This material and its container must be disposed of in a safe way. Care should be taken when handling emptied containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers.

SECTION 14: Transport information

	ADR/RID	ADN	IMDG	IATA
14.1 UN number	Not regulated.	Not regulated.	Not regulated.	Not regulated.
14.2 UN proper shipping name	-	-	-	-
14.3 Transport hazard class (es)	-	-	-	-
14.4 Packing group	-	-	-	-

SECTION 14: Transport information

14.5 Environmental hazards	No.	No.	No.	No.

14.6 Special precautions for user : Not applicable.

14.7 Transport in bulk according to Annex II of Marpol and the IBC Code : Not available.

SECTION 15: Regulatory information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

EU Regulation (EC) No. 1907/2006 (REACH)

Annex XIV - List of substances subject to authorisation

Annex XIV

None of the components are listed.

Substances of very high concern

None of the components are listed.

Annex XVII - Restrictions on the manufacture, placing on the market and use of certain dangerous substances, mixtures and articles : Restricted to professional users.

Other EU regulations

Industrial emissions (integrated pollution prevention and control) - Air : Listed

Industrial emissions (integrated pollution prevention and control) - Water : Listed

Product/ingredient name	Carcinogenic effects	Mutagenic effects	Developmental effects	Fertility effects
nickel	Carc. 2, H351 (inhalation)	-	-	-
nickel monoxide	Carc. 1A, H350i (inhalation)	-	-	-

Ozone depleting substances (1005/2009/EU)

Not listed.

Prior Informed Consent (PIC) (649/2012/EU)

Not listed.

National regulations

SECTION 15: Regulatory information

Product/ingredient name	List name	Name on list	Classification	Notes
nickel monoxide	UK Occupational Exposure Limits EH40 - WEL	inorganic nickel compounds Insoluble in water Except nickel carbonyl	Carc.	-

International regulations

Chemical Weapon Convention List Schedules I, II & III Chemicals

Ingredient name	List name	Status
Not listed.		

Montreal Protocol (Annexes A, B, C, E)

Ingredient name	Status
Not listed.	

Stockholm Convention on Persistent Organic Pollutants

Ingredient name	List name	Status
Not listed.		

Rotterdam Convention on Prior Informed Consent (PIC)

Ingredient name	Status
Not listed.	

UNECE Aarhus Protocol on POPs and Heavy Metals

Ingredient name	List name	Status
Not listed.		

International lists

Inventory list

Australia : All components are listed or exempted.
Canada : All components are listed or exempted.
China : All components are listed or exempted.
Europe : All components are listed or exempted.
Japan : **Japan inventory (ENCS)**: All components are listed or exempted.
Japan inventory (ISHL): All components are listed or exempted.
Malaysia : At least one component is not listed.
New Zealand : All components are listed or exempted.
Philippines : All components are listed or exempted.
Republic of Korea : All components are listed or exempted.
Taiwan : All components are listed or exempted.
Thailand : Not determined.
Turkey : All components are listed or exempted.
United States : All components are listed or exempted.
Viet Nam : Not determined.

15.2 Chemical safety assessment

This product contains substances for which Chemical Safety Assessments are still required.

SECTION 16: Other information

Indicates information that has changed from previously issued version.

Abbreviations and acronyms : ATE = Acute Toxicity Estimate
CLP = Classification, Labelling and Packaging Regulation [Regulation (EC) No. 1272/2008]
DNEL = Derived No Effect Level
EUH statement = CLP-specific Hazard statement
PNEC = Predicted No Effect Concentration
RRN = REACH Registration Number

Procedure used to derive the classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]

Classification	Justification
Carc. 1A, H350i (inhalation) STOT RE 1, H372 (lungs, respiratory tract) (inhalation)	According to package According to package

Full text of abbreviated H statements

H317	May cause an allergic skin reaction.
H350i (inhalation)	May cause cancer by inhalation.
H351 (inhalation)	Suspected of causing cancer if inhaled.
H372 (lungs and respiratory tract) (inhalation)	Causes damage to organs through prolonged or repeated exposure if inhaled. (lungs and respiratory tract)
H372 (lungs) (inhalation)	Causes damage to organs through prolonged or repeated exposure if inhaled. (lungs)
H372 (respiratory tract) (inhalation)	Causes damage to organs through prolonged or repeated exposure if inhaled. (respiratory tract)
H412	Harmful to aquatic life with long lasting effects.
H413	May cause long lasting harmful effects to aquatic life.

Full text of classifications [CLP/GHS]

Aquatic Chronic 3, H412	LONG-TERM (CHRONIC) AQUATIC HAZARD - Category 3
Aquatic Chronic 4, H413	LONG-TERM (CHRONIC) AQUATIC HAZARD - Category 4
Carc. 1A, H350i (inhalation)	CARCINOGENICITY (inhalation) - Category 1A
Carc. 2, H351 (inhalation)	CARCINOGENICITY (inhalation) - Category 2
Skin Sens. 1, H317	SKIN SENSITISATION - Category 1
STOT RE 1, H372 (lungs and respiratory tract) (inhalation)	SPECIFIC TARGET ORGAN TOXICITY - REPEATED EXPOSURE (lungs and respiratory tract) (inhalation) - Category 1
STOT RE 1, H372 (lungs) (inhalation)	SPECIFIC TARGET ORGAN TOXICITY - REPEATED EXPOSURE (lungs) (inhalation) - Category 1
STOT RE 1, H372 (respiratory tract) (inhalation)	SPECIFIC TARGET ORGAN TOXICITY - REPEATED EXPOSURE (respiratory tract) (inhalation) - Category 1

Notice to reader

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It is the policy of Johnson Matthey to update this information regularly. You are therefore advised to check that this sheet is the most recent issue.

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SECTION 16: Other information

Johnson Matthey
Inspiring science, enhancing life

SAFETY DATA SHEET

Conforms to Regulation (EC) No. 1907/2006 (REACH), Annex II (including amendments) - United Kingdom (UK)

KATALCO 28-4Q

Version	:	1
Date of issue/ Date of revision	:	12/06/2018
Date of previous issue	:	No previous validation

SECTION 1: Identification of the substance/mixture and of the company/ undertaking

1.1 Product identifier

Product identifier	:	**KATALCO™** 28-4Q
Product type	:	Solid.
Product definition	:	Mixture Classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]

1.2 Relevant identified uses of the substance or mixture and uses advised against

Specific uses	:	Catalyst for steam reforming of hydrocarbons

1.3 Details of the supplier of the safety data sheet

Supplier	:	Johnson Matthey PO Box No 1,Belasis Avenue, Billingham, Stockton on Tees, TS23 1LB, UK +44 (0) 1642 523343
e-mail address of person responsible for this SDS	:	jmsds1@matthey.com

1.4 Emergency telephone number

For Chemical Emergency ONLY (spill, leak, fire, exposure or accident) call :

Emergency telephone number (with hours of operation)	:	+44 (0) 870 8200418 CHEMTREC UK (London)	(24 hours)
		+(1) 703-527-3887 CHEMTREC International	(24 hours)
Country information	:	000-800-100-7141 CHEMTREC India (local)	(24 hours)
Information limitations	:	For emergency calls only. Non-emergency calls cannot be serviced at this number.	
CHEMTREC Customer Number (CCN)	:	CCN12026	

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

By analogy with similar mixtures this material is unlikely to be a skin sensitiser.

Product definition : Mixture

Classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]

Carc. 1A, H350i (inhalation)
STOT RE 1, H372 (lungs) (inhalation)

The product is classified as hazardous according to Regulation (EC) 1272/2008 as amended.

See Section 16 for the full text of the H statements declared above.

See Section 11 for more detailed information on health effects and symptoms.

2.2 Label elements

Hazard pictograms :

Signal word : Danger

Hazard statements : May cause cancer by inhalation.
Causes damage to organs through prolonged or repeated exposure if inhaled. (lungs)

Precautionary statements

Prevention : Obtain special instructions before use. Do not breathe dust. Wear protective gloves/clothing and eye/face protection.

Response : Get medical attention if you feel unwell. IF exposed or concerned: Get medical attention.

Storage : Not applicable.

Disposal : Dispose of contents and container in accordance with all local, regional, national and international regulations.

Supplemental label elements : Contains nickel monoxide. May produce an allergic reaction.

Annex XVII - Restrictions on the manufacture, placing on the market and use of certain dangerous substances, mixtures and articles : Restricted to professional users.

Special packaging requirements

Containers to be fitted with child-resistant fastenings : Not applicable.

Tactile warning of danger : Not applicable.

2.3 Other hazards

Other hazards which do not result in classification : None known.

SECTION 3: Composition/information on ingredients

3.2 Mixtures

Substance/mixture : Mixture

Product/ ingredient name	Identifiers	%	Regulation (EC) No. 1272/2008 [CLP]	Type
aluminium oxide	REACH #: 01-2119529248-35 EC: 215-691-6 CAS: 1344-28-1	≥75 - ≤90	Not classified.	[2]
nickel monoxide	REACH #: 01-2119467172-41 EC: 215-215-7 CAS: 1313-99-1 Index: 028-003-00-2	≥10 - <25	Skin Sens. 1, H317 Carc. 1A, H350i (inhalation) STOT RE 1, H372 (lungs) (inhalation) Aquatic Chronic 4, H413 **See Section 16 for the full text of the H statements declared above.**	[1] [2]

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment, are PBTs or vPvBs or have been assigned a workplace exposure limit and hence require reporting in this section.

Type

[1] Substance classified with a health or environmental hazard
[2] Substance with a workplace exposure limit
[3] Substance meets the criteria for PBT according to Regulation (EC) No. 1907/2006, Annex XIII
[4] Substance meets the criteria for vPvB according to Regulation (EC) No. 1907/2006, Annex XIII
[5] Substance of equivalent concern
[6] Additional disclosure due to company policy

Occupational exposure limits, if available, are listed in Section 8.

SECTION 4: First aid measures

4.1 Description of first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Continue to rinse for at least 10 minutes. Get medical attention.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Get medical attention. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Skin contact : Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Wash contaminated clothing thoroughly with water before removing it, or wear gloves. Continue to rinse for at least 10 minutes. Get medical attention. Wash clothing before reuse. Clean shoes thoroughly before reuse.

SECTION 4: First aid measures

Ingestion : Wash out mouth with water. Remove dentures if any. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. Stop if the exposed person feels sick as vomiting may be dangerous. Do not induce vomiting unless directed to do so by medical personnel. If vomiting occurs, the head should be kept low so that vomit does not enter the lungs. Get medical attention. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Wash contaminated clothing thoroughly with water before removing it, or wear gloves.

4.2 Most important symptoms and effects, both acute and delayed

Potential acute health effects

Inhalation : Unlikely to be hazardous by inhalation unless present as a dust. High concentrations of dust may be irritant to the upper respiratory tract. Dust may enter the lung and be slow to clear.

Ingestion : Ingestion may cause irritation of the gastrointestinal tract.

Skin contact : Repeated or prolonged skin contact may cause irritation. May cause physical abrasion in contact with skin.

Eye contact : Dust may cause irritation to eyes.

Over-exposure signs/symptoms

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Ingestion : No specific data.

4.3 Indication of any immediate medical attention and special treatment needed

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

SECTION 5: Firefighting measures

5.1 Extinguishing media

Suitable extinguishing media : Use an extinguishing agent suitable for the surrounding fire.

Unsuitable extinguishing media : None known.

5.2 Special hazards arising from the substance or mixture

Hazards from the substance or mixture : No specific fire or explosion hazard.

SECTION 5: Firefighting measures

Hazardous combustion products : Decomposition products may include the following materials: metal oxide/oxides

5.3 Advice for firefighters

Special precautions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode. Clothing for fire-fighters (including helmets, protective boots and gloves) conforming to European standard EN 469 will provide a basic level of protection for chemical incidents.

Additional information : Discharged material may be pyrophoric (see Process Hazards).

SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilt material. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

For emergency responders : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

6.2 Environmental precautions

Environmental precautions : Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

6.3 Methods and material for containment and cleaning up

Small spill : Move containers from spill area. Avoid dust generation. Do not dry sweep. Vacuum dust with equipment fitted with a HEPA filter and place in a closed, labelled waste container. Dispose of via a licensed waste disposal contractor.

Large spill : Move containers from spill area. Approach the release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Avoid dust generation. Do not dry sweep. Vacuum dust with equipment fitted with a HEPA filter and place in a closed, labelled waste container. Dispose of via a licensed waste disposal contractor.

6.4 Reference to other sections

See Section 1 for emergency contact information.
See Section 8 for information on appropriate personal protective equipment.
See Section 13 for additional waste treatment information.

SECTION 7: Handling and storage

7.1 Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8). Avoid exposure - obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Do not get in eyes or on skin or clothing. Do not ingest. If during normal use the material presents a respiratory hazard, use only with adequate ventilation or wear appropriate respirator. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Empty containers retain product residue and can be hazardous. Do not reuse container.

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Process hazards : Following activation in a reducing environment the material should be regarded as pyrophoric. Pyrophoric and self-heating materials can act as sources of ignition and should be kept away from combustible materials. As a minimum, water hoses should be available to cool the material. The action of water on the material may result in the evolution of small quantities of hydrogen. The material should not be exposed to gases containing carbon monoxide at temperatures between 50 deg C and 200 deg C because of the danger of formation of nickel carbonyl under these conditions.

7.2 Conditions for safe storage, including any incompatibilities

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a dry place. Keep only in the original container. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabelled containers. Use appropriate containment to avoid environmental contamination. Store away from incompatible materials (see Section 10). See Section 10 for incompatible materials before handling or use.

Additional information : Further advice given in the Johnson Matthey publication 'Catalyst Handling'.

7.3 Specific end use(s)

Recommendations : Not available.

Industrial sector specific solutions : Not available.

SECTION 8: Exposure controls/personal protection

The information in this section contains generic advice and guidance. Information is provided based on typical anticipated uses of the product. Additional measures might be required for bulk handling or other uses that could significantly increase worker exposure or environmental releases.

8.1 Control parameters

Occupational exposure limits

SECTION 8: Exposure controls/personal protection

Product/ingredient name	Exposure limit values
aluminium oxide	**EH40/2005 WELs (United Kingdom (UK), 12/2011).** TWA: 10 mg/m³ 8 hours. Form: inhalable dust
nickel monoxide	**EH40/2005 WELs (United Kingdom (UK), 12/2011). Absorbed through skin. Inhalation sensitiser.** TWA: 0.5 mg/m³, (as Ni) 8 hours.
Inhalable fraction	***[Air contaminant]*** **EH40/2005 WELs (United Kingdom (UK)).** TWA: 10 mg/m³ 8 hours.
Respirable dust	***[Air contaminant]*** **EH40/2005 WELs (United Kingdom (UK)).** TWA: 4 mg/m³ 8 hours.

Recommended monitoring procedures : If this product contains ingredients with exposure limits, personal, workplace atmosphere or biological monitoring may be required to determine the effectiveness of the ventilation or other control measures and/or the necessity to use respiratory protective equipment. Reference should be made to monitoring standards, such as the following: European Standard EN 689 (Workplace atmospheres - Guidance for the assessment of exposure by inhalation to chemical agents for comparison with limit values and measurement strategy) European Standard EN 14042 (Workplace atmospheres - Guide for the application and use of procedures for the assessment of exposure to chemical and biological agents) European Standard EN 482 (Workplace atmospheres - General requirements for the performance of procedures for the measurement of chemical agents) Reference to national guidance documents for methods for the determination of hazardous substances will also be required.

DNELs/DMELs

Product/ingredient name	Type	Exposure	Value	Population	Effects
nickel monoxide	DNEL	Long term Dermal	0.012 mg/cm²	Workers	Local
	DNEL	Long term Inhalation	0.05 mg/m³	Workers	Systemic

PNECs

Product/ingredient name	Type	Compartment Detail	Value	Method Detail
nickel monoxide	-	Fresh water	7.1 µg/l	Assessment Factors
	-	Marine water	8.6 µg/l	Assessment Factors
	-	Soil	29.9 mg/kg dwt	Assessment Factors
	-	Sewage Treatment Plant	0.33 mg/l	Assessment Factors
	-	Fresh water sediment	109 mg/kg dwt	Assessment Factors
	-	Marine water sediment	109 mg/kg dwt	Assessment Factors

8.2 Exposure controls

Appropriate engineering controls : If user operations generate dust, fumes, gas, vapour or mist, use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits.

Individual protection measures

SECTION 8: Exposure controls/personal protection

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

General information : All personal protective equipment (PPE) should be selected and used under the direction of a trained health and safety professional. PPE should be in compliance with any relevant local or national standard. Where no local or national standards apply, compliance with the relevant EU standard is recommended.
It remains the responsibility of the user to ensure that this product is used safely within the context of their site conditions.

Eye/face protection : Safety eyewear complying with an approved standard (EN 166 or local equivalent) is required during loading and unloading of reactors, cleaning and maintenance operations, and sampling, where exposure to dust, powder or liquid splashes is possible.

Skin protection

Hand protection : Chemical/bio-chemical resistant, impervious gloves complying with an approved chemical standard (EN 374 or local equivalent) should be worn at all times when handling chemical products. For tasks involving physical or mechanical hazards, gloves should also comply with an approved physical standard (EN 388 or local equivalent).
Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Safety shoes complying with an approved standard (EN 20346 or equivalent) and a hard hat complying with an approved standard (EN 297 or equivalent) is required during loading and unloading of reactors, cleaning and maintenance operations and sampling.

Other skin protection : A protective suit complying with an approved standard (EN 13982-1 Type 5 or equivalent) should be worn during loading and unloading or reactors, sampling and cleaning and maintenance operations where dermal contact is possible.

Respiratory protection : Use of Respiratory Protective Equipment (RPE) (Particle filter with high efficiency for solid particles (EN 143 or 149, Type P3 or FFP3, Associated Protection Factor (APF) = 20) or local equivalent as a minimum) is required during loading and unloading of reactors, cleaning and maintenance operations, and sampling, where exposure to dust or powder is possible. Air-fed Respiratory Protective Equipment may be used if entry to the reactor is required.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

SECTION 9: Physical and chemical properties

9.1 Information on basic physical and chemical properties

Appearance		
Physical state	:	Solid. [4-hole pellets]
Colour	:	Grey.
Odour	:	Odourless.
Odour threshold	:	Not applicable.
pH	:	Not applicable.
Melting point/freezing point	:	Not determined.
Initial boiling point and boiling range	:	Not applicable.
Flash point	:	Not applicable.
Evaporation rate (butyl acetate = 1)	:	Not applicable.
Flammability (solid, gas)	:	Not classified.
Upper/lower flammability or explosive limits	:	Not applicable.
Vapour pressure (mm Hg)	:	Not applicable.
Vapour density	:	Not applicable.
Relative density	:	Not applicable.
Bulk Density (g/ml)	:	0.9 - 1.25
Solubility(ies)	:	Soluble in the following materials: strong acids
Solubility - Water	:	insoluble in water.
Partition coefficient: n-octanol/water	:	Not applicable.
Auto-ignition temperature	:	Not applicable.
Decomposition temperature	:	Not available.
Viscosity (m.Pa.s)	:	Not applicable.
Explosive properties	:	Not available.
Oxidising properties	:	Not available.

9.2 Other information

No additional information.

SECTION 10: Stability and reactivity

10.1 Reactivity

No specific test data related to reactivity available for this product or its ingredients.

10.2 Chemical stability

The product is stable.

10.3 Possibility of hazardous reactions

SECTION 10: Stability and reactivity

Under normal conditions of storage and use, hazardous reactions will not occur.

See Process Hazards section for hazards associated with the discharged material resulting from its intended use.

10.4 Conditions to avoid

No specific data.

10.5 Incompatible materials

No specific data.

10.6 Hazardous decomposition products

Under normal conditions of storage and use, hazardous decomposition products should not be produced.

SECTION 11: Toxicological information

11.1 Information on toxicological effects

Acute toxicity

Conclusion/Summary : Not classified.

Acute toxicity estimates

Route	ATE value
Not available.	

Irritation/Corrosion

Conclusion/Summary

Skin : Not classified.

Eyes : Not classified.

Respiratory : Not classified.

Sensitiser

Product/ingredient name	Route of exposure	Species	Result
KATALCO 28-4Q	skin	Guinea pig	Not sensitizing

Conclusion/Summary

Skin : By analogy with similar preparations this material is unlikely to be a skin sensitiser.

Respiratory : Not classified.

Mutagenicity

Conclusion/Summary : Not classified.

Carcinogenicity

Conclusion/Summary : May cause cancer by inhalation.

Reproductive toxicity

Conclusion/Summary : Not classified.

SECTION 11: Toxicological information

Teratogenicity

Conclusion/Summary : Not classified.

Specific target organ toxicity (single exposure)

Not available.

Specific target organ toxicity (repeated exposure)

Product/ingredient name	Category	Route of exposure	Target organs
KATALCO 28-4Q nickel monoxide	Category 1 Category 1	Inhalation Inhalation	lungs lungs

Aspiration hazard

Not applicable.

Information on likely routes of exposure : Routes of entry anticipated: Dermal, Inhalation.

Potential acute health effects

Inhalation : Unlikely to be hazardous by inhalation unless present as a dust. High concentrations of dust may be irritant to the upper respiratory tract. Dust may enter the lung and be slow to clear.

Ingestion : Ingestion may cause irritation of the gastrointestinal tract.

Skin contact : Repeated or prolonged skin contact may cause irritation. May cause physical abrasion in contact with skin.

Eye contact : Dust may cause irritation to eyes.

Symptoms related to the physical, chemical and toxicological characteristics

Inhalation : No specific data.

Ingestion : No specific data.

Skin contact : No specific data.

Eye contact : No specific data.

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Conclusion/Summary : Causes damage to organs through prolonged or repeated exposure if inhaled.

General : Causes damage to organs through prolonged or repeated exposure if inhaled.

SECTION 11: Toxicological information

Carcinogenicity	:	May cause cancer by inhalation. Risk of cancer depends on duration and level of exposure.
Mutagenicity	:	No known significant effects or critical hazards.
Teratogenicity	:	No known significant effects or critical hazards.
Developmental effects	:	No known significant effects or critical hazards.
Fertility effects	:	No known significant effects or critical hazards.
Other information	:	Not available.

SECTION 12: Ecological information

12.1 Toxicity

Conclusion/Summary : Not classified.

12.2 Persistence and degradability

Conclusion/Summary : The bioaccumulative criteria are not applicable to inorganic metals

12.3 Bioaccumulative potential

Not available.

12.4 Mobility in soil

Soil/water partition coefficient (K_{OC})	:	Not available.
Mobility	:	Not available.

12.5 Results of PBT and vPvB assessment

PBT	:	Not applicable.
vPvB	:	Not applicable.

12.6 Other adverse effects

No known significant effects or critical hazards.

SECTION 13: Disposal considerations

Used material may have different hazards or properties from the new material. This safety data sheet does not apply to the used material.

In all cases where a EWC code is given, this applies to the material under normal conditions of use and may not be appropriate for used material where the properties may have changed. It is the responsibility of the user to check that any waste code recommendation is appropriate to their material in accordance with the recommendation of the European Waste Catalogue.

13.1 Waste treatment methods

Product

SECTION 13: Disposal considerations

Methods of disposal : The generation of waste should be avoided or minimised wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction.

Dispose of through the metal recovery industry.

Container information: : Since the emptied container retains product residue, follow label warnings even after it has been emptied.

Hazardous waste : The classification of the product may meet the criteria for a hazardous waste.

European waste catalogue (EWC) : The user should assign a waste code to the material in accordance with the recommendations of the European Waste Catalogue.

Packaging

Methods of disposal : The generation of waste should be avoided or minimised wherever possible. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible.

Special precautions : This material and its container must be disposed of in a safe way. Care should be taken when handling emptied containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers.

SECTION 14: Transport information

	ADR/RID	ADN	IMDG	IATA
14.1 UN number	Not regulated.	Not regulated.	Not regulated.	Not regulated.
14.2 UN proper shipping name	-	-	-	-
14.3 Transport hazard class (es)	-	-	-	-
14.4 Packing group	-	-	-	-
14.5 Environmental hazards	No.	No.	No.	No.

14.6 Special precautions for user : Not applicable

14.7 Transport in bulk according to Annex II of Marpol and the IBC Code : Not available.

SECTION 14: Transport information

SECTION 15: Regulatory information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

EU Regulation (EC) No. 1907/2006 (REACH)

Annex XIV - List of substances subject to authorisation

Annex XIV

None of the components are listed.

Substances of very high concern

None of the components are listed.

Annex XVII - Restrictions on the manufacture, placing on the market and use of certain dangerous substances, mixtures and articles : Restricted to professional users.

Other EU regulations

Product/ingredient name	Carcinogenic effects	Mutagenic effects	Developmental effects	Fertility effects
nickel monoxide	Carc. 1A, H350i (inhalation)	-	-	-

Ozone depleting substances (1005/2009/EU)

Not listed.

Prior Informed Consent (PIC) (649/2012/EU)

Not listed.

National regulations

Product/ingredient name	List name	Name on list	Classification	Notes
nickel monoxide	UK Occupational Exposure Limits EH40 - WEL	inorganic nickel compounds Insoluble in water Except nickel carbonyl	Carc.	-

International regulations

Chemical Weapon Convention List Schedules I, II & III Chemicals

Ingredient name	List name	Status
Not listed.		

Montreal Protocol (Annexes A, B, C, E)

Ingredient name	Status
Not listed.	

Stockholm Convention on Persistent Organic Pollutants

Ingredient name	List name	Status
Not listed.		

SECTION 15: Regulatory information

Rotterdam Convention on Prior Informed Consent (PIC)

Ingredient name	Status
Not listed.	

UNECE Aarhus Protocol on POPs and Heavy Metals

Ingredient name	List name	Status
Not listed.		

International lists

Inventory list

Australia : All components are listed or exempted.

Canada : All components are listed or exempted.

China : All components are listed or exempted.

Europe : All components are listed or exempted.

Japan : **Japan inventory (ENCS)**: All components are listed or exempted.
Japan inventory (ISHL): All components are listed or exempted.

Malaysia : At least one component is not listed.

New Zealand : All components are listed or exempted.

Philippines : All components are listed or exempted.

Republic of Korea : All components are listed or exempted.

Taiwan : All components are listed or exempted.

Thailand : Not determined.

Turkey : All components are listed or exempted.

United States : All components are listed or exempted.

Viet Nam : Not determined.

15.2 Chemical safety assessment

Chemical Safety Assessments for all substances in this product are either Complete or Not applicable.

SECTION 16: Other information

Indicates information that has changed from previously issued version.

Abbreviations and acronyms : ATE = Acute Toxicity Estimate
CLP = Classification, Labelling and Packaging Regulation [Regulation (EC) No. 1272/2008]
DNEL = Derived No Effect Level
EUH statement = CLP-specific Hazard statement
PNEC = Predicted No Effect Concentration
RRN = REACH Registration Number

Procedure used to derive the classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]

Classification	Justification
Carc. 1A, H350i (inhalation) STOT RE 1, H372 (lungs) (inhalation)	According to package According to package

Full text of abbreviated H statements

SECTION 16: Other information

H317 H350i (inhalation) H372 (lungs) (inhalation) H413	May cause an allergic skin reaction. May cause cancer by inhalation. Causes damage to organs through prolonged or repeated exposure if inhaled. (lungs) May cause long lasting harmful effects to aquatic life.

Full text of classifications [CLP/GHS]

Aquatic Chronic 4, H413 Carc. 1A, H350i (inhalation) Skin Sens. 1, H317 STOT RE 1, H372 (lungs) (inhalation)	LONG-TERM (CHRONIC) AQUATIC HAZARD - Category 4 CARCINOGENICITY (inhalation) - Category 1A SKIN SENSITISATION - Category 1 SPECIFIC TARGET ORGAN TOXICITY - REPEATED EXPOSURE (lungs) (inhalation) - Category 1

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Inspiring science, enhancing life

SAFETY DATA SHEET

Conforms to Regulation (EC) No. 1907/2006 (REACH), Annex II (including amendments) - United Kingdom (UK)

KATALCO 79-1

Version	:	1
Date of issue/ Date of revision	:	20/07/2018
Date of previous issue	:	No previous validation

SECTION 1: Identification of the substance/mixture and of the company/ undertaking

1.1 Product identifier

Product identifier	:	**KATALCO™** 79-1
Product type	:	Solid.
Product definition	:	Mixture Classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]

1.2 Relevant identified uses of the substance or mixture and uses advised against

Specific uses	:	Gas purification

1.3 Details of the supplier of the safety data sheet

Supplier	:	Johnson Matthey PO Box No 1,Belasis Avenue, Billingham, Stockton on Tees, TS23 1LB, UK +44 (0) 1642 523343
e-mail address of person responsible for this SDS	:	jmsds1@matthey.com

1.4 Emergency telephone number

For Chemical Emergency ONLY (spill, leak, fire, exposure or accident) call :

Emergency telephone number (with hours of operation)	:	+44 (0) 870 8200418 CHEMTREC UK (London)	(24 hours)
		+(1) 703-527-3887 CHEMTREC International	(24 hours)
Country information	:	000-800-100-7141 CHEMTREC India (local)	(24 hours)
Information limitations	:	For emergency calls only. Non-emergency calls cannot be serviced at this number.	
CHEMTREC Customer Number (CCN)	:	CCN12026	

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

By analogy with similar preparations this material is unlikely to be a skin sensitiser.

Product definition : Mixture

Classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]

Carc. 1A, H350i (inhalation)
STOT RE 2, H373 (lungs) (inhalation)
Aquatic Acute 1, H400
Aquatic Chronic 1, H410

The product is classified as hazardous according to Regulation (EC) 1272/2008 as amended.

See Section 16 for the full text of the H statements declared above.

See Section 11 for more detailed information on health effects and symptoms.

2.2 Label elements

Hazard pictograms :

Signal word : Danger

Hazard statements : May cause cancer by inhalation.
May cause damage to organs through prolonged or repeated exposure if inhaled. (lungs)
Very toxic to aquatic life with long lasting effects.

Precautionary statements

Prevention : Obtain special instructions before use. Avoid release to the environment. Do not breathe dust. Wear protective gloves/clothing and eye/face protection.

Response : Get medical attention if you feel unwell. IF exposed or concerned: Get medical attention.

Storage : Not applicable.

Disposal : Dispose of contents and container in accordance with all local, regional, national and international regulations.

Supplemental label elements : Contains nickel monoxide. May produce an allergic reaction.

Annex XVII - Restrictions on the manufacture, placing on the market and use of certain dangerous substances, mixtures and articles : Restricted to professional users.

Special packaging requirements

Containers to be fitted with child-resistant fastenings : Not applicable.

Tactile warning of danger : Not applicable.

2.3 Other hazards

SECTION 2: Hazards identification

Other hazards which do not result in classification : None known.

SECTION 3: Composition/information on ingredients

3.2 Mixtures

Substance/mixture : Mixture

Product/ ingredient name	Identifiers	%	Regulation (EC) No. 1272/2008 [CLP]	Type
zinc oxide	REACH #: 01-2119463881-32 EC: 215-222-5 CAS: 1314-13-2 Index: 030-013-00-7	≥75 - ≤90	Aquatic Acute 1, H400 (M=1) Aquatic Chronic 1, H410 (M=1)	[1]
copper oxide	REACH #: 01-2119502447-44 EC: 215-269-1 CAS: 1317-38-0	≤5	Aquatic Acute 1, H400 (M=100) Aquatic Chronic 1, H410 (M=1)	[1] [2]
nickel monoxide	REACH #: 01-2119467172-41 EC: 215-215-7 CAS: 1313-99-1 Index: 028-003-00-2	≤5	Skin Sens. 1, H317 Carc. 1A, H350i (inhalation) STOT RE 1, H372 (lungs) (inhalation) Aquatic Chronic 4, H413 **See Section 16 for the full text of the H statements declared above.**	[1] [2]

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment, are PBTs or vPvBs or have been assigned a workplace exposure limit and hence require reporting in this section.

Type

[1] Substance classified with a health or environmental hazard
[2] Substance with a workplace exposure limit
[3] Substance meets the criteria for PBT according to Regulation (EC) No. 1907/2006, Annex XIII
[4] Substance meets the criteria for vPvB according to Regulation (EC) No. 1907/2006, Annex XIII
[5] Substance of equivalent concern
[6] Additional disclosure due to company policy

Occupational exposure limits, if available, are listed in Section 8.

SECTION 4: First aid measures

4.1 Description of first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Continue to rinse for at least 10 minutes. Get medical attention.

SECTION 4: First aid measures

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Get medical attention. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Skin contact : Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Wash contaminated clothing thoroughly with water before removing it, or wear gloves. Continue to rinse for at least 10 minutes. Get medical attention. Wash clothing before reuse. Clean shoes thoroughly before reuse.

Ingestion : Wash out mouth with water. Remove dentures if any. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. Stop if the exposed person feels sick as vomiting may be dangerous. Do not induce vomiting unless directed to do so by medical personnel. If vomiting occurs, the head should be kept low so that vomit does not enter the lungs. Get medical attention. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Wash contaminated clothing thoroughly with water before removing it, or wear gloves.

4.2 Most important symptoms and effects, both acute and delayed

Potential acute health effects

Inhalation : Unlikely to be hazardous by inhalation unless present as a dust. High concentrations of dust may be irritant to the upper respiratory tract. Dust may enter the lung and be slow to clear. In the metals industry, high concentrations of very finely divided dust containing copper and/or zinc compounds have been known to produce the symptoms of metal fume fever. This condition is characterised by influenza type symptoms occurring a few hours after exposure and lasting for up to 48 hours. However, the handling and use of this product in line with Section 7 is not expected to pose such a risk.

Ingestion : Ingestion may cause irritation of the gastrointestinal tract.

Skin contact : Repeated or prolonged skin contact may cause irritation. May cause physical abrasion in contact with skin.

Eye contact : Dust may cause irritation to eyes.

Over-exposure signs/symptoms

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Ingestion : No specific data.

SECTION 4: First aid measures

4.3 Indication of any immediate medical attention and special treatment needed

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

SECTION 5: Firefighting measures

5.1 Extinguishing media

Suitable extinguishing media : Use an extinguishing agent suitable for the surrounding fire.

Unsuitable extinguishing media : None known.

5.2 Special hazards arising from the substance or mixture

Hazards from the substance or mixture : This material is very toxic to aquatic life with long lasting effects. Fire water contaminated with this material must be contained and prevented from being discharged to any waterway, sewer or drain.

Hazardous combustion products : Decomposition products may include the following materials: metal oxide/oxides

5.3 Advice for firefighters

Special precautions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode. Clothing for fire-fighters (including helmets, protective boots and gloves) conforming to European standard EN 469 will provide a basic level of protection for chemical incidents.

SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilt material. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

For emergency responders : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

6.2 Environmental precautions

Environmental precautions : Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air). Water polluting material. May be harmful to the environment if released in large quantities. Collect spillage.

6.3 Methods and material for containment and cleaning up

SECTION 6: Accidental release measures

Small spill : Move containers from spill area. Avoid dust generation. Do not dry sweep. Vacuum dust with equipment fitted with a HEPA filter and place in a closed, labelled waste container. Dispose of via a licensed waste disposal contractor.

Large spill : Move containers from spill area. Approach the release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Avoid dust generation. Do not dry sweep. Vacuum dust with equipment fitted with a HEPA filter and place in a closed, labelled waste container. Dispose of via a licensed waste disposal contractor.

6.4 Reference to other sections

See Section 1 for emergency contact information.
See Section 8 for information on appropriate personal protective equipment.
See Section 13 for additional waste treatment information.

SECTION 7: Handling and storage

7.1 Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8). Avoid exposure - obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Do not get in eyes or on skin or clothing. Do not ingest. Avoid release to the environment. If during normal use the material presents a respiratory hazard, use only with adequate ventilation or wear appropriate respirator. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Empty containers retain product residue and can be hazardous. Do not reuse container.

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Process hazards : Prior to discharge the material may contain residual hydrocarbons. The material should be purged free of hydrocarbons and cooled with an inert gas before it is discharged. The material may also contain deposited carbon and should be regarded as potentially pyrophoric when hot. Pyrophoric and self-heating materials can act as sources of ignition and should be kept away from combustible materials. As a minimum, water sprays should be available to cool the material.

7.2 Conditions for safe storage, including any incompatibilities

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a dry place. Keep only in the original container. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabelled containers. Use appropriate containment to avoid environmental contamination. Store away from incompatible materials (see Section 10). See Section 10 for incompatible materials before handling or use.

Additional information : Further advice given in the Johnson Matthey publication 'Catalyst Handling'.

7.3 Specific end use(s)

Recommendations : Not available.

SECTION 7: Handling and storage

Industrial sector specific solutions : Not available.

SECTION 8: Exposure controls/personal protection

The information in this section contains generic advice and guidance. Information is provided based on typical anticipated uses of the product. Additional measures might be required for bulk handling or other uses that could significantly increase worker exposure or environmental releases.

8.1 Control parameters

Occupational exposure limits

Product/ingredient name	Exposure limit values
copper oxide	**EH40/2005 WELs (United Kingdom (UK), 3/2012).** TWA: 1 mg/m³, (As Cu) 8 hours. Form: Dusts and mists STEL: 2 mg/m³, (As Cu) 15 minutes. Form: Dusts and mists
nickel monoxide	**EH40/2005 WELs (United Kingdom (UK), 12/2011). Absorbed through skin. Inhalation sensitiser.** TWA: 0.5 mg/m³, (as Ni) 8 hours.
Respirable dust	***[Air contaminant]*** **EH40/2005 WELs (United Kingdom (UK)).** TWA: 4 mg/m³ 8 hours.
Inhalable fraction	***[Air contaminant]*** **EH40/2005 WELs (United Kingdom (UK)).** TWA: 10 mg/m³ 8 hours.

Recommended monitoring procedures : If this product contains ingredients with exposure limits, personal, workplace atmosphere or biological monitoring may be required to determine the effectiveness of the ventilation or other control measures and/or the necessity to use respiratory protective equipment. Reference should be made to monitoring standards, such as the following: European Standard EN 689 (Workplace atmospheres - Guidance for the assessment of exposure by inhalation to chemical agents for comparison with limit values and measurement strategy) European Standard EN 14042 (Workplace atmospheres - Guide for the application and use of procedures for the assessment of exposure to chemical and biological agents) European Standard EN 482 (Workplace atmospheres - General requirements for the performance of procedures for the measurement of chemical agents) Reference to national guidance documents for methods for the determination of hazardous substances will also be required.

DNELs/DMELs

Product/ingredient name	Type	Exposure	Value	Population	Effects
zinc oxide	DNEL	Long term Inhalation	1 mg/m³	Workers	Systemic
	DNEL	Long term Inhalation	5 mg/m³	Workers	Systemic
	DNEL	Long term Oral	0.83 mg/kg bw/day	Workers	Systemic
	DNEL	Long term Oral	0.83 mg/kg bw/day	Workers	Systemic
	DNEL	Long term Dermal	8.3 mg/kg bw/	Workers	Systemic

SECTION 8: Exposure controls/personal protection

			day		
	DNEL	Long term Dermal	83 mg/ kg bw/ day	Workers	Systemic
copper oxide	DNEL	Long term Inhalation	1 mg/m³	Workers	Systemic
	DNEL	Long term Dermal	137 mg/ kg bw/ day	Workers	-
nickel monoxide	DNEL	Long term Dermal	0.012 mg/cm²	Workers	Local
	DNEL	Long term Inhalation	0.05 mg/ m³	Workers	Systemic

PNECs

Product/ingredient name	Type	Compartment Detail	Value	Method Detail
zinc oxide	PNEC	Fresh water	20.6 µg/l	Sensitivity Distribution
	PNEC	Marine	6.1 µg/l	Sensitivity Distribution
	PNEC	Fresh water sediment	235.6 mg/kg dwt	Sensitivity Distribution
	PNEC	Marine water sediment	113 mg/kg dwt	Sensitivity Distribution
	PNEC	Soil	106.8 mg/kg dwt	Sensitivity Distribution
	PNEC	Sewage Treatment Plant	52 µg/l	Assessment Factors
copper oxide	PNEC	Fresh water	7.8 µg/l	Assessment Factors
	PNEC	Fresh water sediment	87 mg/kg dwt	Assessment Factors
	PNEC	Sewage Treatment Plant	0.23 mg/l	Assessment Factors
	PNEC	Soil	65.5 mg/kg dwt	Assessment Factors
nickel monoxide	-	Fresh water	7.1 µg/l	Assessment Factors
	-	Marine water	8.6 µg/l	Assessment Factors
	-	Soil	29.9 mg/kg dwt	Assessment Factors
	-	Sewage Treatment Plant	0.33 mg/l	Assessment Factors
	-	Fresh water sediment	109 mg/kg dwt	Assessment Factors
	-	Marine water sediment	109 mg/kg dwt	Assessment Factors

8.2 Exposure controls

Appropriate engineering controls : If user operations generate dust, fumes, gas, vapour or mist, use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits.

Individual protection measures

SECTION 8: Exposure controls/personal protection

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

General information : All personal protective equipment (PPE) should be selected and used under the direction of a trained health and safety professional. PPE should be in compliance with any relevant local or national standard. Where no local or national standards apply, compliance with the relevant EU standard is recommended.
It remains the responsibility of the user to ensure that this product is used safely within the context of their site conditions.

Eye/face protection : Safety eyewear complying with an approved standard (EN 166 or local equivalent) is required during loading and unloading of reactors, cleaning and maintenance operations, and sampling, where exposure to dust, powder or liquid splashes is possible.

Skin protection

Hand protection : Chemical/bio-chemical resistant, impervious gloves complying with an approved chemical standard (EN 374 or local equivalent) should be worn at all times when handling chemical products. For tasks involving physical or mechanical hazards, gloves should also comply with an approved physical standard (EN 388 or local equivalent).
Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Safety shoes complying with an approved standard (EN 20346 or equivalent) and a hard hat complying with an approved standard (EN 297 or equivalent) is required during loading and unloading of reactors, cleaning and maintenance operations and sampling.

Other skin protection : A protective suit complying with an approved standard (EN 13982-1 Type 5 or equivalent) should be worn during loading and unloading or reactors, sampling and cleaning and maintenance operations where dermal contact is possible.

Respiratory protection : Use of Respiratory Protective Equipment (RPE) (Particle filter with high efficiency for solid particles (EN 143 or 149, Type P3 or FFP3, Associated Protection Factor (APF) = 20) or local equivalent as a minimum) is required during loading and unloading of reactors, cleaning and maintenance operations, and sampling, where exposure to dust or powder is possible. Air-fed Respiratory Protective Equipment may be used if entry to the reactor is required.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

SECTION 9: Physical and chemical properties

9.1 Information on basic physical and chemical properties

Appearance		
Physical state	:	Solid. [spheres]
Colour	:	Green. Grey.
Odour	:	Odourless.
Odour threshold	:	Not applicable.
pH	:	Not applicable.
Melting point/freezing point	:	Not determined.
Initial boiling point and boiling range	:	Not applicable.
Flash point	:	Not applicable.
Evaporation rate (butyl acetate = 1)	:	Not applicable.
Flammability (solid, gas)	:	Not classified.
Upper/lower flammability or explosive limits	:	Not applicable.
Vapour pressure (mm Hg)	:	Not applicable.
Vapour density	:	Not applicable.
Relative density	:	Not applicable.
Bulk Density (g/ml)	:	0.8 - 1
Solubility(ies)	:	Soluble in the following materials: strong acids
Solubility - Water	:	insoluble in water.
Partition coefficient: n-octanol/water	:	Not applicable.
Auto-ignition temperature	:	Not applicable.
Decomposition temperature	:	Not available.
Viscosity (m.Pa.s)	:	Not applicable.
Explosive properties	:	Not available.
Oxidising properties	:	Not available.

9.2 Other information

No additional information.

SECTION 10: Stability and reactivity

10.1 Reactivity

No specific test data related to reactivity available for this product or its ingredients.

10.2 Chemical stability

The product is stable.

10.3 Possibility of hazardous reactions

SECTION 10: Stability and reactivity

Under normal conditions of storage and use, hazardous reactions will not occur.

See Process Hazards section for hazards associated with the discharged material resulting from its intended use.

10.4 Conditions to avoid

No specific data.

10.5 Incompatible materials

No specific data.

10.6 Hazardous decomposition products

Under normal conditions of storage and use, hazardous decomposition products should not be produced.

SECTION 11: Toxicological information

11.1 Information on toxicological effects

Acute toxicity

Product/ingredient name	Result	Species	Dose	Exposure
zinc oxide	LC50 Inhalation Dusts and mists LD50 Oral	Rat - Male, Female Rat	5.7 mg/l Continuous >5000 mg/kg Single dose	4 hours -

Conclusion/Summary : Not classified.

Acute toxicity estimates

Route	ATE value
Not available.	

Irritation/Corrosion

Conclusion/Summary

Skin : Not classified.
Eyes : Not classified.
Respiratory : Not classified.

Sensitiser

Product/ingredient name	Route of exposure	Species	Result
zinc oxide	skin	Guinea pig	Not sensitizing

Conclusion/Summary

Skin : By analogy with similar preparations this material is unlikely to be a skin sensitiser.
Respiratory : Not classified.

Mutagenicity

SECTION 11: Toxicological information

Product/ingredient name	Test	Experiment	Result
zinc oxide	OECD 471 Bacterial Reverse Mutation Test	Experiment: In vitro Subject: Bacteria	Negative

Conclusion/Summary : Not classified.

Carcinogenicity

Conclusion/Summary : May cause cancer by inhalation.

Reproductive toxicity

Conclusion/Summary : Not classified.

Teratogenicity

Conclusion/Summary : Not classified.

Specific target organ toxicity (single exposure)

Not available.

Specific target organ toxicity (repeated exposure)

Product/ingredient name	Category	Route of exposure	Target organs
KATALCO 79-1 nickel monoxide	Category 2 Category 1	Inhalation Inhalation	lungs lungs

Aspiration hazard

Not applicable.

Information on likely routes of exposure : Routes of entry anticipated: Dermal, Inhalation.

Potential acute health effects

Inhalation : Unlikely to be hazardous by inhalation unless present as a dust. High concentrations of dust may be irritant to the upper respiratory tract. Dust may enter the lung and be slow to clear. In the metals industry, high concentrations of very finely divided dust containing copper and/or zinc compounds have been known to produce the symptoms of metal fume fever. This condition is characterised by influenza type symptoms occurring a few hours after exposure and lasting for up to 48 hours. However, the handling and use of this product in line with Section 7 is not expected to pose such a risk.

Ingestion : Ingestion may cause irritation of the gastrointestinal tract.

Skin contact : Repeated or prolonged skin contact may cause irritation. May cause physical abrasion in contact with skin.

Eye contact : Dust may cause irritation to eyes.

Symptoms related to the physical, chemical and toxicological characteristics

Inhalation : No specific data.

Ingestion : No specific data.

Skin contact : No specific data.

Eye contact : No specific data.

SECTION 11: Toxicological information

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Product/ingredient name	Result	Species	Dose	Exposure
copper oxide	Chronic NOAEL Oral	Rat	16.7 mg/kg Repeated dose	-

Conclusion/Summary : May cause damage to organs through prolonged or repeated exposure if inhaled.

General : May cause damage to organs through prolonged or repeated exposure if inhaled.

Carcinogenicity : May cause cancer by inhalation. Risk of cancer depends on duration and level of exposure.

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Other information : Not available.

SECTION 12: Ecological information

12.1 Toxicity

Product/ingredient name	Result	Species	Exposure
zinc oxide	Acute EC50 0.83 mg/l Fresh water	Daphnia - Ceriodaphnia Dubnia - Neonate	48 hours
	Acute EC50 5.2 mg/l Fresh water	Micro-organism - Activated sludge	3 hours
	Acute IC50 0.27 mg/l Fresh water	Algae - Pseudokirchnerella subcapitata - Exponential growth phase	72 hours
	Acute LC50 0.338 mg/l Fresh water	Fish - Oncorrhynchus mykiss - Juvenile (Fledgling, Hatchling, Weanling)	96 hours
	Acute NOEC 0.025 mg/l Marine water	Fish - Clupea harengus - Atlantic Herring - Embryo	27 days
	Acute NOEC 0.044 mg/l Fresh water	Fish - Lowest NOEC from 7 species	5 days (minimum)

SECTION 12: Ecological information

	Chronic NOEC 0.019 mg/l Fresh water	Algae - Pseudokirchnerella subcapitata - Exponential growth phase	72 hours
	Chronic NOEC 0.0078 mg/l Marine water	Algae - lowest NOEC from 12 species - Exponential growth phase	72 hours
	Chronic NOEC 0.037 mg/l Fresh water	Daphnia - Lowest NOEC from 13 invertebrate species	7 days (minimum)
	Chronic NOEC 0.056 mg/l Marine water	Daphnia - Lowest NOEC from 26 invertebrate species	7 days (minimum)
	Chronic NOEC 0.4 mg/l Fresh water	Daphnia - Daphnia magna - Neonate	48 hours
copper oxide	Acute LC50 25 ppb Single dose Fresh water	Daphnia	48 hours
	Chronic NOEC 7.8 ppb Fresh water	Algae	-
	Chronic NOEC 87 mg/kg dwt Fresh water	Crustaceans	-
	Chronic NOEC 0.23 mg/l	Micro-organism	-
	Chronic NOEC 65.5 mg/kg dwt	Micro-organism	-

Conclusion/Summary : Very toxic to aquatic life with long lasting effects.

12.2 Persistence and degradability

Conclusion/Summary : The bioaccumulative criteria are not applicable to inorganic metals

Product/ingredient name	Aquatic half-life	Photolysis	Biodegradability
zinc oxide	-	-	Not readily

12.3 Bioaccumulative potential

Not available.

12.4 Mobility in soil

Soil/water partition coefficient (K_{OC}) : Not available.

Mobility : Not available.

12.5 Results of PBT and vPvB assessment

PBT : Not applicable.

vPvB : Not applicable.

12.6 Other adverse effects

No known significant effects or critical hazards.

SECTION 13: Disposal considerations

Used material may have different hazards or properties from the new material. This safety data sheet does not apply to the used material.

In all cases where a EWC code is given, this applies to the material under normal conditions of use and may not be appropriate for used material where the properties may have changed. It is the responsibility of the user to check that any waste code recommendation is appropriate to their material in accordance with the recommendation of the European Waste Catalogue.

13.1 Waste treatment methods

Product

Methods of disposal : The generation of waste should be avoided or minimised wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction.

Dispose of through the metal recovery industry.

Container information: : Since the emptied container retains product residue, follow label warnings even after it has been emptied.

Hazardous waste : The classification of the product may meet the criteria for a hazardous waste.

Packaging

Methods of disposal : The generation of waste should be avoided or minimised wherever possible. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible.

Special precautions : This material and its container must be disposed of in a safe way. Care should be taken when handling emptied containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers.

SECTION 14: Transport information

	ADR/RID	ADN	IMDG	IATA
14.1 UN number	UN3077	UN3077	UN3077	UN3077
14.2 UN proper shipping name	Environmentally hazardous substance, solid, n. o.s. (zinc oxide, copper oxide)	Environmentally hazardous substance, solid, n. o.s. (zinc oxide, copper oxide)	Environmentally hazardous substance, solid, n. o.s. (zinc oxide, copper oxide)	Environmentally hazardous substance, solid, n. o.s. (zinc oxide, copper oxide)
14.3 Transport hazard class (es)	9	9	9	9
14.4 Packing group	III	III	III	III

SECTION 14: Transport information

14.5 Environmental hazards	Yes.	Yes.	Yes.	Yes.

Additional information

ADR/RID : This product is not regulated as a dangerous good when transported in sizes of ≤5 L or ≤5 kg, provided the packagings meet the general provisions of 4.1.1.1, 4.1.1.2 and 4.1.1.4 to 4.1.1.8.
Hazard identification number 90
Limited quantity 5 kg
Special provisions 274, 335, 601, 375
Tunnel code -

ADN : This product is not regulated as a dangerous good when transported in sizes of ≤5 L or ≤5 kg, provided the packagings meet the general provisions of 4.1.1.1, 4.1.1.2 and 4.1.1.4 to 4.1.1.8.
Special provisions 274, 335, 375, 601

IMDG : This product is not regulated as a dangerous good when transported in sizes of ≤5 L or ≤5 kg, provided the packagings meet the general provisions of 4.1.1.1, 4.1.1.2 and 4.1.1.4 to 4.1.1.8.
Emergency schedules F-A, S-F
Special provisions 274, 335, 966, 967, 969
IMDG Code Segregation group 7 - Heavy metals and their salts (including their organometallic compounds)

IATA : This product is not regulated as a dangerous good when transported in sizes of ≤5 L or ≤5 kg, provided the packagings meet the general provisions of 5.0.2.4.1, 5.0.2.6.1.1 and 5.0.2.8.
Quantity limitation Passenger and Cargo Aircraft: 400 kg. Packaging instructions: 956. Cargo Aircraft Only: 400 kg. Packaging instructions: 956. Limited Quantities - Passenger Aircraft: 30 kg. Packaging instructions: Y956.
Special provisions A97, A158, A179, A197

14.6 Special precautions for user : Not applicable.

14.7 Transport in bulk according to Annex II of Marpol and the IBC Code : Not available.

SECTION 15: Regulatory information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

EU Regulation (EC) No. 1907/2006 (REACH)

Annex XIV - List of substances subject to authorisation

Annex XIV

None of the components are listed.

Substances of very high concern

None of the components are listed.

SECTION 15: Regulatory information

Annex XVII - Restrictions on the manufacture, placing on the market and use of certain dangerous substances, mixtures and articles : Restricted to professional users.

Other EU regulations

Product/ingredient name	Carcinogenic effects	Mutagenic effects	Developmental effects	Fertility effects
nickel monoxide	Carc. 1A, H350i (inhalation)	-	-	-

Ozone depleting substances (1005/2009/EU)

Not listed.

Prior Informed Consent (PIC) (649/2012/EU)

Not listed.

National regulations

Product/ingredient name	List name	Name on list	Classification	Notes
nickel monoxide	UK Occupational Exposure Limits EH40 - WEL	inorganic nickel compounds Insoluble in water Except nickel carbonyl	Carc.	-

International regulations

Chemical Weapon Convention List Schedules I, II & III Chemicals

Ingredient name	List name	Status
Not listed.		

Montreal Protocol (Annexes A, B, C, E)

Ingredient name	Status
Not listed.	

Stockholm Convention on Persistent Organic Pollutants

Ingredient name	List name	Status
Not listed.		

Rotterdam Convention on Prior Informed Consent (PIC)

Ingredient name	Status
Not listed.	

UNECE Aarhus Protocol on POPs and Heavy Metals

Ingredient name	List name	Status
Not listed.		

International lists

Inventory list

Australia : All components are listed or exempted.

SECTION 15: Regulatory information

Canada	:	All components are listed or exempted.
China	:	All components are listed or exempted.
Europe	:	All components are listed or exempted.
Japan	:	**Japan inventory (ENCS)**: All components are listed or exempted. **Japan inventory (ISHL)**: All components are listed or exempted.
Malaysia	:	At least one component is not listed.
New Zealand	:	All components are listed or exempted.
Philippines	:	All components are listed or exempted.
Republic of Korea	:	All components are listed or exempted.
Taiwan	:	All components are listed or exempted.
Thailand	:	Not determined.
Turkey	:	All components are listed or exempted.
United States	:	All components are listed or exempted.
Viet Nam	:	Not determined.

15.2 Chemical safety assessment

Chemical Safety Assessments for all substances in this product are either Complete or Not applicable.

SECTION 16: Other information

Indicates information that has changed from previously issued version.

Abbreviations and acronyms : ATE = Acute Toxicity Estimate
CLP = Classification, Labelling and Packaging Regulation [Regulation (EC) No. 1272/2008]
DNEL = Derived No Effect Level
EUH statement = CLP-specific Hazard statement
PNEC = Predicted No Effect Concentration
RRN = REACH Registration Number

Procedure used to derive the classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]

Classification	Justification
Carc. 1A, H350i (inhalation)	On basis of test data
STOT RE 2, H373 (lungs) (inhalation)	On basis of test data
Aquatic Acute 1, H400	Calculation method
Aquatic Chronic 1, H410	Calculation method

Full text of abbreviated H statements

H317	May cause an allergic skin reaction.
H350i (inhalation)	May cause cancer by inhalation.
H372 (lungs) (inhalation)	Causes damage to organs through prolonged or repeated exposure if inhaled. (lungs)
H373 (lungs) (inhalation)	May cause damage to organs through prolonged or repeated exposure if inhaled. (lungs)
H400	Very toxic to aquatic life.
H410	Very toxic to aquatic life with long lasting effects.
H412	Harmful to aquatic life with long lasting effects.
H413	May cause long lasting harmful effects to aquatic life.

Full text of classifications [CLP/GHS]

SECTION 16: Other information

Aquatic Acute 1, H400	SHORT-TERM (ACUTE) AQUATIC HAZARD - Category 1
Aquatic Chronic 1, H410	LONG-TERM (CHRONIC) AQUATIC HAZARD - Category 1
Aquatic Chronic 3, H412	LONG-TERM (CHRONIC) AQUATIC HAZARD - Category 3
Aquatic Chronic 4, H413	LONG-TERM (CHRONIC) AQUATIC HAZARD - Category 4
Carc. 1A, H350i (inhalation)	CARCINOGENICITY (inhalation) - Category 1A
Skin Sens. 1, H317	SKIN SENSITISATION - Category 1
STOT RE 1, H372 (lungs) (inhalation)	SPECIFIC TARGET ORGAN TOXICITY - REPEATED EXPOSURE (lungs) (inhalation) - Category 1
STOT RE 2, H373 (lungs) (inhalation)	SPECIFIC TARGET ORGAN TOXICITY - REPEATED EXPOSURE (lungs) (inhalation) - Category 2

Notice to reader

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Johnson Matthey
Inspiring science, enhancing life

SAFETY DATA SHEET

Conforms to Regulation (EC) No. 1907/2006 (REACH), Annex II (including amendments) - United Kingdom (UK)

KATALCO 83-5

Version	:	1
Date of issue/ Date of revision	:	26/02/2018
Date of previous issue	:	No previous validation

SECTION 1: Identification of the substance/mixture and of the company/ undertaking

1.1 Product identifier

Product identifier	:	**KATALCO™** 83-5
Product type	:	Solid.
Product definition	:	Mixture Classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]

1.2 Relevant identified uses of the substance or mixture and uses advised against

Specific uses	:	Medium temperature shift conversion

1.3 Details of the supplier of the safety data sheet

Supplier	:	Johnson Matthey PO Box No 1,Belasis Avenue, Billingham, Stockton on Tees, TS23 1LB, UK +44 (0) 1642 523343
e-mail address of person responsible for this SDS	:	jmsds1@matthey.com

1.4 Emergency telephone number

For Chemical Emergency ONLY (spill, leak, fire, exposure or accident) call :

Emergency telephone number (with hours of operation)	:	+44 (0) 870 8200418 CHEMTREC UK (London)	(24 hours)
		+(1) 703-527-3887 CHEMTREC International	(24 hours)
Country information	:	000-800-100-7141 CHEMTREC India (local)	(24 hours)
Information limitations	:	For emergency calls only. Non-emergency calls cannot be serviced at this number.	
CHEMTREC Customer Number (CCN)	:	CCN12026	

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

Product definition : Mixture

Classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]

Aquatic Acute 1, H400
Aquatic Chronic 1, H410

The product is classified as hazardous according to Regulation (EC) 1272/2008 as amended.

See Section 16 for the full text of the H statements declared above.

See Section 11 for more detailed information on health effects and symptoms.

2.2 Label elements

Hazard pictograms :

Signal word : Warning

Hazard statements : Very toxic to aquatic life with long lasting effects.

Precautionary statements

Prevention : Avoid release to the environment.

Response : Collect spillage.

Storage : Not applicable.

Disposal : Dispose of contents and container in accordance with all local, regional, national and international regulations.

Annex XVII - Restrictions on the manufacture, placing on the market and use of certain dangerous substances, mixtures and articles : Not applicable.

Special packaging requirements

Containers to be fitted with child-resistant fastenings : Not applicable.

Tactile warning of danger : Not applicable.

2.3 Other hazards

Other hazards which do not result in classification : None known.

SECTION 3: Composition/information on ingredients

3.2 Mixtures

Substance/mixture : Mixture

Product/ ingredient name	Identifiers	%	Regulation (EC) No. 1272/2008 [CLP]	Type
copper oxide	REACH #: 01-2119502447-44 EC: 215-269-1 CAS: 1317-38-0	≥25 - ≤50	Aquatic Acute 1, H400 (M=100) Aquatic Chronic 1, H410 (M=1)	[1] [2]
zinc oxide	REACH #: 01-2119463881-32 EC: 215-222-5 CAS: 1314-13-2 Index: 030-013-00-7	≥25 - ≤50	Aquatic Acute 1, H400 (M=1) Aquatic Chronic 1, H410 (M=1)	[1]
aluminium oxide	REACH #: 01-2119529248-35 EC: 215-691-6 CAS: 1344-28-1	≥10 - ≤25	Not classified.	[2]
Graphite	REACH #: 01-2119486977-12 EC: 231-955-3 CAS: 7782-42-5	≤3	Not classified. **See Section 16 for the full text of the H statements declared above.**	[2]

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment, are PBTs or vPvBs or have been assigned a workplace exposure limit and hence require reporting in this section.

Type

[1] Substance classified with a health or environmental hazard
[2] Substance with a workplace exposure limit
[3] Substance meets the criteria for PBT according to Regulation (EC) No. 1907/2006, Annex XIII
[4] Substance meets the criteria for vPvB according to Regulation (EC) No. 1907/2006, Annex XIII
[5] Substance of equivalent concern
[6] Additional disclosure due to company policy

Occupational exposure limits, if available, are listed in Section 8.

SECTION 4: First aid measures

4.1 Description of first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Continue to rinse for at least 10 minutes. Get medical attention if irritation occurs.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Get medical attention if adverse health effects persist or are severe. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

SECTION 4: First aid measures

Skin contact : Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Get medical attention if symptoms occur. Wash clothing before reuse. Clean shoes thoroughly before reuse.

Ingestion : Wash out mouth with water. Remove dentures if any. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. Stop if the exposed person feels sick as vomiting may be dangerous. Do not induce vomiting unless directed to do so by medical personnel. If vomiting occurs, the head should be kept low so that vomit does not enter the lungs. Get medical attention if adverse health effects persist or are severe. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.

4.2 Most important symptoms and effects, both acute and delayed

Potential acute health effects

Inhalation : Unlikely to be hazardous by inhalation unless present as a dust. High concentrations of dust may be irritant to the upper respiratory tract. Dust may enter the lung and be slow to clear. In the metals industry, high concentrations of very finely divided dust containing copper and/or zinc compounds have been known to produce the symptoms of metal fume fever. This condition is characterised by influenza type symptoms occurring a few hours after exposure and lasting for up to 48 hours. However, the handling and use of this product in line with Section 7 is not expected to pose such a risk.

Ingestion : Ingestion may cause irritation of the gastrointestinal tract.

Skin contact : Repeated or prolonged skin contact may cause irritation. May cause physical abrasion in contact with skin.

Eye contact : Dust may cause irritation to eyes.

Over-exposure signs/symptoms

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Ingestion : No specific data.

4.3 Indication of any immediate medical attention and special treatment needed

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

SECTION 5: Firefighting measures

5.1 Extinguishing media

Suitable extinguishing media : Use an extinguishing agent suitable for the surrounding fire.

Unsuitable extinguishing media : None known.

5.2 Special hazards arising from the substance or mixture

Hazards from the substance or mixture : This material is very toxic to aquatic life with long lasting effects. Fire water contaminated with this material must be contained and prevented from being discharged to any waterway, sewer or drain.

Hazardous combustion products : Decomposition products may include the following materials:
carbon dioxide
carbon monoxide
metal oxide/oxides

5.3 Advice for firefighters

Special precautions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode. Clothing for fire-fighters (including helmets, protective boots and gloves) conforming to European standard EN 469 will provide a basic level of protection for chemical incidents.

Additional information : Discharged material may be pyrophoric (see Process Hazards).

SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilt material. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

For emergency responders : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

6.2 Environmental precautions

Environmental precautions : Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air). Water polluting material. May be harmful to the environment if released in large quantities. Collect spillage.

6.3 Methods and material for containment and cleaning up

Small spill : Move containers from spill area. Vacuum or sweep up material and place in a designated, labelled waste container. Dispose of via a licensed waste disposal contractor.

SECTION 6: Accidental release measures

Large spill : Move containers from spill area. Approach the release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Vacuum or sweep up material and place in a designated, labelled waste container. Dispose of via a licensed waste disposal contractor.

6.4 Reference to other sections

See Section 1 for emergency contact information.
See Section 8 for information on appropriate personal protective equipment.
See Section 13 for additional waste treatment information.

SECTION 7: Handling and storage

7.1 Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8). Do not ingest. Avoid contact with eyes, skin and clothing. Avoid release to the environment. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Empty containers retain product residue and can be hazardous. Do not reuse container.

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Process hazards : Following activation in a reducing environment the material should be regarded as pyrophoric. Pyrophoric and self-heating materials can act as sources of ignition and should be kept away from combustible materials. As a minimum, water sprays should be available to cool the material. The action of water on the reduced material may result in the evolution of small quantities of hydrogen.

7.2 Conditions for safe storage, including any incompatibilities

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a dry place. Keep only in the original container. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabelled containers. Use appropriate containment to avoid environmental contamination. Store away from incompatible materials (see Section 10). See Section 10 for incompatible materials before handling or use.

Additional information : Further advice given in the Johnson Matthey publication 'Catalyst Handling'.

7.3 Specific end use(s)

Recommendations : Not available.

Industrial sector specific solutions : Not available.

SECTION 8: Exposure controls/personal protection

The information in this section contains generic advice and guidance. Information is provided based on typical anticipated uses of the product. Additional measures might be required for bulk handling or other uses that could significantly increase worker exposure or environmental releases.

8.1 Control parameters

Occupational exposure limits

Product/ingredient name	Exposure limit values
copper oxide	**EH40/2005 WELs (United Kingdom (UK), 3/2012).** TWA: 1 mg/m³, (As Cu) 8 hours. Form: Dusts and mists STEL: 2 mg/m³, (As Cu) 15 minutes. Form: Dusts and mists
aluminium oxide	**EH40/2005 WELs (United Kingdom (UK), 12/2011).** TWA: 10 mg/m³ 8 hours. Form: inhalable dust
Graphite	**EH40/2005 WELs (United Kingdom (UK), 12/2011).** TWA: 10 mg/m³ 8 hours. Form: inhalable dust TWA: 4 mg/m³ 8 hours. Form: respirable dust
Inhalable fraction	***[Air contaminant]*** **EH40/2005 WELs (United Kingdom (UK)).** TWA: 10 mg/m³ 8 hours.
Respirable dust	***[Air contaminant]*** **EH40/2005 WELs (United Kingdom (UK)).** TWA: 4 mg/m³ 8 hours.

Recommended monitoring procedures : If this product contains ingredients with exposure limits, personal, workplace atmosphere or biological monitoring may be required to determine the effectiveness of the ventilation or other control measures and/or the necessity to use respiratory protective equipment. Reference should be made to monitoring standards, such as the following: European Standard EN 689 (Workplace atmospheres - Guidance for the assessment of exposure by inhalation to chemical agents for comparison with limit values and measurement strategy) European Standard EN 14042 (Workplace atmospheres - Guide for the application and use of procedures for the assessment of exposure to chemical and biological agents) European Standard EN 482 (Workplace atmospheres - General requirements for the performance of procedures for the measurement of chemical agents) Reference to national guidance documents for methods for the determination of hazardous substances will also be required.

DNELs/DMELs

Product/ingredient name	Type	Exposure	Value	Population	Effects
copper oxide	DNEL	Long term Inhalation	1 mg/m³	Workers	Systemic
	DNEL	Long term Dermal	137 mg/kg bw/day	Workers	-
zinc oxide	DNEL	Long term Inhalation	1 mg/m³	Workers	Systemic
	DNEL	Long term Inhalation	5 mg/m³	Workers	Systemic
	DNEL	Long term Oral	0.83 mg/kg bw/day	Workers	Systemic
	DNEL	Long term Oral	0.83 mg/kg bw/day	Workers	Systemic

SECTION 8: Exposure controls/personal protection

	DNEL	Long term Dermal	8.3 mg/ kg bw/ day	Workers	Systemic
	DNEL	Long term Dermal	83 mg/ kg bw/ day	Workers	Systemic

PNECs

Product/ingredient name	Type	Compartment Detail	Value	Method Detail
copper oxide	PNEC	Fresh water	7.8 µg/l	Assessment Factors
	PNEC	Fresh water sediment	87 mg/kg dwt	Assessment Factors
	PNEC	Sewage Treatment Plant	0.23 mg/l	Assessment Factors
	PNEC	Soil	65.5 mg/kg dwt	Assessment Factors
zinc oxide	PNEC	Fresh water	20.6 µg/l	Sensitivity Distribution
	PNEC	Marine	6.1 µg/l	Sensitivity Distribution
	PNEC	Fresh water sediment	235.6 mg/kg dwt	Sensitivity Distribution
	PNEC	Marine water sediment	113 mg/kg dwt	Sensitivity Distribution
	PNEC	Soil	106.8 mg/kg dwt	Sensitivity Distribution
	PNEC	Sewage Treatment Plant	52 µg/l	Assessment Factors

8.2 Exposure controls

Appropriate engineering controls : Good general ventilation should be sufficient to control worker exposure to airborne contaminants.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

General information : All personal protective equipment (PPE) should be selected and used under the direction of a trained health and safety professional. PPE should be in compliance with any relevant local or national standard. Where no local or national standards apply, compliance with the relevant EU standard is recommended.
It remains the responsibility of the user to ensure that this product is used safely within the context of their site conditions.

Eye/face protection : Safety eyewear complying with an approved standard (EN 166 or local equivalent) is required during loading and unloading of reactors, cleaning and maintenance operations, and sampling, where exposure to dust, powder or liquid splashes is possible.

Skin protection

SECTION 8: Exposure controls/personal protection

Hand protection	:	Chemical/bio-chemical resistant, impervious gloves complying with an approved chemical standard (EN 374 or local equivalent) should be worn at all times when handling chemical products. For tasks involving physical or mechanical hazards, gloves should also comply with an approved physical standard (EN 388 or local equivalent). Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.
Body protection	:	Safety shoes complying with an approved standard (EN 20346 or equivalent) and a hard hat complying with an approved standard (EN 297 or equivalent) is required during loading and unloading of reactors, cleaning and maintenance operations and sampling.
Other skin protection	:	Wear protective coveralls. For dusty tasks where dermal contact is possible a protective suit complying with an approved standard (EN 13982-1 Type 5 or equivalent) may be worn
Respiratory protection	:	Use of Respiratory Protective Equipment (RPE) (Particle filter with high efficiency for solid particles (EN 143 or 149, Type P2 or FFP2, Associated Protection Factor (APF) = 10) or local equivalent as a minimum) is required during loading and unloading of reactors, cleaning and maintenance operations, and sampling, where exposure to dust or powder is possible. Air-fed Respiratory Protective Equipment may be used if entry to the reactor is required.
Environmental exposure controls	:	Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

SECTION 9: Physical and chemical properties

9.1 Information on basic physical and chemical properties

Appearance		
Physical state	:	Solid. [Pellets.]
Colour	:	Brown. [Dark]
Odour	:	Not available.
Odour threshold	:	Not applicable.
pH	:	Not applicable.
Melting point/freezing point	:	Not determined.
Initial boiling point and boiling range	:	Not applicable.
Flash point	:	Not applicable.
Evaporation rate (butyl acetate = 1)	:	Not applicable.
Flammability (solid, gas)	:	Not classified.
Upper/lower flammability or explosive limits	:	Not applicable.
Vapour pressure (mm Hg)	:	Not applicable.
Vapour density	:	Not applicable.

SECTION 9: Physical and chemical properties

Relative density	:	Not applicable.
Bulk Density (g/ml)	:	1.35 - 1.45
Solubility(ies)	:	Soluble in the following materials: strong acids
Solubility - Water	:	insoluble in water.
Partition coefficient: n-octanol/water	:	Not applicable.
Auto-ignition temperature	:	Not applicable.
Decomposition temperature	:	Not available.
Viscosity (m.Pa.s)	:	Not applicable.
Explosive properties	:	Not available.
Oxidising properties	:	Not available.

9.2 Other information

No additional information.

SECTION 10: Stability and reactivity

10.1 Reactivity

No specific test data related to reactivity available for this product or its ingredients.

10.2 Chemical stability

The product is stable.

10.3 Possibility of hazardous reactions

Under normal conditions of storage and use, hazardous reactions will not occur.

See Process Hazards section for hazards associated with the discharged material resulting from its intended use.

10.4 Conditions to avoid

No specific data.

10.5 Incompatible materials

No specific data.

10.6 Hazardous decomposition products

Under normal conditions of storage and use, hazardous decomposition products should not be produced.

SECTION 11: Toxicological information

11.1 Information on toxicological effects

Acute toxicity

Product/ingredient name	Result	Species	Dose	Exposure
zinc oxide	LC50 Inhalation Dusts and mists LD50 Oral	Rat - Male, Female Rat	5.7 mg/l Continuous >5000 mg/kg Single dose	4 hours -

Conclusion/Summary : Not classified.

Acute toxicity estimates

Route	ATE value
Not available.	

Irritation/Corrosion

Conclusion/Summary

Skin : Not classified.

Eyes : Not classified.

Respiratory : Not classified.

Sensitiser

Product/ingredient name	Route of exposure	Species	Result
zinc oxide	skin	Guinea pig	Not sensitizing

Conclusion/Summary

Skin : Not classified.

Respiratory : Not classified.

Mutagenicity

Product/ingredient name	Test	Experiment	Result
zinc oxide	OECD 471 Bacterial Reverse Mutation Test	Experiment: In vitro Subject: Bacteria	Negative

Conclusion/Summary : Not classified.

Carcinogenicity

Conclusion/Summary : Not classified.

Reproductive toxicity

Conclusion/Summary : Not classified.

Teratogenicity

Conclusion/Summary : Not classified.

Specific target organ toxicity (single exposure)

SECTION 11: Toxicological information

Not available.

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not applicable.

Information on likely routes of exposure : Routes of entry anticipated: Dermal, Inhalation.

Potential acute health effects

Inhalation : Unlikely to be hazardous by inhalation unless present as a dust. High concentrations of dust may be irritant to the upper respiratory tract. Dust may enter the lung and be slow to clear. In the metals industry, high concentrations of very finely divided dust containing copper and/or zinc compounds have been known to produce the symptoms of metal fume fever. This condition is characterised by influenza type symptoms occurring a few hours after exposure and lasting for up to 48 hours. However, the handling and use of this product in line with Section 7 is not expected to pose such a risk.

Ingestion : Ingestion may cause irritation of the gastrointestinal tract.

Skin contact : Repeated or prolonged skin contact may cause irritation. May cause physical abrasion in contact with skin.

Eye contact : Dust may cause irritation to eyes.

Symptoms related to the physical, chemical and toxicological characteristics

Inhalation : No specific data.

Ingestion : No specific data.

Skin contact : No specific data.

Eye contact : No specific data.

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Product/ingredient name	Result	Species	Dose	Exposure
copper oxide	Chronic NOAEL Oral	Rat	16.7 mg/kg Repeated dose	-

Conclusion/Summary : Not classified.

SECTION 11: Toxicological information

General	:	No known significant effects or critical hazards.
Carcinogenicity	:	No known significant effects or critical hazards.
Mutagenicity	:	No known significant effects or critical hazards.
Teratogenicity	:	No known significant effects or critical hazards.
Developmental effects	:	No known significant effects or critical hazards.
Fertility effects	:	No known significant effects or critical hazards.
Other information	:	Not available.

SECTION 12: Ecological information

12.1 Toxicity

Product/ingredient name	Result	Species	Exposure
copper oxide	Acute LC50 25 ppb Single dose Fresh water	Daphnia	48 hours
	Chronic NOEC 7.8 ppb Fresh water	Algae	-
	Chronic NOEC 87 mg/kg dwt Fresh water	Crustaceans	-
	Chronic NOEC 0.23 mg/l	Micro-organism	-
	Chronic NOEC 65.5 mg/kg dwt	Micro-organism	-
zinc oxide	Acute EC50 0.83 mg/l Fresh water	Daphnia - Ceriodaphnia Dubnia - Neonate	48 hours
	Acute EC50 5.2 mg/l Fresh water	Micro-organism - Activated sludge	3 hours
	Acute IC50 0.27 mg/l Fresh water	Algae - Pseudokirchnerella subcapitata - Exponential growth phase	72 hours
	Acute LC50 0.338 mg/l Fresh water	Fish - Oncorrhynchus mykiss - Juvenile (Fledgling, Hatchling, Weanling)	96 hours
	Acute NOEC 0.025 mg/l Marine water	Fish - Clupea harengus - Atlantic Herring - Embryo	27 days
	Acute NOEC 0.044 mg/l Fresh water	Fish - Lowest NOEC from 7 species	5 days (minimum)
	Chronic NOEC 0.019 mg/l Fresh water	Algae - Pseudokirchnerella subcapitata - Exponential growth phase	72 hours
	Chronic NOEC 0.0078 mg/l Marine water	Algae - lowest NOEC from 12 species - Exponential growth phase	72 hours
	Chronic NOEC 0.037 mg/l Fresh water	Daphnia - Lowest NOEC from 13 invertebrate species	7 days (minimum)
	Chronic NOEC 0.056 mg/l Marine water	Daphnia - Lowest NOEC from 26 invertebrate species	7 days (minimum)
	Chronic NOEC 0.4 mg/l Fresh water	Daphnia - Daphnia magna - Neonate	48 hours

Conclusion/Summary : Very toxic to aquatic life with long lasting effects.

12.2 Persistence and degradability

Conclusion/Summary : The bioaccumulative criteria are not applicable to inorganic metals

SECTION 12: Ecological information

Product/ingredient name	Aquatic half-life	Photolysis	Biodegradability
zinc oxide	-	-	Not readily

12.3 Bioaccumulative potential

Not available.

12.4 Mobility in soil

Soil/water partition coefficient (K_{OC}) : Not available.

Mobility : Not available.

12.5 Results of PBT and vPvB assessment

PBT : Not applicable.

vPvB : Not applicable.

12.6 Other adverse effects

No known significant effects or critical hazards.

SECTION 13: Disposal considerations

Used material may have different hazards or properties from the new material. This safety data sheet does not apply to the used material.

In all cases where a EWC code is given, this applies to the material under normal conditions of use and may not be appropriate for used material where the properties may have changed. It is the responsibility of the user to check that any waste code recommendation is appropriate to their material in accordance with the recommendation of the European Waste Catalogue.

13.1 Waste treatment methods

Product

Methods of disposal : The generation of waste should be avoided or minimised wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction.

Dispose of through the metal recovery industry.

Container information: : Since the emptied container retains product residue, follow label warnings even after it has been emptied.

Hazardous waste : The classification of the product may meet the criteria for a hazardous waste.

European waste catalogue (EWC) : The user should assign a waste code to the material in accordance with the recommendations of the European Waste Catalogue.

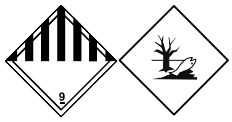
Packaging

Methods of disposal : The generation of waste should be avoided or minimised wherever possible. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible.

SECTION 13: Disposal considerations

Special precautions : This material and its container must be disposed of in a safe way. Care should be taken when handling emptied containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers.

SECTION 14: Transport information

	ADR/RID	ADN	IMDG	IATA
14.1 UN number	UN3077	UN3077	UN3077	UN3077
14.2 UN proper shipping name	Environmentally hazardous substance, solid, n. o.s. (copper oxide, zinc oxide)	Environmentally hazardous substance, solid, n. o.s. (copper oxide, zinc oxide)	Environmentally hazardous substance, solid, n. o.s. (copper oxide, zinc oxide)	Environmentally hazardous substance, solid, n. o.s. (copper oxide, zinc oxide)
14.3 Transport hazard class (es)	9	9	9 	9
14.4 Packing group	III	III	III	III
14.5 Environmental hazards	Yes.	Yes.	Yes.	Yes.

Additional information

ADR/RID : This product is not regulated as a dangerous good when transported in sizes of ≤5 L or ≤5 kg, provided the packagings meet the general provisions of 4.1.1.1, 4.1.1.2 and 4.1.1.4 to 4.1.1.8.
Hazard identification number 90
Limited quantity 5 kg
Special provisions 274, 335, 601, 375

ADN : This product is not regulated as a dangerous good when transported in sizes of ≤5 L or ≤5 kg, provided the packagings meet the general provisions of 4.1.1.1, 4.1.1.2 and 4.1.1.4 to 4.1.1.8.
Special provisions 274, 335, 375, 601

IMDG : This product is not regulated as a dangerous good when transported in sizes of ≤5 L or ≤5 kg, provided the packagings meet the general provisions of 4.1.1.1, 4.1.1.2 and 4.1.1.4 to 4.1.1.8.
Emergency schedules F-A, S-F
Special provisions 274, 335, 966, 967, 969
IMDG Code Segregation group 7 - Heavy metals and their salts (including their organometallic compounds)

SECTION 14: Transport information

IATA : This product is not regulated as a dangerous good when transported in sizes of ≤5 L or ≤5 kg, provided the packagings meet the general provisions of 5.0.2.4.1, 5.0.2.6.1.1 and 5.0.2.8.
Quantity limitation Passenger and Cargo Aircraft: 400 kg. Packaging instructions: 956. Cargo Aircraft Only: 400 kg. Packaging instructions: 956. Limited Quantities - Passenger Aircraft: 30 kg. Packaging instructions: Y956.
Special provisions A97, A158, A179, A197

14.6 Special precautions for user : Not applicable.

14.7 Transport in bulk according to Annex II of Marpol and the IBC Code : Not available.

SECTION 15: Regulatory information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

EU Regulation (EC) No. 1907/2006 (REACH)

Annex XIV - List of substances subject to authorisation

Annex XIV

None of the components are listed.

Substances of very high concern

None of the components are listed.

Annex XVII - Restrictions on the manufacture, placing on the market and use of certain dangerous substances, mixtures and articles : Not applicable.

Other EU regulations

Ozone depleting substances (1005/2009/EU)

Not listed.

Prior Informed Consent (PIC) (649/2012/EU)

Not listed.

International regulations

Chemical Weapon Convention List Schedules I, II & III Chemicals

Ingredient name	List name	Status
Not listed.		

Montreal Protocol (Annexes A, B, C, E)

Ingredient name	Status
Not listed.	

Stockholm Convention on Persistent Organic Pollutants

SECTION 15: Regulatory information

Ingredient name	List name	Status
Not listed.		

Rotterdam Convention on Prior Informed Consent (PIC)

Ingredient name	Status
Not listed.	

UNECE Aarhus Protocol on POPs and Heavy Metals

Ingredient name	List name	Status
Not listed.		

International lists

Inventory list

Australia : All components are listed or exempted.

Canada : All components are listed or exempted.

China : All components are listed or exempted.

Europe : All components are listed or exempted.

Japan : **Japan inventory (ENCS)**: All components are listed or exempted.
Japan inventory (ISHL): All components are listed or exempted.

Malaysia : Not determined.

New Zealand : All components are listed or exempted.

Philippines : All components are listed or exempted.

Republic of Korea : All components are listed or exempted.

Taiwan : All components are listed or exempted.

Thailand : Not determined.

Turkey : All components are listed or exempted.

United States : All components are listed or exempted.

Viet Nam : Not determined.

15.2 Chemical safety assessment

This product contains substances for which Chemical Safety Assessments are still required.

SECTION 16: Other information

Indicates information that has changed from previously issued version.

Abbreviations and acronyms : ATE = Acute Toxicity Estimate
CLP = Classification, Labelling and Packaging Regulation [Regulation (EC) No. 1272/2008]
DNEL = Derived No Effect Level
EUH statement = CLP-specific Hazard statement
PNEC = Predicted No Effect Concentration
RRN = REACH Registration Number

Procedure used to derive the classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]

Classification	Justification
Aquatic Acute 1, H400 Aquatic Chronic 1, H410	Calculation method Calculation method

SECTION 16: Other information

Full text of abbreviated H statements

H400	Very toxic to aquatic life.
H410	Very toxic to aquatic life with long lasting effects.
H412	Harmful to aquatic life with long lasting effects.

Full text of classifications [CLP/GHS]

Aquatic Acute 1, H400	SHORT-TERM (ACUTE) AQUATIC HAZARD - Category 1
Aquatic Chronic 1, H410	LONG-TERM (CHRONIC) AQUATIC HAZARD - Category 1
Aquatic Chronic 3, H412	LONG-TERM (CHRONIC) AQUATIC HAZARD - Category 3

Notice to reader

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Product Specific Information

KATALCO 92-1G

Version	:	1
Date of issue/ Date of revision	:	19/03/2019
Date of previous issue	:	No previous validation

SECTION 1: Identification of the substance/mixture and of the company/ undertaking

Identification of the material and supplier

Product identifier	:	**KATALCO™** 92-1G
Product type	:	Solid.
Product definition	:	Article.
Specific uses	:	Catalyst support
Supplier	:	Johnson Matthey PO Box No 1,Belasis Avenue, Billingham, Stockton on Tees, TS23 1LB, UK +44 (0) 1642 523343
e-mail address of person responsible for this SDS	:	jmsds1@matthey.com

Emergency telephone number

For Chemical Emergency ONLY (spill, leak, fire, exposure or accident) call :

Emergency telephone number (with hours of operation)	:	+44 (0) 870 8200418 CHEMTREC UK (London)	(24 hours)
		+(1) 703-527-3887 CHEMTREC International	(24 hours)
Country information	:	000-800-100-7141 CHEMTREC India (local)	(24 hours)
Information limitations	:	For emergency calls only. Non-emergency calls cannot be serviced at this number.	
CHEMTREC Customer Number (CCN)	:	CCN12026	

SECTION 2: Hazards identification

No known significant effects or critical hazards.

See Section 11 for more detailed information on health effects and symptoms.

Other hazards

SECTION 2: Hazards identification

Substance meets the criteria for PBT according to Regulation (EC) No. 1907/2006, Annex XIII : Not applicable.
P: Not available. B: Not available. T: Not available.

Substance meets the criteria for vPvB according to Regulation (EC) No. 1907/2006, Annex XIII : Not applicable.
vP: Not available. vB: Not available.

Other hazards which do not result in classification : None known.

SECTION 3: Composition/information on ingredients

Product definition : Article.

Product/ ingredient name	Identifiers	%	Regulation (EC) No. 1272/2008 [CLP]	Type
aluminium oxide	EC: 215-691-6 CAS: 1344-28-1	100	Not classified.	[A]

There are no additional ingredients present which, within the current knowledge of the supplier, are classified and contribute to the classification of the substance and hence require reporting in this section.

Type

[A] Constituent
[B] Impurity
[C] Stabilising additive

Occupational exposure limits, if available, are listed in Section 8.

SECTION 4: First aid measures

Description of first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Get medical attention if irritation occurs.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. Get medical attention if symptoms occur.

Skin contact : Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Get medical attention if symptoms occur.

Ingestion : Wash out mouth with water. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. Do not induce vomiting unless directed to do so by medical personnel. Get medical attention if symptoms occur.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training.

Most important symptoms and effects, both acute and delayed

Potential acute health effects

SECTION 4: First aid measures

Inhalation : Unlikely to be hazardous by inhalation unless present as a dust. High concentrations of dust may be irritant to the upper respiratory tract. Dust may enter the lung and be slow to clear.

Ingestion : Ingestion may cause irritation of the gastrointestinal tract.

Skin contact : Repeated or prolonged skin contact may cause irritation. May cause physical abrasion in contact with skin.

Eye contact : Dust may cause irritation to eyes.

Over-exposure signs/symptoms

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Ingestion : No specific data.

Indication of any immediate medical attention and special treatment needed

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

SECTION 5: Firefighting measures

Extinguishing media

Suitable extinguishing media : Use an extinguishing agent suitable for the surrounding fire.

Unsuitable extinguishing media : None known.

Special hazards arising from the substance or mixture

Hazards from the substance or mixture : No specific fire or explosion hazard.

Hazardous combustion products : Decomposition products may include the following materials: metal oxide/oxides

Advice for firefighters

Special precautions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode. Clothing for fire-fighters (including helmets, protective boots and gloves) conforming to European standard EN 469 will provide a basic level of protection for chemical incidents.

SECTION 6: Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilt material. Put on appropriate personal protective equipment.

SECTION 6: Accidental release measures

For emergency responders : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Environmental precautions

Environmental precautions : Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods and material for containment and cleaning up

Small spill : Move containers from spill area. Vacuum or sweep up material and place in a designated, labelled waste container. Dispose of via a licensed waste disposal contractor.

Large spill : Move containers from spill area. Prevent entry into sewers, water courses, basements or confined areas. Vacuum or sweep up material and place in a designated, labelled waste container. Dispose of via a licensed waste disposal contractor.

Reference to other sections

See Section 1 for emergency contact information.
See Section 8 for information on appropriate personal protective equipment.
See Section 13 for additional waste treatment information.

SECTION 7: Handling and storage

Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8).

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Conditions for safe storage, including any incompatibilities

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a dry place. Keep only in the original container. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabelled containers. Use appropriate containment to avoid environmental contamination. Store away from incompatible materials (see Section 10). See Section 10 for incompatible materials before handling or use.

Specific end use(s)

Recommendations : Not available.

Industrial sector specific solutions : Not available.

SECTION 8: Exposure controls/personal protection

The information in this section contains generic advice and guidance. Information is provided based on typical anticipated uses of the product. Additional measures might be required for bulk handling or other uses that could significantly increase worker exposure or environmental releases.

Control parameters

Occupational exposure limits

Product/ingredient name	Exposure limit values
aluminium oxide Inhalable fraction Respirable dust	**EH40/2005 WELs (United Kingdom (UK), 12/2011).** TWA: 10 mg/m³ 8 hours. Form: inhalable dust ***[Air contaminant]*** **EH40/2005 WELs (United Kingdom (UK)).** TWA: 10 mg/m³ 8 hours. ***[Air contaminant]*** **EH40/2005 WELs (United Kingdom (UK)).** TWA: 4 mg/m³ 8 hours.

Recommended monitoring procedures : If this product contains ingredients with exposure limits, personal, workplace atmosphere or biological monitoring may be required to determine the effectiveness of the ventilation or other control measures and/or the necessity to use respiratory protective equipment. Reference should be made to monitoring standards, such as the following: European Standard EN 689 (Workplace atmospheres - Guidance for the assessment of exposure by inhalation to chemical agents for comparison with limit values and measurement strategy) European Standard EN 14042 (Workplace atmospheres - Guide for the application and use of procedures for the assessment of exposure to chemical and biological agents) European Standard EN 482 (Workplace atmospheres - General requirements for the performance of procedures for the measurement of chemical agents) Reference to national guidance documents for methods for the determination of hazardous substances will also be required.

Exposure controls

Appropriate engineering controls : Good general ventilation should be sufficient to control worker exposure to airborne contaminants.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

General information : All personal protective equipment (PPE) should be selected and used under the direction of a trained health and safety professional. PPE should be in compliance with any relevant local or national standard. Where no local or national standards apply, compliance with the relevant EU standard is recommended.
It remains the responsibility of the user to ensure that this product is used safely within the context of their site conditions.

Eye/face protection : Safety eyewear complying with an approved standard (EN 166 or local equivalent) is required during loading and unloading of reactors, cleaning and maintenance operations, and sampling, where exposure to dust, powder or liquid splashes is possible.

Skin protection

SECTION 8: Exposure controls/personal protection

Hand protection : Chemical/bio-chemical resistant, impervious gloves complying with an approved chemical standard (EN 374 or local equivalent) should be worn at all times when handling chemical products. For tasks involving physical or mechanical hazards, gloves should also comply with an approved physical standard (EN 388 or local equivalent).
Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Safety shoes complying with an approved standard (EN 20346 or equivalent) and a hard hat complying with an approved standard (EN 297 or equivalent) is required during loading and unloading of reactors, cleaning and maintenance operations and sampling.

Other skin protection : Wear protective coveralls. For dusty tasks where dermal contact is possible a protective suit complying with an approved standard (EN 13982-1 Type 5 or equivalent) may be worn

Respiratory protection : Use of Respiratory Protective Equipment (RPE) (Particle filter with high efficiency for solid particles (EN 143 or 149, Type P2 or FFP2, Associated Protection Factor (APF) = 10) or local equivalent as a minimum) is required during loading and unloading of reactors, cleaning and maintenance operations, and sampling, where exposure to dust or powder is possible. Air-fed Respiratory Protective Equipment may be used if entry to the reactor is required.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

SECTION 9: Physical and chemical properties

Information on basic physical and chemical properties

Appearance

Physical state : Solid. [spheres]

Colour : White.

Odour : Odourless.

Odour threshold : Not applicable.

pH : Not applicable.

Melting point/freezing point : Not determined.

Initial boiling point and boiling range : Not applicable.

Flash point : Not applicable.

Evaporation rate (butyl acetate = 1) : Not applicable.

Flammability (solid, gas) : Not classified.

Upper/lower flammability or explosive limits : Not applicable.

Vapour pressure (mm Hg) : Not applicable.

Vapour density : Not applicable.

Relative density : Not applicable.

SECTION 9: Physical and chemical properties

Bulk Density (g/ml)	:	2.0
Solubility(ies)	:	Soluble in the following materials: strong acids
Solubility - Water	:	insoluble in water.
Partition coefficient: n-octanol/water	:	Not applicable.
Auto-ignition temperature	:	Not applicable.
Decomposition temperature	:	Not available.
Viscosity (m.Pa.s)	:	Not applicable.
Explosive properties	:	Not available.
Oxidising properties	:	Not available.

Other information

No additional information.

SECTION 10: Stability and reactivity

Reactivity

No specific test data related to reactivity available for this product or its ingredients.

Chemical stability

The product is stable.

Possibility of hazardous reactions

Under normal conditions of storage and use, hazardous reactions will not occur.

Conditions to avoid

No specific data.

Incompatible materials

No specific data.

Hazardous decomposition products

Under normal conditions of storage and use, hazardous decomposition products should not be produced.

SECTION 11: Toxicological information

Information on toxicological effects

Acute toxicity

Conclusion/Summary : Not classified.

Irritation/Corrosion

Conclusion/Summary

Skin	:	Not classified.
Eyes	:	Not classified.
Respiratory	:	Not classified.

SECTION 11: Toxicological information

Sensitiser

Conclusion/Summary

Skin : Not classified.

Respiratory : Not classified.

Mutagenicity

Conclusion/Summary : Not classified.

Carcinogenicity

Conclusion/Summary : Not classified.

Reproductive toxicity

Conclusion/Summary : Not classified.

Teratogenicity

Conclusion/Summary : Not classified.

Specific target organ toxicity (single exposure)

Not available.

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not applicable.

Information on likely routes of exposure : Routes of entry anticipated: Dermal, Inhalation.

Potential acute health effects

Inhalation : Unlikely to be hazardous by inhalation unless present as a dust. High concentrations of dust may be irritant to the upper respiratory tract. Dust may enter the lung and be slow to clear.

Ingestion : Ingestion may cause irritation of the gastrointestinal tract.

Skin contact : Repeated or prolonged skin contact may cause irritation. May cause physical abrasion in contact with skin.

Eye contact : Dust may cause irritation to eyes.

Symptoms related to the physical, chemical and toxicological characteristics

Inhalation : No specific data.

Ingestion : No specific data.

Skin contact : No specific data.

Eye contact : No specific data.

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Potential immediate effects : Not available.

SECTION 11: Toxicological information

Potential delayed effects : Not available.

Potential chronic health effects

Conclusion/Summary : Not classified.

General : No known significant effects or critical hazards.
Carcinogenicity : No known significant effects or critical hazards.
Mutagenicity : No known significant effects or critical hazards.
Teratogenicity : No known significant effects or critical hazards.
Developmental effects : No known significant effects or critical hazards.
Fertility effects : No known significant effects or critical hazards.
Other information : Not available.

SECTION 12: Ecological information

Toxicity

Product/ingredient name	Result	Species	Exposure
aluminium oxide	EC50 >100 mg/l IC50 >100 mg/l LC50 >100 mg/l	Daphnia - magna Algae - (Selenastrum capricornutum) Fish - (Trout Trotten)	48 hours 72 hours 96 hours

Conclusion/Summary : Not classified.

Persistence and degradability

Conclusion/Summary : The bioaccumulative criteria are not applicable to inorganic metals

Bioaccumulative potential

Not available.

Mobility in soil

Soil/water partition coefficient (K_{OC}) : Not available.
Mobility : Not available.

Results of PBT and vPvB assessment

PBT : Not applicable.
P: Not available. B: Not available. T: Not available.
vPvB : Not applicable.
vP: Not available. vB: Not available.

Other adverse effects

No known significant effects or critical hazards.

SECTION 13: Disposal considerations

Waste treatment methods

Product

Methods of disposal : The generation of waste should be avoided or minimised wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction.

Container information: : Since the emptied container retains product residue, follow label warnings even after it has been emptied.

Hazardous waste : Within the present knowledge of the supplier, this product is not regarded as hazardous waste, as defined by EU Directive 2008/98/EC.

European waste catalogue (EWC) : The user should assign a waste code to the material in accordance with the recommendations of the European Waste Catalogue.

Packaging

Methods of disposal : The generation of waste should be avoided or minimised wherever possible. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible.

Special precautions : This material and its container must be disposed of in a safe way. Empty containers or liners may retain some product residues. Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers.

SECTION 14: Transport information

	ADR/RID	ADN	IMDG	IATA
UN number	Not regulated.	Not regulated.	Not regulated.	Not regulated.
UN proper shipping name	-	-	-	-
Transport hazard class (es)	-	-	-	-
Packing group	-	-	-	-
Environmental hazards	No.	No.	No.	No.
Additional information	-	-	-	-

Special precautions for user : Not applicable

Transport in bulk according to Annex II of Marpol and the IBC Code : Not available.

SECTION 14: Transport information

SECTION 15: Regulatory information

Safety, health and environmental regulations/legislation specific for the substance or mixture

EU Regulation (EC) No. 1907/2006 (REACH)

Annex XIV - List of substances subject to authorisation

Annex XIV

None of the components are listed.

Substances of very high concern

None of the components are listed.

Annex XVII - Restrictions on the manufacture, placing on the market and use of certain dangerous substances, mixtures and articles : Not applicable.

Other EU regulations

Ozone depleting substances (1005/2009/EU)

Not listed.

Prior Informed Consent (PIC) (649/2012/EU)

Not listed.

International regulations

Chemical Weapon Convention List Schedules I, II & III Chemicals

Ingredient name	List name	Status
Not listed.		

Montreal Protocol (Annexes A, B, C, E)

Ingredient name	Status
Not listed.	

Stockholm Convention on Persistent Organic Pollutants

Ingredient name	List name	Status
Not listed.		

Rotterdam Convention on Prior Informed Consent (PIC)

Ingredient name	Status
Not listed.	

UNECE Aarhus Protocol on POPs and Heavy Metals

Ingredient name	List name	Status
Not listed.		

International lists

Inventory list

Australia : All components are listed or exempted.

Canada : All components are listed or exempted.

China : All components are listed or exempted.

Europe : All components are listed or exempted.

SECTION 15: Regulatory information

Japan	:	**Japan inventory (ENCS)**: All components are listed or exempted. **Japan inventory (ISHL)**: All components are listed or exempted.
Malaysia	:	All components are listed or exempted.
New Zealand	:	All components are listed or exempted.
Republic of Korea	:	All components are listed or exempted.
Philippines	:	All components are listed or exempted.
Taiwan	:	All components are listed or exempted.
Thailand	:	Not determined.
Turkey	:	All components are listed or exempted.
United States	:	All components are listed or exempted.
Viet Nam	:	Not determined.

SECTION 16: Other information

Indicates information that has changed from previously issued version.

Abbreviations and acronyms : ATE = Acute Toxicity Estimate
CLP = Classification, Labelling and Packaging Regulation [Regulation (EC) No. 1272/2008]
DNEL = Derived No Effect Level
EUH statement = CLP-specific Hazard statement
PNEC = Predicted No Effect Concentration
RRN = REACH Registration Number

Procedure used to derive the classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]

Classification	Justification
Not classified.	

Full text of abbreviated H statements

Not applicable.

Full text of classifications [CLP/GHS]

Not applicable.

Notice to reader

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Inspiring science, enhancing life

Product Specific Information

KATALCO 92-1J

Version	:	1
Date of issue/ Date of revision	:	02/04/2019
Date of previous issue	:	No previous validation

SECTION 1: Identification of the substance/mixture and of the company/ undertaking

Identification of the material and supplier

Product identifier	:	**KATALCO™** 92-1J
Product type	:	Solid.
Product definition	:	Article.
Specific uses	:	Catalyst support
Supplier	:	Johnson Matthey PO Box No 1,Belasis Avenue, Billingham, Stockton on Tees, TS23 1LB, UK +44 (0) 1642 523343
e-mail address of person responsible for this SDS	:	jmsds1@matthey.com

Emergency telephone number

For Chemical Emergency ONLY (spill, leak, fire, exposure or accident) call :

Emergency telephone number (with hours of operation)	:	+44 (0) 870 8200418 CHEMTREC UK (London)	(24 hours)
		+(1) 703-527-3887 CHEMTREC International	(24 hours)
Country information	:	000-800-100-7141 CHEMTREC India (local)	(24 hours)
Information limitations	:	For emergency calls only. Non-emergency calls cannot be serviced at this number.	
CHEMTREC Customer Number (CCN)	:	CCN12026	

SECTION 2: Hazards identification

No known significant effects or critical hazards.

See Section 11 for more detailed information on health effects and symptoms.

Other hazards

SECTION 2: Hazards identification

Substance meets the criteria for PBT according to Regulation (EC) No. 1907/2006, Annex XIII : Not applicable.
P: Not available. B: Not available. T: Not available.

Substance meets the criteria for vPvB according to Regulation (EC) No. 1907/2006, Annex XIII : Not applicable.
vP: Not available. vB: Not available.

Other hazards which do not result in classification : None known.

SECTION 3: Composition/information on ingredients

Product definition : Article.

Product/ ingredient name	Identifiers	%	Regulation (EC) No. 1272/2008 [CLP]	Type
aluminium oxide	EC: 215-691-6 CAS: 1344-28-1	100	Not classified.	[A]

There are no additional ingredients present which, within the current knowledge of the supplier, are classified and contribute to the classification of the substance and hence require reporting in this section.

Type

[A] Constituent
[B] Impurity
[C] Stabilising additive

Occupational exposure limits, if available, are listed in Section 8.

SECTION 4: First aid measures

Description of first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Get medical attention if irritation occurs.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. Get medical attention if symptoms occur.

Skin contact : Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Get medical attention if symptoms occur.

Ingestion : Wash out mouth with water. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. Do not induce vomiting unless directed to do so by medical personnel. Get medical attention if symptoms occur.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training.

Most important symptoms and effects, both acute and delayed

Potential acute health effects

SECTION 4: First aid measures

Inhalation : Unlikely to be hazardous by inhalation unless present as a dust. High concentrations of dust may be irritant to the upper respiratory tract. Dust may enter the lung and be slow to clear.

Ingestion : Ingestion may cause irritation of the gastrointestinal tract.

Skin contact : Repeated or prolonged skin contact may cause irritation. May cause physical abrasion in contact with skin.

Eye contact : Dust may cause irritation to eyes.

Over-exposure signs/symptoms

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Ingestion : No specific data.

Indication of any immediate medical attention and special treatment needed

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

SECTION 5: Firefighting measures

Extinguishing media

Suitable extinguishing media : Use an extinguishing agent suitable for the surrounding fire.

Unsuitable extinguishing media : None known.

Special hazards arising from the substance or mixture

Hazards from the substance or mixture : No specific fire or explosion hazard.

Hazardous combustion products : Decomposition products may include the following materials: metal oxide/oxides

Advice for firefighters

Special precautions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode. Clothing for fire-fighters (including helmets, protective boots and gloves) conforming to European standard EN 469 will provide a basic level of protection for chemical incidents.

SECTION 6: Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilt material. Put on appropriate personal protective equipment.

SECTION 6: Accidental release measures

For emergency responders : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Environmental precautions

Environmental precautions : Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods and material for containment and cleaning up

Small spill : Move containers from spill area. Vacuum or sweep up material and place in a designated, labelled waste container. Dispose of via a licensed waste disposal contractor.

Large spill : Move containers from spill area. Prevent entry into sewers, water courses, basements or confined areas. Vacuum or sweep up material and place in a designated, labelled waste container. Dispose of via a licensed waste disposal contractor.

Reference to other sections

See Section 1 for emergency contact information.
See Section 8 for information on appropriate personal protective equipment.
See Section 13 for additional waste treatment information.

SECTION 7: Handling and storage

Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8).

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Conditions for safe storage, including any incompatibilities

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a dry place. Keep only in the original container. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabelled containers. Use appropriate containment to avoid environmental contamination. Store away from incompatible materials (see Section 10). See Section 10 for incompatible materials before handling or use.

Specific end use(s)

Recommendations : Not available.

Industrial sector specific solutions : Not available.

SECTION 8: Exposure controls/personal protection

The information in this section contains generic advice and guidance. Information is provided based on typical anticipated uses of the product. Additional measures might be required for bulk handling or other uses that could significantly increase worker exposure or environmental releases.

Control parameters

Occupational exposure limits

Product/ingredient name	Exposure limit values
aluminium oxide Inhalable fraction Respirable dust	**EH40/2005 WELs (United Kingdom (UK), 12/2011).** TWA: 10 mg/m³ 8 hours. Form: inhalable dust ***[Air contaminant]*** **EH40/2005 WELs (United Kingdom (UK)).** TWA: 10 mg/m³ 8 hours. ***[Air contaminant]*** **EH40/2005 WELs (United Kingdom (UK)).** TWA: 4 mg/m³ 8 hours.

Recommended monitoring procedures : If this product contains ingredients with exposure limits, personal, workplace atmosphere or biological monitoring may be required to determine the effectiveness of the ventilation or other control measures and/or the necessity to use respiratory protective equipment. Reference should be made to monitoring standards, such as the following: European Standard EN 689 (Workplace atmospheres - Guidance for the assessment of exposure by inhalation to chemical agents for comparison with limit values and measurement strategy) European Standard EN 14042 (Workplace atmospheres - Guide for the application and use of procedures for the assessment of exposure to chemical and biological agents) European Standard EN 482 (Workplace atmospheres - General requirements for the performance of procedures for the measurement of chemical agents) Reference to national guidance documents for methods for the determination of hazardous substances will also be required.

Exposure controls

Appropriate engineering controls : Good general ventilation should be sufficient to control worker exposure to airborne contaminants.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

General information : All personal protective equipment (PPE) should be selected and used under the direction of a trained health and safety professional. PPE should be in compliance with any relevant local or national standard. Where no local or national standards apply, compliance with the relevant EU standard is recommended.
It remains the responsibility of the user to ensure that this product is used safely within the context of their site conditions.

Eye/face protection : Safety eyewear complying with an approved standard (EN 166 or local equivalent) is required during loading and unloading of reactors, cleaning and maintenance operations, and sampling, where exposure to dust, powder or liquid splashes is possible.

Skin protection

SECTION 8: Exposure controls/personal protection

Hand protection : Chemical/bio-chemical resistant, impervious gloves complying with an approved chemical standard (EN 374 or local equivalent) should be worn at all times when handling chemical products. For tasks involving physical or mechanical hazards, gloves should also comply with an approved physical standard (EN 388 or local equivalent).
Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Safety shoes complying with an approved standard (EN 20346 or equivalent) and a hard hat complying with an approved standard (EN 297 or equivalent) is required during loading and unloading of reactors, cleaning and maintenance operations and sampling.

Other skin protection : Wear protective coveralls. For dusty tasks where dermal contact is possible a protective suit complying with an approved standard (EN 13982-1 Type 5 or equivalent) may be worn

Respiratory protection : Use of Respiratory Protective Equipment (RPE) (Particle filter with high efficiency for solid particles (EN 143 or 149, Type P2 or FFP2, Associated Protection Factor (APF) = 10) or local equivalent as a minimum) is required during loading and unloading of reactors, cleaning and maintenance operations, and sampling, where exposure to dust or powder is possible. Air-fed Respiratory Protective Equipment may be used if entry to the reactor is required.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

SECTION 9: Physical and chemical properties

Information on basic physical and chemical properties

Appearance

Physical state : Solid. [spheres]

Colour : White.

Odour : Odourless.

Odour threshold : Not applicable.

pH : Not applicable.

Melting point/freezing point : Not determined.

Initial boiling point and boiling range : Not applicable.

Flash point : Not applicable.

Evaporation rate (butyl acetate = 1) : Not applicable.

Flammability (solid, gas) : Not classified.

Upper/lower flammability or explosive limits : Not applicable.

Vapour pressure (mm Hg) : Not applicable.

Vapour density : Not applicable.

Relative density : Not applicable.

SECTION 9: Physical and chemical properties

Bulk Density (g/ml)	:	2.0
Solubility(ies)	:	Soluble in the following materials: strong acids
Solubility - Water	:	insoluble in water.
Partition coefficient: n-octanol/water	:	Not applicable.
Auto-ignition temperature	:	Not applicable.
Decomposition temperature	:	Not available.
Viscosity (m.Pa.s)	:	Not applicable.
Explosive properties	:	Not available.
Oxidising properties	:	Not available.

Other information

No additional information.

SECTION 10: Stability and reactivity

Reactivity

No specific test data related to reactivity available for this product or its ingredients.

Chemical stability

The product is stable.

Possibility of hazardous reactions

Under normal conditions of storage and use, hazardous reactions will not occur.

Conditions to avoid

No specific data.

Incompatible materials

No specific data.

Hazardous decomposition products

Under normal conditions of storage and use, hazardous decomposition products should not be produced.

SECTION 11: Toxicological information

Information on toxicological effects

Acute toxicity

Conclusion/Summary : Not classified.

Irritation/Corrosion

Conclusion/Summary

Skin	:	Not classified.
Eyes	:	Not classified.
Respiratory	:	Not classified.

SECTION 11: Toxicological information

Sensitiser

Conclusion/Summary

Skin : Not classified.

Respiratory : Not classified.

Mutagenicity

Conclusion/Summary : Not classified.

Carcinogenicity

Conclusion/Summary : Not classified.

Reproductive toxicity

Conclusion/Summary : Not classified.

Teratogenicity

Conclusion/Summary : Not classified.

Specific target organ toxicity (single exposure)

Not available.

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not applicable.

Information on likely routes of exposure : Routes of entry anticipated: Dermal, Inhalation.

Potential acute health effects

Inhalation : Unlikely to be hazardous by inhalation unless present as a dust. High concentrations of dust may be irritant to the upper respiratory tract. Dust may enter the lung and be slow to clear.

Ingestion : Ingestion may cause irritation of the gastrointestinal tract.

Skin contact : Repeated or prolonged skin contact may cause irritation. May cause physical abrasion in contact with skin.

Eye contact : Dust may cause irritation to eyes.

Symptoms related to the physical, chemical and toxicological characteristics

Inhalation : No specific data.

Ingestion : No specific data.

Skin contact : No specific data.

Eye contact : No specific data.

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

SECTION 11: Toxicological information

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Conclusion/Summary : Not classified.

General : No known significant effects or critical hazards.

Carcinogenicity : No known significant effects or critical hazards.

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Other information : Not available.

SECTION 12: Ecological information

Toxicity

Product/ingredient name	Result	Species	Exposure
aluminium oxide	EC50 >100 mg/l IC50 >100 mg/l LC50 >100 mg/l	Daphnia - magna Algae - (Selenastrum capricornutum) Fish - (Trout Trotten)	48 hours 72 hours 96 hours

Conclusion/Summary : Not classified.

Persistence and degradability

Conclusion/Summary : The bioaccumulative criteria are not applicable to inorganic metals

Bioaccumulative potential

Not available.

Mobility in soil

Soil/water partition coefficient (K_{OC}) : Not available.

Mobility : Not available.

Results of PBT and vPvB assessment

PBT : Not applicable.
P: Not available. B: Not available. T: Not available.

vPvB : Not applicable.
vP: Not available. vB: Not available.

Other adverse effects

No known significant effects or critical hazards.

SECTION 13: Disposal considerations

Waste treatment methods

Product

Methods of disposal : The generation of waste should be avoided or minimised wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction.

Container information: : Since the emptied container retains product residue, follow label warnings even after it has been emptied.

Hazardous waste : Within the present knowledge of the supplier, this product is not regarded as hazardous waste, as defined by EU Directive 2008/98/EC.

European waste catalogue (EWC) : The user should assign a waste code to the material in accordance with the recommendations of the European Waste Catalogue.

Packaging

Methods of disposal : The generation of waste should be avoided or minimised wherever possible. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible.

Special precautions : This material and its container must be disposed of in a safe way. Empty containers or liners may retain some product residues. Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers.

SECTION 14: Transport information

	ADR/RID	ADN	IMDG	IATA
UN number	Not regulated.	Not regulated.	Not regulated.	Not regulated.
UN proper shipping name	-	-	-	-
Transport hazard class (es)	-	-	-	-
Packing group	-	-	-	-
Environmental hazards	No.	No.	No.	No.
Additional information	-	-	-	-

Special precautions for user : Not applicable

Transport in bulk according to Annex II of Marpol and the IBC Code : Not available.

SECTION 14: Transport information

SECTION 15: Regulatory information

Safety, health and environmental regulations/legislation specific for the substance or mixture

EU Regulation (EC) No. 1907/2006 (REACH)

Annex XIV - List of substances subject to authorisation

Annex XIV

None of the components are listed.

Substances of very high concern

None of the components are listed.

Annex XVII - Restrictions on the manufacture, placing on the market and use of certain dangerous substances, mixtures and articles : Not applicable.

Other EU regulations

Ozone depleting substances (1005/2009/EU)

Not listed.

Prior Informed Consent (PIC) (649/2012/EU)

Not listed.

International regulations

Chemical Weapon Convention List Schedules I, II & III Chemicals

Ingredient name	List name	Status
Not listed.		

Montreal Protocol (Annexes A, B, C, E)

Ingredient name	Status
Not listed.	

Stockholm Convention on Persistent Organic Pollutants

Ingredient name	List name	Status
Not listed.		

Rotterdam Convention on Prior Informed Consent (PIC)

Ingredient name	Status
Not listed.	

UNECE Aarhus Protocol on POPs and Heavy Metals

Ingredient name	List name	Status
Not listed.		

International lists

Inventory list

Australia : All components are listed or exempted.

Canada : All components are listed or exempted.

China : All components are listed or exempted.

Europe : All components are listed or exempted.

SECTION 15: Regulatory information

Japan	:	**Japan inventory (ENCS)**: All components are listed or exempted. **Japan inventory (ISHL)**: All components are listed or exempted.
Malaysia	:	All components are listed or exempted.
New Zealand	:	All components are listed or exempted.
Republic of Korea	:	All components are listed or exempted.
Philippines	:	All components are listed or exempted.
Taiwan	:	All components are listed or exempted.
Thailand	:	Not determined.
Turkey	:	All components are listed or exempted.
United States	:	All components are listed or exempted.
Viet Nam	:	Not determined.

SECTION 16: Other information

Indicates information that has changed from previously issued version.

Abbreviations and acronyms : ATE = Acute Toxicity Estimate
CLP = Classification, Labelling and Packaging Regulation [Regulation (EC) No. 1272/2008]
DNEL = Derived No Effect Level
EUH statement = CLP-specific Hazard statement
PNEC = Predicted No Effect Concentration
RRN = REACH Registration Number

Procedure used to derive the classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]

Classification	Justification
Not classified.	

Full text of abbreviated H statements

Not applicable.

Full text of classifications [CLP/GHS]

Not applicable.

Notice to reader

Information in this publication is believed to be accurate and is given in good faith, but it is for the Customer to satisfy itself of the suitability for its own particular purpose. Accordingly, Johnson Matthey gives no warranty as to the fitness of the Product for any particular purpose and any implied warranty or condition (statutory or otherwise) is excluded except to the extent that such exclusion is prevented by law. Freedom under Patent, Copyright and Designs cannot be assumed.
It is the policy of Johnson Matthey to update this information regularly. You are therefore advised to check that this sheet is the most recent issue.

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Version	:	1
Date of issue/ Date of revision	:	13/03/2014.
Date of previous issue	:	No previous validation.
Prepared by	:	Johnson Matthey Catalysts Regulatory Affairs Department

SECTION 1: Identification of the substance/mixture and of the company/ undertaking

Identification of the material and supplier

Product name	:	KATALCO$_{JM}$ 92-2C
Product type	:	Article.
Specific uses	:	Catalyst support
Supplier	:	Johnson Matthey Catalysts PO Box No 1, Billingham Stockton on Tees, TS23 1LB UNITED KINGDOM +44 (0) 1642 523343
e-mail address of person responsible for this SDS	:	jmcptsds@matthey.com

Emergency telephone number

Emergency telephone number (with hours of operation)	:	SembCorp Utilities, Middlesbrough, UK +44 (0) 1642 452461	(24 hours)

New emergency phone number to be used from : 16/07/2013

For Chemical Emergency ONLY (spill, leak, fire, exposure or accident) call :

Emergency telephone number (with hours of operation)	:	+44 (0) 870 8200418 CHEMTREC UK (London)	(24 hours)
		+(1) 703-527-3887 CHEMTREC International	(24 hours)
Country information	:	000-800-100-7141 CHEMTREC India (local) +(972)-37630639 CHEMTREC Israel	(24 hours)
Information limitations	:	For emergency calls only. Non-emergency calls cannot be serviced at this number.	
CHEMTREC Customer Number (CCN)	:	CCN12026	

2. HAZARDS IDENTIFICATION

No known significant effects or critical hazards.

Substance meets the criteria for PBT according to Regulation (EC) No. 1907/2006, Annex XIII	:	Not applicable. P: Not available. B: Not available. T: Not available.
Substance meets the criteria for vPvB according to Regulation (EC) No. 1907/2006, Annex XIII	:	Not applicable. vP: Not available. vB: Not available.

See Section 11 for more detailed information on health effects and symptoms.

SECTION 3: Composition/information on ingredients

Product definition : Article.

Product/ingredient name	Identifiers	%	Classification		Type
			67/548/EEC	Regulation (EC) No. 1272/2008 [CLP]	
Aluminatesilicate	EC: 215-475-1 CAS: 1327-36-2	100	Not classified.	Not classified.	[A]

There are no additional ingredients present which, within the current knowledge of the supplier, are classified and contribute to the classification of the substance and hence require reporting in this section.

Type

[A] Constituent
[B] Impurity
[C] Stabilising additive

Occupational exposure limits, if available, are listed in Section 8.

SECTION 4: First aid measures

Description of first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Get medical attention if irritation occurs.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. Get medical attention if symptoms occur.

Skin contact : Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Get medical attention if symptoms occur.

Ingestion : Wash out mouth with water. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. Do not induce vomiting unless directed to do so by medical personnel. Get medical attention if symptoms occur.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training.

Most important symptoms and effects, both acute and delayed

Potential acute health effects

Inhalation : Unlikely to be hazardous by inhalation unless present as a dust. High concentrations of dust may be irritant to the upper respiratory tract. Dust may enter the lung and be slow to clear.

Ingestion : Ingestion may cause irritation of the gastrointestinal tract.

Skin contact : Repeated or prolonged skin contact may cause irritation. May cause physical abrasion in contact with skin.

Eye contact : Dust may cause irritation to eyes.

Over-exposure signs/symptoms

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Ingestion : No specific data.

Indication of any immediate medical attention and special treatment needed

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

See Section 11 for more detailed information on health effects and symptoms.

SECTION 5: Firefighting measures

Extinguishing media

Suitable extinguishing media : Use an extinguishing agent suitable for the surrounding fire.

Unsuitable extinguishing media : None known.

Special hazards arising from the substance or mixture

Hazards from the substance or mixture : No specific fire or explosion hazard.

Hazardous combustion products : Decomposition products may include the following materials:
metal oxide/oxides

Advice for firefighters

Special precautions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode. Clothing for fire-fighters (including helmets, protective boots and gloves) conforming to European standard EN 469 will provide a basic level of protection for chemical incidents.

SECTION 6: Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilt material. Put on appropriate personal protective equipment.

For emergency responders : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Environmental precautions : Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods and materials for containment and cleaning up

Small spill : Move containers from spill area. Vacuum or sweep up material and place in a designated, labelled waste container. Dispose of via a licensed waste disposal contractor.

Large spill : Move containers from spill area. Prevent entry into sewers, water courses, basements or confined areas. Vacuum or sweep up material and place in a designated, labelled waste container. Dispose of via a licensed waste disposal contractor.

Reference to other sections : See Section 1 for emergency contact information.
See Section 8 for information on appropriate personal protective equipment.
See Section 13 for additional waste treatment information.

SECTION 7: Handling and storage

Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8).

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a dry place. Keep only in the original container. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabelled containers. Use appropriate containment to avoid environmental contamination. Store away from incompatible materials (see Section 10).

Additional information : Further advice given in the Johnson Matthey publication 'Catalyst Handling'.

SECTION 8: Exposure controls/personal protection

Control parameters

Occupational exposure limits

Product/ingredient name	Exposure limit values
Inhalable fraction	*[Air contaminant]* **EH40/2005 WELs (United Kingdom (UK)).** TWA: 10 mg/m³ 8 hours.
Respirable dust	*[Air contaminant]* **EH40/2005 WELs (United Kingdom (UK)).** TWA: 4 mg/m³ 8 hours.

Recommended monitoring procedures : If this product contains ingredients with exposure limits, personal, workplace atmosphere or biological monitoring may be required to determine the effectiveness of the ventilation or other control measures and/or the necessity to use respiratory protective equipment. Reference should be made to monitoring standards, such as the following: European Standard EN 689 (Workplace atmospheres - Guidance for the assessment of exposure by inhalation to chemical agents for comparison with limit values and measurement strategy) European Standard EN 14042 (Workplace atmospheres - Guide for the application and use of procedures for the assessment of exposure to chemical and biological agents) European Standard EN 482 (Workplace atmospheres - General requirements for the performance of procedures for the measurement of chemical agents) Reference to national guidance documents for methods for the determination of hazardous substances will also be required.

Exposure controls

Appropriate engineering controls : Good general ventilation should be sufficient to control worker exposure to airborne contaminants.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

General information : All personal protective equipment (PPE) should be selected and used under the direction of a trained health and safety professional. PPE should be in compliance with any relevant local or national standard. Where no local or national standards apply, compliance with the relevant EU standard is recommended.
It remains the responsibility of the user to ensure that this product is used safely within the context of their site conditions.

SECTION 8: Exposure controls/personal protection

Eye/face protection : Safety eyewear complying with an approved standard (EN 166 or local equivalent) is required during loading and unloading of reactors, cleaning and maintenance operations, and sampling, where exposure to dust, powder or liquid splashes is possible.

Skin protection

Hand protection : Chemical/bio-chemical resistant, impervious gloves complying with an approved chemical standard (EN 374 or local equivalent) should be worn at all times when handling chemical products. For tasks involving physical or mechanical hazards, gloves should also comply with an approved physical standard (EN 388 or local equivalent).
Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties.
In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Safety shoes complying with an approved standard (EN 20346 or equivalent) and a hard hat complying with an approved standard (EN 297 or equivalent) is required during loading and unloading of reactors, cleaning and maintenance operations and sampling.

Other skin protection : Wear protective coveralls. For dusty tasks where dermal contact is possible a protective suit complying with an approved standard (EN 13982-1 Type 5 or equivalent) may be worn

Respiratory protection : Use of Respiratory Protective Equipment (RPE) (Particle filter with high efficiency for solid particles (EN 143 or 149, Type P2 or FFP2, Associated Protection Factor (APF) = 10) or local equivalent as a minimum) is required during loading and unloading of reactors, cleaning and maintenance operations, and sampling, where exposure to dust or powder is possible. Air-fed Respiratory Protective Equipment may be used if entry to the reactor is required.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

SECTION 9: Physical and chemical properties

Information on basic physical and chemical properties

Appearance

Physical state	:	Solid. [spheres]
Colour	:	Off-white.
Odour	:	Odourless.
Odour threshold	:	Not applicable.
pH	:	Not applicable.
Melting point/freezing point	:	Not determined.
Initial boiling point and boiling range	:	Not applicable.
Flash point	:	Not applicable.
Evaporation rate (butyl acetate = 1)	:	Not applicable.
Flammability (solid, gas)	:	Not classified.
Upper/lower flammability or explosive limits	:	Not applicable.
Vapour pressure (mm Hg)	:	Not applicable.
Vapour density	:	Not applicable.
Relative density	:	Not applicable.
Bulk Density (g/ml)	:	1.25 - 1.50
Solubility(ies)	:	Partially soluble in the following materials: strong acids
Solubility - Water	:	insoluble in water.

SECTION 9: Physical and chemical properties

Partition coefficient: n-octanol/ water : Not applicable.

Auto-ignition temperature : Not applicable.

Decomposition temperature : Not available.

Viscosity (m.Pa.s) : Not applicable.

Explosive properties : Not available.

Oxidising properties : Not available.

Other information

No additional information.

SECTION 10: Stability and reactivity

Reactivity : No specific test data related to reactivity available for this product or its ingredients.

Chemical stability : The product is stable.

Possibility of hazardous reactions : Under normal conditions of storage and use, hazardous reactions will not occur.

Conditions to avoid : No specific data.

Incompatible materials : No specific data.

Hazardous decomposition products : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

SECTION 11: Toxicological information

Information on toxicological effects

Acute toxicity

Conclusion/Summary : Not classified.

Irritation/Corrosion

Conclusion/Summary

Skin : Not classified.

Eyes : Not classified.

Respiratory : Not classified.

Sensitiser

Conclusion/Summary

Skin : Not classified.

Respiratory : Not classified.

Mutagenicity

Conclusion/Summary : Not classified.

Carcinogenicity

Conclusion/Summary : Not classified.

Reproductive toxicity

Conclusion/Summary : Not classified.

Teratogenicity

Conclusion/Summary : Not classified.

Specific target organ toxicity (single exposure)

SECTION 11: Toxicological information

Not available.

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not available.

Information on the likely routes of exposure : Routes of entry anticipated: Dermal, Inhalation.

Potential acute health effects

Inhalation : Unlikely to be hazardous by inhalation unless present as a dust. High concentrations of dust may be irritant to the upper respiratory tract. Dust may enter the lung and be slow to clear.

Ingestion : Ingestion may cause irritation of the gastrointestinal tract.

Skin contact : Repeated or prolonged skin contact may cause irritation. May cause physical abrasion in contact with skin.

Eye contact : Dust may cause irritation to eyes.

Symptoms related to the physical, chemical and toxicological characteristics

Inhalation : No specific data.

Ingestion : No specific data.

Skin contact : No specific data.

Eye contact : No specific data.

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Conclusion/Summary : Not classified.

General : No known significant effects or critical hazards.

Carcinogenicity : No known significant effects or critical hazards.

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Other information : Not available.

SECTION 12: Ecological information

Toxicity

Conclusion/Summary : Not classified.

Persistence and degradability

Conclusion/Summary : The bioaccumulative criteria are not applicable to essential metals.

Bioaccumulative potential

Not available.

Mobility in soil

SECTION 12: Ecological information

Soil/water partition coefficient (K_{OC}) : Not available.

Mobility : Not available.

P: Not available. B: Not available. T: Not available.

vP: Not available. vB: Not available.

Other adverse effects : No known significant effects or critical hazards.

SECTION 13: Disposal considerations

Waste treatment methods

Product

Methods of disposal : The generation of waste should be avoided or minimised wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction.

Container information: : Since the emptied container retains product residue, follow label warnings even after it has been emptied.

Hazardous waste : Within the present knowledge of the supplier, this product is not regarded as hazardous waste, as defined by EU Directive 91/689/EEC.

European waste catalogue (EWC) : The user should assign a waste code to the material in accordance with the recommendations of the European Waste Catalogue.

Packaging

Methods of disposal : The generation of waste should be avoided or minimised wherever possible. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible.

Special precautions : This material and its container must be disposed of in a safe way. Empty containers or liners may retain some product residues. Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers.

SECTION 14: Transport information

	ADR/RID	ADN	IMDG	IATA
UN number	Not regulated.	Not regulated.	Not regulated.	Not regulated.
UN proper shipping name	-	-	-	-
Transport hazard class(es)	-	-	-	-
Packing group	-	-	-	-
Environmental hazards	No.	No.	No.	No.
Additional information	-	-	-	-

Special precautions for user : Not applicable

SECTION 14: Transport information

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code : Not available.

SECTION 15: Regulatory information

Safety, health and environmental regulations/legislation specific for the substance or mixture

EU Regulation (EC) No. 1907/2006 (REACH)

Annex XIV - List of substances subject to authorisation

Substances of very high concern

None of the components are listed.

Annex XVII - Restrictions on the manufacture, placing on the market and use of certain dangerous substances, mixtures and articles : Not applicable.

Other EU regulations

Europe inventory : All components are listed or exempted.

Black List Chemicals (76/464/EEC) : Not listed

Priority List Chemicals (793/93/EEC) : Not listed

International regulations

Chemical Weapons Convention List Schedule I Chemicals : Not listed

Chemical Weapons Convention List Schedule II Chemicals : Not listed

Chemical Weapons Convention List Schedule III Chemicals : Not listed

SECTION 16: Other information

Indicates information that has changed from previously issued version.

Abbreviations and acronyms : ATE = Acute Toxicity Estimate
CLP = Classification, Labelling and Packaging Regulation [Regulation (EC) No. 1272/2008]
DNEL = Derived No Effect Level
EUH statement = CLP-specific Hazard statement
PNEC = Predicted No Effect Concentration
RRN = REACH Registration Number

Procedure used to derive the classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]

Classification	Justification
Not classified.	

Full text of abbreviated H statements : Not applicable.

Full text of classifications [CLP/GHS] : Not applicable.

Full text of abbreviated R phrases : Not applicable.

Full text of classifications [DSD/DPD] : Not applicable.

SECTION 16: Other information

Notice to reader

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Inspiring science, enhancing life

Product Specific Information

KATALCO 92-2F

Version	:	1
Date of issue/ Date of revision	:	28/05/2019
Date of previous issue	:	No previous validation

SECTION 1: Identification of the substance/mixture and of the company/ undertaking

Identification of the material and supplier

Product identifier	:	**KATALCO™** 92-2F
Product type	:	Solid.
Product definition	:	Article.
Specific uses	:	Catalyst support
Supplier	:	Johnson Matthey PO Box No 1,Belasis Avenue, Billingham, Stockton on Tees, TS23 1LB, UK +44 (0) 1642 523343
e-mail address of person responsible for this SDS	:	jmsds1@matthey.com

Emergency telephone number

For Chemical Emergency ONLY (spill, leak, fire, exposure or accident) call :

Emergency telephone number (with hours of operation)	:	+44 (0) 870 8200418 CHEMTREC UK (London)	(24 hours)
		+(1) 703-527-3887 CHEMTREC International	(24 hours)
Country information	:	000-800-100-7141 CHEMTREC India (local)	(24 hours)
Information limitations	:	For emergency calls only. Non-emergency calls cannot be serviced at this number.	
CHEMTREC Customer Number (CCN)	:	CCN12026	

SECTION 2: Hazards identification

No known significant effects or critical hazards.

See Section 11 for more detailed information on health effects and symptoms.

Other hazards

SECTION 2: Hazards identification

Substance meets the criteria for PBT according to Regulation (EC) No. 1907/2006, Annex XIII : Not applicable.
P: Not available. B: Not available. T: Not available.

Substance meets the criteria for vPvB according to Regulation (EC) No. 1907/2006, Annex XIII : Not applicable.
vP: Not available. vB: Not available.

Other hazards which do not result in classification : None known.

SECTION 3: Composition/information on ingredients

Product definition : Article.

Product/ ingredient name	Identifiers	%	Regulation (EC) No. 1272/2008 [CLP]	Type
Aluminatesilicate	EC: 215-475-1 CAS: 1327-36-2	100	Not classified.	[A]

There are no additional ingredients present which, within the current knowledge of the supplier, are classified and contribute to the classification of the substance and hence require reporting in this section.

Type

[A] Constituent
[B] Impurity
[C] Stabilising additive

Occupational exposure limits, if available, are listed in Section 8.

SECTION 4: First aid measures

Description of first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Get medical attention if irritation occurs.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. Get medical attention if symptoms occur.

Skin contact : Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Get medical attention if symptoms occur.

Ingestion : Wash out mouth with water. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. Do not induce vomiting unless directed to do so by medical personnel. Get medical attention if symptoms occur.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training.

Most important symptoms and effects, both acute and delayed

Potential acute health effects

SECTION 4: First aid measures

Inhalation : Unlikely to be hazardous by inhalation unless present as a dust. High concentrations of dust may be irritant to the upper respiratory tract. Dust may enter the lung and be slow to clear.

Ingestion : Ingestion may cause irritation of the gastrointestinal tract.

Skin contact : Repeated or prolonged skin contact may cause irritation. May cause physical abrasion in contact with skin.

Eye contact : Dust may cause irritation to eyes.

Over-exposure signs/symptoms

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Ingestion : No specific data.

Indication of any immediate medical attention and special treatment needed

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

SECTION 5: Firefighting measures

Extinguishing media

Suitable extinguishing media : Use an extinguishing agent suitable for the surrounding fire.

Unsuitable extinguishing media : None known.

Special hazards arising from the substance or mixture

Hazards from the substance or mixture : No specific fire or explosion hazard.

Hazardous combustion products : Decomposition products may include the following materials: metal oxide/oxides

Advice for firefighters

Special precautions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode. Clothing for fire-fighters (including helmets, protective boots and gloves) conforming to European standard EN 469 will provide a basic level of protection for chemical incidents.

SECTION 6: Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilt material. Put on appropriate personal protective equipment.

SECTION 6: Accidental release measures

For emergency responders : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Environmental precautions

Environmental precautions : Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods and material for containment and cleaning up

Small spill : Move containers from spill area. Vacuum or sweep up material and place in a designated, labelled waste container. Dispose of via a licensed waste disposal contractor.

Large spill : Move containers from spill area. Prevent entry into sewers, water courses, basements or confined areas. Vacuum or sweep up material and place in a designated, labelled waste container. Dispose of via a licensed waste disposal contractor.

Reference to other sections

See Section 1 for emergency contact information.
See Section 8 for information on appropriate personal protective equipment.
See Section 13 for additional waste treatment information.

SECTION 7: Handling and storage

Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8).

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Conditions for safe storage, including any incompatibilities

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a dry place. Keep only in the original container. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabelled containers. Use appropriate containment to avoid environmental contamination. Store away from incompatible materials (see Section 10). See Section 10 for incompatible materials before handling or use.

Additional information : Further advice given in the Johnson Matthey publication 'Catalyst Handling'.

Specific end use(s)

Recommendations : Not available.

Industrial sector specific solutions : Not available.

SECTION 8: Exposure controls/personal protection

The information in this section contains generic advice and guidance. Information is provided based on typical anticipated uses of the product. Additional measures might be required for bulk handling or other uses that could significantly increase worker exposure or environmental releases.

Control parameters

Occupational exposure limits

Product/ingredient name	Exposure limit values
Inhalable fraction	***[Air contaminant]*** **EH40/2005 WELs (United Kingdom (UK)).** TWA: 10 mg/m³ 8 hours.
Respirable dust	***[Air contaminant]*** **EH40/2005 WELs (United Kingdom (UK)).** TWA: 4 mg/m³ 8 hours.

Recommended monitoring procedures : If this product contains ingredients with exposure limits, personal, workplace atmosphere or biological monitoring may be required to determine the effectiveness of the ventilation or other control measures and/or the necessity to use respiratory protective equipment. Reference should be made to monitoring standards, such as the following: European Standard EN 689 (Workplace atmospheres - Guidance for the assessment of exposure by inhalation to chemical agents for comparison with limit values and measurement strategy) European Standard EN 14042 (Workplace atmospheres - Guide for the application and use of procedures for the assessment of exposure to chemical and biological agents) European Standard EN 482 (Workplace atmospheres - General requirements for the performance of procedures for the measurement of chemical agents) Reference to national guidance documents for methods for the determination of hazardous substances will also be required.

Exposure controls

Appropriate engineering controls : Good general ventilation should be sufficient to control worker exposure to airborne contaminants.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

General information : All personal protective equipment (PPE) should be selected and used under the direction of a trained health and safety professional. PPE should be in compliance with any relevant local or national standard. Where no local or national standards apply, compliance with the relevant EU standard is recommended.
It remains the responsibility of the user to ensure that this product is used safely within the context of their site conditions.

Eye/face protection : Safety eyewear complying with an approved standard (EN 166 or local equivalent) is required during loading and unloading of reactors, cleaning and maintenance operations, and sampling, where exposure to dust, powder or liquid splashes is possible.

Skin protection

SECTION 8: Exposure controls/personal protection

Hand protection : Chemical/bio-chemical resistant, impervious gloves complying with an approved chemical standard (EN 374 or local equivalent) should be worn at all times when handling chemical products. For tasks involving physical or mechanical hazards, gloves should also comply with an approved physical standard (EN 388 or local equivalent).
Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Safety shoes complying with an approved standard (EN 20346 or equivalent) and a hard hat complying with an approved standard (EN 297 or equivalent) is required during loading and unloading of reactors, cleaning and maintenance operations and sampling.

Other skin protection : Wear protective coveralls. For dusty tasks where dermal contact is possible a protective suit complying with an approved standard (EN 13982-1 Type 5 or equivalent) may be worn

Respiratory protection : Use of Respiratory Protective Equipment (RPE) (Particle filter with high efficiency for solid particles (EN 143 or 149, Type P2 or FFP2, Associated Protection Factor (APF) = 10) or local equivalent as a minimum) is required during loading and unloading of reactors, cleaning and maintenance operations, and sampling, where exposure to dust or powder is possible. Air-fed Respiratory Protective Equipment may be used if entry to the reactor is required.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

SECTION 9: Physical and chemical properties

Information on basic physical and chemical properties

Appearance

Physical state : Solid. [spheres]

Colour : Off-white.

Odour : Odourless.

Odour threshold : Not applicable.

pH : Not applicable.

Melting point/freezing point : Not determined.

Initial boiling point and boiling range : Not applicable.

Flash point : Not applicable.

Evaporation rate (butyl acetate = 1) : Not applicable.

Flammability (solid, gas) : Not classified.

Upper/lower flammability or explosive limits : Not applicable.

Vapour pressure (mm Hg) : Not applicable.

Vapour density : Not applicable.

Relative density : Not applicable.

SECTION 9: Physical and chemical properties

Bulk Density (g/ml)	:	1.39
Solubility(ies)	:	Partially soluble in the following materials: strong acids
Solubility - Water	:	insoluble in water.
Partition coefficient: n-octanol/water	:	Not applicable.
Auto-ignition temperature	:	Not applicable.
Decomposition temperature	:	Not available.
Viscosity (m.Pa.s)	:	Not applicable.
Explosive properties	:	Not available.
Oxidising properties	:	Not available.

Other information

No additional information.

SECTION 10: Stability and reactivity

Reactivity

No specific test data related to reactivity available for this product or its ingredients.

Chemical stability

The product is stable.

Possibility of hazardous reactions

Under normal conditions of storage and use, hazardous reactions will not occur.

Conditions to avoid

No specific data.

Incompatible materials

No specific data.

Hazardous decomposition products

Under normal conditions of storage and use, hazardous decomposition products should not be produced.

SECTION 11: Toxicological information

Information on toxicological effects

Acute toxicity

Conclusion/Summary : Not classified.

Irritation/Corrosion

Conclusion/Summary

Skin	:	Not classified.
Eyes	:	Not classified.
Respiratory	:	Not classified.

SECTION 11: Toxicological information

Sensitiser

Conclusion/Summary

Skin : Not classified.

Respiratory : Not classified.

Mutagenicity

Conclusion/Summary : Not classified.

Carcinogenicity

Conclusion/Summary : Not classified.

Reproductive toxicity

Conclusion/Summary : Not classified.

Teratogenicity

Conclusion/Summary : Not classified.

Specific target organ toxicity (single exposure)

Not available.

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not applicable.

Information on likely routes of exposure : Routes of entry anticipated: Dermal, Inhalation.

Potential acute health effects

Inhalation : Unlikely to be hazardous by inhalation unless present as a dust. High concentrations of dust may be irritant to the upper respiratory tract. Dust may enter the lung and be slow to clear.

Ingestion : Ingestion may cause irritation of the gastrointestinal tract.

Skin contact : Repeated or prolonged skin contact may cause irritation. May cause physical abrasion in contact with skin.

Eye contact : Dust may cause irritation to eyes.

Symptoms related to the physical, chemical and toxicological characteristics

Inhalation : No specific data.

Ingestion : No specific data.

Skin contact : No specific data.

Eye contact : No specific data.

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

SECTION 11: Toxicological information

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Conclusion/Summary : Not classified.

General : No known significant effects or critical hazards.

Carcinogenicity : No known significant effects or critical hazards.

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Other information : Not available.

SECTION 12: Ecological information

Toxicity

Conclusion/Summary : Not classified.

Persistence and degradability

Conclusion/Summary : The bioaccumulative criteria are not applicable to inorganic metals

Bioaccumulative potential

Not available.

Mobility in soil

Soil/water partition coefficient (K_{OC}) : Not available.

Mobility : Not available.

Results of PBT and vPvB assessment

PBT : Not applicable.
P: Not available. B: Not available. T: Not available.

vPvB : Not applicable.
vP: Not available. vB: Not available.

Other adverse effects

No known significant effects or critical hazards.

SECTION 13: Disposal considerations

Waste treatment methods

Product

Methods of disposal : The generation of waste should be avoided or minimised wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction.

Container information: : Since the emptied container retains product residue, follow label warnings even after it has been emptied.

Hazardous waste : Within the present knowledge of the supplier, this product is not regarded as hazardous waste, as defined by EU Directive 2008/98/EC.

European waste catalogue (EWC) : The user should assign a waste code to the material in accordance with the recommendations of the European Waste Catalogue.

Packaging

Methods of disposal : The generation of waste should be avoided or minimised wherever possible. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible.

Special precautions : This material and its container must be disposed of in a safe way. Empty containers or liners may retain some product residues. Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers.

SECTION 14: Transport information

	ADR/RID	ADN	IMDG	IATA
UN number	Not regulated.	Not regulated.	Not regulated.	Not regulated.
UN proper shipping name	-	-	-	-
Transport hazard class (es)	-	-	-	-
Packing group	-	-	-	-
Environmental hazards	No.	No.	No.	No.
Additional information	-	-	-	-

Special precautions for user : Not applicable

Transport in bulk according to Annex II of Marpol and the IBC Code : Not available.

SECTION 14: Transport information

SECTION 15: Regulatory information

Safety, health and environmental regulations/legislation specific for the substance or mixture

EU Regulation (EC) No. 1907/2006 (REACH)

Annex XIV - List of substances subject to authorisation

Annex XIV

None of the components are listed.

Substances of very high concern

None of the components are listed.

Annex XVII - Restrictions on the manufacture, placing on the market and use of certain dangerous substances, mixtures and articles : Not applicable.

Other EU regulations

Ozone depleting substances (1005/2009/EU)

Not listed.

Prior Informed Consent (PIC) (649/2012/EU)

Not listed.

International regulations

Chemical Weapon Convention List Schedules I, II & III Chemicals

Ingredient name	List name	Status
Not listed.		

Montreal Protocol (Annexes A, B, C, E)

Ingredient name	Status
Not listed.	

Stockholm Convention on Persistent Organic Pollutants

Ingredient name	List name	Status
Not listed.		

Rotterdam Convention on Prior Informed Consent (PIC)

Ingredient name	Status
Not listed.	

UNECE Aarhus Protocol on POPs and Heavy Metals

Ingredient name	List name	Status
Not listed.		

International lists

Inventory list

Australia : All components are listed or exempted.

Canada : All components are listed or exempted.

China : All components are listed or exempted.

Europe : All components are listed or exempted.

SECTION 15: Regulatory information

Japan	:	**Japan inventory (ENCS)**: All components are listed or exempted. **Japan inventory (ISHL)**: All components are listed or exempted.
Malaysia	:	Not determined.
New Zealand	:	All components are listed or exempted.
Republic of Korea	:	All components are listed or exempted.
Philippines	:	All components are listed or exempted.
Taiwan	:	All components are listed or exempted.
Thailand	:	Not determined.
Turkey	:	All components are listed or exempted.
United States	:	All components are listed or exempted.
Viet Nam	:	Not determined.

SECTION 16: Other information

Indicates information that has changed from previously issued version.

Abbreviations and acronyms : ATE = Acute Toxicity Estimate
CLP = Classification, Labelling and Packaging Regulation [Regulation (EC) No. 1272/2008]
DNEL = Derived No Effect Level
EUH statement = CLP-specific Hazard statement
PNEC = Predicted No Effect Concentration
RRN = REACH Registration Number

Procedure used to derive the classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]

Classification	Justification
Not classified.	

Full text of abbreviated H statements

Not applicable.

Full text of classifications [CLP/GHS]

Not applicable.

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Prepared by	:	Johnson Matthey Process Technologies Regulatory Affairs Department

SECTION 1: Identification of the substance/mixture and of the company/ undertaking

Identification of the material and supplier

Product name	:	KATALCO$_{JM}$ 92-2J
Product definition	:	Article.
Specific uses	:	Catalyst support
Product type	:	Solid.
Supplier	:	Johnson Matthey Process Technologies PO Box No 1, Billingham Stockton on Tees, TS23 1LB UNITED KINGDOM +44 (0) 1642 523343
e-mail address of person responsible for this SDS	:	protechsds.enquiries@matthey.com

Emergency telephone number

For Chemical Emergency ONLY (spill, leak, fire, exposure or accident) call :

Emergency telephone number (with hours of operation)	:	+44 (0) 870 8200418 CHEMTREC UK (London)	(24 hours)
		+(1) 703-527-3887 CHEMTREC International	(24 hours)
Country information	:	000-800-100-7141 CHEMTREC India (local)	(24 hours)
Information limitations	:	For emergency calls only. Non-emergency calls cannot be serviced at this number.	
CHEMTREC Customer Number (CCN)	:	CCN12026	

2. HAZARDS IDENTIFICATION

No known significant effects or critical hazards.

Substance meets the criteria for PBT according to Regulation (EC) No. 1907/2006, Annex XIII	:	Not applicable. P: Not available. B: Not available. T: Not available.
Substance meets the criteria for vPvB according to Regulation (EC) No. 1907/2006, Annex XIII	:	Not applicable. vP: Not available. vB: Not available.

See Section 11 for more detailed information on health effects and symptoms.

SECTION 3: Composition/information on ingredients

Product definition : Article.

Product/ingredient name	Identifiers	%	Classification Regulation (EC) No. 1272/2008 [CLP]	Type
Aluminatesilicate	EC: 215-475-1 CAS: 1327-36-2	100	Not classified. **See Section 16 for the full text of the H statements declared above.**	[A]

There are no additional ingredients present which, within the current knowledge of the supplier, are classified and contribute to the classification of the substance and hence require reporting in this section.

Type

[A] Constituent
[B] Impurity
[C] Stabilising additive

Occupational exposure limits, if available, are listed in Section 8.

SECTION 4: First aid measures

Description of first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Get medical attention if irritation occurs.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. Get medical attention if symptoms occur.

Skin contact : Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Get medical attention if symptoms occur.

Ingestion : Wash out mouth with water. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. Do not induce vomiting unless directed to do so by medical personnel. Get medical attention if symptoms occur.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training.

Most important symptoms and effects, both acute and delayed

Potential acute health effects

Inhalation : Unlikely to be hazardous by inhalation unless present as a dust. High concentrations of dust may be irritant to the upper respiratory tract. Dust may enter the lung and be slow to clear.

Ingestion : Ingestion may cause irritation of the gastrointestinal tract.

Skin contact : Repeated or prolonged skin contact may cause irritation. May cause physical abrasion in contact with skin.

Eye contact : Dust may cause irritation to eyes.

Over-exposure signs/symptoms

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Ingestion : No specific data.

Indication of any immediate medical attention and special treatment needed

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

See Section 11 for more detailed information on health effects and symptoms.

SECTION 4: First aid measures

SECTION 5: Firefighting measures

Extinguishing media

Suitable extinguishing media : Use an extinguishing agent suitable for the surrounding fire.

Unsuitable extinguishing media : None known.

Special hazards arising from the substance or mixture

Hazards from the substance or mixture : No specific fire or explosion hazard.

Hazardous combustion products : Decomposition products may include the following materials:
metal oxide/oxides

Advice for firefighters

Special precautions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode. Clothing for fire-fighters (including helmets, protective boots and gloves) conforming to European standard EN 469 will provide a basic level of protection for chemical incidents.

SECTION 6: Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilt material. Put on appropriate personal protective equipment.

For emergency responders : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Environmental precautions : Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods and material for containment and cleaning up

Small spill : Move containers from spill area. Vacuum or sweep up material and place in a designated, labelled waste container. Dispose of via a licensed waste disposal contractor.

Large spill : Move containers from spill area. Prevent entry into sewers, water courses, basements or confined areas. Vacuum or sweep up material and place in a designated, labelled waste container. Dispose of via a licensed waste disposal contractor.

Reference to other sections : See Section 1 for emergency contact information.
See Section 8 for information on appropriate personal protective equipment.
See Section 13 for additional waste treatment information.

SECTION 7: Handling and storage

Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8).

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a dry place. Keep only in the original container. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabelled containers. Use appropriate containment to avoid environmental contamination. Store away from incompatible materials (see Section 10).

Additional information : Further advice given in the Johnson Matthey publication 'Catalyst Handling'.

SECTION 8: Exposure controls/personal protection

Control parameters

Occupational exposure limits

Product/ingredient name	Exposure limit values
Inhalable fraction	*[Air contaminant]* **EH40/2005 WELs (United Kingdom (UK)).** TWA: 10 mg/m³ 8 hours.
Respirable dust	*[Air contaminant]* **EH40/2005 WELs (United Kingdom (UK)).** TWA: 4 mg/m³ 8 hours.

Recommended monitoring procedures : If this product contains ingredients with exposure limits, personal, workplace atmosphere or biological monitoring may be required to determine the effectiveness of the ventilation or other control measures and/or the necessity to use respiratory protective equipment. Reference should be made to monitoring standards, such as the following: European Standard EN 689 (Workplace atmospheres - Guidance for the assessment of exposure by inhalation to chemical agents for comparison with limit values and measurement strategy) European Standard EN 14042 (Workplace atmospheres - Guide for the application and use of procedures for the assessment of exposure to chemical and biological agents) European Standard EN 482 (Workplace atmospheres - General requirements for the performance of procedures for the measurement of chemical agents) Reference to national guidance documents for methods for the determination of hazardous substances will also be required.

Exposure controls

Appropriate engineering controls : Good general ventilation should be sufficient to control worker exposure to airborne contaminants.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

General information : All personal protective equipment (PPE) should be selected and used under the direction of a trained health and safety professional. PPE should be in compliance with any relevant local or national standard. Where no local or national standards apply, compliance with the relevant EU standard is recommended.
It remains the responsibility of the user to ensure that this product is used safely within the context of their site conditions.

SECTION 8: Exposure controls/personal protection

Eye/face protection : Safety eyewear complying with an approved standard (EN 166 or local equivalent) is required during loading and unloading of reactors, cleaning and maintenance operations, and sampling, where exposure to dust, powder or liquid splashes is possible.

Skin protection

Hand protection : Chemical/bio-chemical resistant, impervious gloves complying with an approved chemical standard (EN 374 or local equivalent) should be worn at all times when handling chemical products. For tasks involving physical or mechanical hazards, gloves should also comply with an approved physical standard (EN 388 or local equivalent).
Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties.
In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Safety shoes complying with an approved standard (EN 20346 or equivalent) and a hard hat complying with an approved standard (EN 297 or equivalent) is required during loading and unloading of reactors, cleaning and maintenance operations and sampling.

Other skin protection : Wear protective coveralls. For dusty tasks where dermal contact is possible a protective suit complying with an approved standard (EN 13982-1 Type 5 or equivalent) may be worn

Respiratory protection : Use of Respiratory Protective Equipment (RPE) (Particle filter with high efficiency for solid particles (EN 143 or 149, Type P2 or FFP2, Associated Protection Factor (APF) = 10) or local equivalent as a minimum) is required during loading and unloading of reactors, cleaning and maintenance operations, and sampling, where exposure to dust or powder is possible. Air-fed Respiratory Protective Equipment may be used if entry to the reactor is required.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

SECTION 9: Physical and chemical properties

Information on basic physical and chemical properties

Appearance

Physical state	:	Solid. [spheres]
Colour	:	Off-white.
Odour	:	Odourless.
Odour threshold	:	Not applicable.
pH	:	Not applicable.
Melting point/freezing point	:	Not determined.
Initial boiling point and boiling range	:	Not applicable.
Flash point	:	Not applicable.
Evaporation rate (butyl acetate = 1)	:	Not applicable.
Flammability (solid, gas)	:	Not classified.
Upper/lower flammability or explosive limits	:	Not applicable.
Vapour pressure (mm Hg)	:	Not applicable.
Vapour density	:	Not applicable.
Relative density	:	Not applicable.
Bulk Density (g/ml)	:	1.4
Solubility(ies)	:	Partially soluble in the following materials: strong acids
Solubility - Water	:	insoluble in water.

SECTION 9: Physical and chemical properties

Partition coefficient: n-octanol/ water : Not applicable.

Auto-ignition temperature : Not applicable.

Decomposition temperature : Not available.

Viscosity (m.Pa.s) : Not applicable.

Explosive properties : Not available.

Oxidising properties : Not available.

Other information

No additional information.

SECTION 10: Stability and reactivity

Reactivity : No specific test data related to reactivity available for this product or its ingredients.

Chemical stability : The product is stable.

Possibility of hazardous reactions : Under normal conditions of storage and use, hazardous reactions will not occur.

Conditions to avoid : No specific data.

Incompatible materials : No specific data.

Hazardous decomposition products : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

SECTION 11: Toxicological information

Information on toxicological effects

Acute toxicity

Conclusion/Summary : Not classified.

Irritation/Corrosion

Conclusion/Summary

Skin : Not classified.

Eyes : Not classified.

Respiratory : Not classified.

Sensitiser

Conclusion/Summary

Skin : Not classified.

Respiratory : Not classified.

Mutagenicity

Conclusion/Summary : Not classified.

Carcinogenicity

Conclusion/Summary : Not classified.

Reproductive toxicity

Conclusion/Summary : Not classified.

Teratogenicity

Conclusion/Summary : Not classified.

Specific target organ toxicity (single exposure)

SECTION 11: Toxicological information

Not available.

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not available.

Information on likely routes of exposure : Routes of entry anticipated: Dermal, Inhalation.

Potential acute health effects

Inhalation : Unlikely to be hazardous by inhalation unless present as a dust. High concentrations of dust may be irritant to the upper respiratory tract. Dust may enter the lung and be slow to clear.

Ingestion : Ingestion may cause irritation of the gastrointestinal tract.

Skin contact : Repeated or prolonged skin contact may cause irritation. May cause physical abrasion in contact with skin.

Eye contact : Dust may cause irritation to eyes.

Symptoms related to the physical, chemical and toxicological characteristics

Inhalation : No specific data.

Ingestion : No specific data.

Skin contact : No specific data.

Eye contact : No specific data.

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Conclusion/Summary : Not classified.

General : No known significant effects or critical hazards.

Carcinogenicity : No known significant effects or critical hazards.

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Other information : Not available.

SECTION 12: Ecological information

Toxicity

Conclusion/Summary : Not classified.

Persistence and degradability

Conclusion/Summary : The bioaccumulative criteria are not applicable to essential metals.

Bioaccumulative potential

Not available.

Mobility in soil

SECTION 12: Ecological information

Soil/water partition coefficient (K_{OC}) : Not available.

Mobility : Not available.

P: Not available. B: Not available. T: Not available.

vP: Not available. vB: Not available.

Other adverse effects : No known significant effects or critical hazards.

SECTION 13: Disposal considerations

Waste treatment methods

Product

Methods of disposal : The generation of waste should be avoided or minimised wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction.

Container information: : Since the emptied container retains product residue, follow label warnings even after it has been emptied.

Hazardous waste : Within the present knowledge of the supplier, this product is not regarded as hazardous waste, as defined by EU Directive 2008/98/EC.

European waste catalogue (EWC) : The user should assign a waste code to the material in accordance with the recommendations of the European Waste Catalogue.

Packaging

Methods of disposal : The generation of waste should be avoided or minimised wherever possible. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible.

Special precautions : This material and its container must be disposed of in a safe way. Empty containers or liners may retain some product residues. Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers.

SECTION 14: Transport information

	ADR/RID	ADN	IMDG	IATA
UN number	Not regulated.	Not regulated.	Not regulated.	Not regulated.
UN proper shipping name	-	-	-	-
Transport hazard class(es)	-	-	-	-
Packing group	-	-	-	-
Environmental hazards	No.	No.	No.	No.
Additional information	-	-	-	-

Special precautions for user : Not applicable

SECTION 14: Transport information

Transport in bulk according to Annex II of Marpol and the IBC Code : Not available.

SECTION 15: Regulatory information

Safety, health and environmental regulations/legislation specific for the substance or mixture

EU Regulation (EC) No. 1907/2006 (REACH)

Annex XIV - List of substances subject to authorisation

Annex XIV

None of the components are listed.

Substances of very high concern

None of the components are listed.

Annex XVII - Restrictions on the manufacture, placing on the market and use of certain dangerous substances, mixtures and articles : Not applicable.

Other EU regulations

Europe inventory : All components are listed or exempted.

Ozone depleting substances (1005/2009/EU)

Not listed.

Prior Informed Consent (PIC) (649/2012/EU)

Not listed.

International regulations

Chemical Weapon Convention List Schedules I, II & III Chemicals

Not listed.

Montreal Protocol (Annexes A, B, C, E)

Not listed.

Stockholm Convention on Persistent Organic Pollutants

Not listed.

Rotterdam Convention on Prior Inform Consent (PIC)

Not listed.

UNECE Aarhus Protocol on POPs and Heavy Metals

Not listed.

International lists

National inventory

Australia	:	All components are listed or exempted.
Canada	:	All components are listed or exempted.
China	:	All components are listed or exempted.
Japan	:	**Japan inventory (ENCS)**: All components are listed or exempted. **Japan inventory (ISHL)**: All components are listed or exempted.
Malaysia	:	Not determined.
New Zealand	:	All components are listed or exempted.
Philippines	:	All components are listed or exempted.
Republic of Korea	:	All components are listed or exempted.
Taiwan	:	All components are listed or exempted.
Turkey	:	Not determined.

SECTION 15: Regulatory information

United States : All components are listed or exempted.

SECTION 16: Other information

Indicates information that has changed from previously issued version.

Abbreviations and acronyms : ATE = Acute Toxicity Estimate
CLP = Classification, Labelling and Packaging Regulation [Regulation (EC) No. 1272/2008]
DNEL = Derived No Effect Level
EUH statement = CLP-specific Hazard statement
PNEC = Predicted No Effect Concentration
RRN = REACH Registration Number

Procedure used to derive the classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]

Classification	Justification
Not classified.	

Full text of abbreviated H statements : Not applicable.

Full text of classifications [CLP/GHS] : Not applicable.

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We create chemistry

Safety data sheet

1. Identification

Product identifier

OASE antifoam A

Relevant identified uses of the substance or mixture and uses advised against

Relevant identified uses: defoamer
Recommended use: defoamer

Details of the supplier of the safety data sheet

Company:
BASF SE
67056 Ludwigshafen
GERMANY
Operating Division Intermediates

Telephone: +49 621 60-0
E-mail address: ci-qshe-request@basf.com

Emergency telephone number

International emergency number:
Telephone: +49 180 2273-112

2. Hazards Identification

Classification of the substance or mixture

According to UN GHS criteria

No need for classification according to GHS criteria for this product.

Label elements

Globally Harmonized System (GHS)

The product does not require a hazard warning label in accordance with GHS criteria.

Other hazards

According to UN GHS criteria

If applicable information is provided in this section on other hazards which do not result in classification but which may contribute to the overall hazards of the substance or mixture.

3. Composition/Information on Ingredients

Substances

Not applicable

Mixtures

Chemical nature

mixture
silicone derivative(s) (85 - 100 %), silicium dioxide (treated)(10 - 25 %)

Hazardous ingredients (GHS)
According to UN GHS criteria

Does not contain any hazardous ingredients.

4. First-Aid Measures

Description of first aid measures

Immediately remove contaminated clothing.

If inhaled:
If difficulties occur after vapour/aerosol has been inhaled, remove to fresh air and seek medical attention.

On skin contact:
Wash thoroughly with soap and water.

On contact with eyes:
Immediately wash affected eyes for at least 15 minutes under running water with eyelids held open, consult an eye specialist.

On ingestion:
Rinse mouth immediately and then drink plenty of water, seek medical attention. Never induce vomiting or give anything by mouth if the victim is unconscious or having convulsions.

Most important symptoms and effects, both acute and delayed
Symptoms: Further symptoms are possible, The most important known symptoms and effects are described in the labelling (see section 2) and/or in section 11.

Indication of any immediate medical attention and special treatment needed
Treatment: Treat according to symptoms (decontamination, vital functions), no known specific antidote. Medical monitoring for at least 24 hours.

5. Fire-Fighting Measures

Extinguishing media
Suitable extinguishing media:
water spray, carbon dioxide, dry powder

Unsuitable extinguishing media for safety reasons:
foam

Special hazards arising from the substance or mixture
carbon monoxide, Carbon dioxide, nitrogen oxides, carbon oxides
The substances/groups of substances mentioned can be released in case of fire. Under certain conditions in case of fire other hazardous combustion products may be generated.

Advice for fire-fighters
Special protective equipment:
Wear a self-contained breathing apparatus.

Further information:
Collect contaminated extinguishing water separately, do not allow to reach sewage or effluent systems.

Water or foam may cause frothing of the substance/product.

6. Accidental Release Measures

High risk of slipping due to leakage/spillage of product.

Personal precautions, protective equipment and emergency procedures
Avoid contact with the skin, eyes and clothing.

Environmental precautions
Do not empty into drains.

Methods and material for containment and cleaning up

For large amounts: Pump off product.
Pick up with suitable absorbent material. Collect waste in suitable containers, which can be labeled and sealed. Incinerate or take to a special waste disposal site in accordance with local authority regulations.

Reference to other sections

Information regarding exposure controls/personal protection and disposal considerations can be found in section 8 and 13.

7. Handling and Storage

Precautions for safe handling

Ensure thorough ventilation of stores and work areas. Handle in accordance with good industrial hygiene and safety practice. When using do not eat, drink or smoke. Hands and/or face should be washed before breaks and at the end of the shift.

Protection against fire and explosion:
Prevent electrostatic charge - sources of ignition should be kept well clear - fire extinguishers should be kept handy.

Conditions for safe storage, including any incompatibilities

Further information on storage conditions: Containers should be stored tightly sealed in a dry place.
Store protected against freezing.

8. Exposure Controls/Personal Protection

Control parameters

Components with occupational exposure limits

No occupational exposure limits known.

Exposure controls

Personal protective equipment

Respiratory protection:
Respiratory protection in case of vapour/aerosol release. Particle filter with medium efficiency for solid and liquid particles (e.g. EN 143 or 149, Type P2 or FFP2)

Hand protection:
Chemical resistant protective gloves (EN 374)
Suitable materials also with prolonged, direct contact (Recommended: Protective index 6, corresponding > 480 minutes of permeation time according to EN 374):
natural rubber/natural latex (NR) - 0.5 mm coating thickness
Manufacturer's directions for use should be observed because of great diversity of types.
Supplementary note: The specifications are based on tests, literature data and information of glove manufacturers or are derived from similar substances by analogy. Due to many conditions (e.g.

temperature) it must be considered, that the practical usage of a chemical-protective glove in practice may be much shorter than the permeation time determined through testing.

Eye protection:
Safety glasses with side-shields (frame goggles) (e.g. EN 166)

Body protection:
light protective clothing, thick material

General safety and hygiene measures
Avoid contact with the skin, eyes and clothing. Wearing of closed work clothing is required additionally to the stated personal protection equipment. Handle in accordance with good industrial hygiene and safety practice. Take off immediately all contaminated clothing. Hands and/or face should be washed before breaks and at the end of the shift. Store work clothing separately.

9. Physical and Chemical Properties

Information on basic physical and chemical properties

Form:	liquid	
Colour:	white	
Odour:	almost odourless	
Odour threshold:	Not determined due to potential health hazard by inhalation.	
pH value:	not applicable	
Melting point:	< 0 °C	
Boiling point:	> 250 °C	
Flash point:	> 250 °C	(ASTM D93)
Evaporation rate:	Value can be approximated from Henry's Law Constant or vapor pressure.	
Flammability:	not flammable	
Lower explosion limit:	not applicable	
Upper explosion limit:	not applicable	
Ignition temperature:	No data available.	
Vapour pressure:	0,2 mbar (20 °C)	
Density:	1,03 g/cm3 (20 °C)	
Relative vapour density (air):	not determined	
Solubility in water:	slightly soluble	

Solubility (qualitative) :
dispersible
Partitioning coefficient n-octanol/water (log Kow):
not applicable for mixtures
Self ignition: Temperature: > 450 °C

Thermal decomposition: not determined
Viscosity, dynamic: 2.500 mPa.s
(approx. 25 °C)
Explosion hazard: not explosive (other)
Fire promoting properties: not fire-propagating

Other information

Miscibility with water:
immiscible
Grain size distribution: The substance / product is marketed or used in a non solid or granular form.
Other Information:
If necessary, information on other physical and chemical parameters is indicated in this section.

10. Stability and Reactivity

Possibility of hazardous reactions
No hazardous reactions if stored and handled as prescribed/indicated.

Conditions to avoid
Avoid extreme heat.

Incompatible materials

Substances to avoid:
strong oxidizing agents

Hazardous decomposition products

Hazardous decomposition products:
hydrogen, Formaldehyde
hydrocarbons, silicates

11. Toxicological Information

Information on toxicological effects

Acute toxicity

Experimental/calculated data:

LD50 rat (oral): > 5.000 mg/kg
Literature data.

(by inhalation):No data available.

Irritation

Assessment of irritating effects:
Irritation is possible when the product comes in contact with the skin, respiratory tract or the eyes.

Experimental/calculated data:
Skin corrosion/irritation: Prolonged exposure to the product can result in irritation of the skin and mucous membranes. Literature data.

Respiratory/Skin sensitization

Experimental/calculated data:
No data available.

Germ cell mutagenicity

Experimental/calculated data:
No data available.

Carcinogenicity

Experimental/calculated data:
No data available.

Reproductive toxicity

Experimental/calculated data:
No data available.

Specific target organ toxicity (single exposure)

Assessment of STOT single:
No data available.

Repeated dose toxicity and Specific target organ toxicity (repeated exposure)

Experimental/calculated data:
No data available.

Aspiration hazard

No aspiration hazard expected.

12. Ecological Information

Toxicity

Toxicity to fish:
LC50 (96 h) > 200 mg/l, Leuciscus idus

Microorganisms/Effect on activated sludge:
EC20 (30 min) > 10.000 mg/l, Pseudomonas putida
The inhibition of the degradation activity of activated sludge is not anticipated when introduced to biological treatment plants in appropriate low concentrations. Literature data.

Persistence and degradability

Assessment biodegradation and elimination (H2O):
The polymer component of the product is poorly biodegradable.

Bioaccumulative potential

Assessment bioaccumulation potential:
not applicable

Mobility in soil

Assessment transport between environmental compartments:
Adsorption in soil: not determined

Results of PBT and vPvB assessment

under evaluation

Other adverse effects

The product does not contain substances that are listed in Regulation (EC) 1005/2009 on substances that deplete the ozone layer.

Additional information

Other ecotoxicological advice:
Do not release untreated into natural waters.

13. Disposal Considerations

Waste treatment methods

Incinerate in suitable incineration plant, observing local authority regulations.

Contaminated packaging:
Contaminated packaging should be emptied as far as possible; then it can be passed on for recycling after being thoroughly cleaned.

14. Transport Information

Land transport

ADR

	Not classified as a dangerous good under transport regulations
UN number:	Not applicable
UN proper shipping name:	Not applicable
Transport hazard class(es):	Not applicable
Packing group:	Not applicable
Environmental hazards:	Not applicable
Special precautions for user	None known

RID

	Not classified as a dangerous good under transport regulations
UN number:	Not applicable
UN proper shipping name:	Not applicable
Transport hazard class(es):	Not applicable
Packing group:	Not applicable
Environmental hazards:	Not applicable
Special precautions for user	None known

Inland waterway transport
ADN

	Not classified as a dangerous good under transport regulations
UN number:	Not applicable
UN proper shipping name:	Not applicable
Transport hazard class(es):	Not applicable
Packing group:	Not applicable
Environmental hazards:	Not applicable
Special precautions for user:	None known

Transport in inland waterway vessel
Not evaluated

Sea transport

IMDG

	Not classified as a dangerous good under transport regulations
UN number:	Not applicable
UN proper shipping name:	Not applicable
Transport hazard class(es):	Not applicable
Packing group:	Not applicable
Environmental hazards:	Not applicable
Special precautions for user	None known

Air transport

IATA/ICAO

	Not classified as a dangerous good under transport regulations
UN number:	Not applicable
UN proper shipping name:	Not applicable
Transport hazard class(es):	Not applicable
Packing group:	Not applicable
Environmental hazards:	Not applicable
Special precautions for user	None known

UN number
See corresponding entries for “UN number” for the respective regulations in the tables above.

UN proper shipping name
See corresponding entries for “UN proper shipping name” for the respective regulations in the tables above.

Transport hazard class(es)
See corresponding entries for “Transport hazard class(es)” for the respective regulations in the tables above.

Packing group
See corresponding entries for “Packing group” for the respective regulations in the tables above.

Environmental hazards
See corresponding entries for “Environmental hazards” for the respective regulations in the tables above.

Special precautions for user
See corresponding entries for “Special precautions for user” for the respective regulations in the tables above.

Transport in bulk according to Annex II of MARPOL and the IBC Code

Regulation:	Not evaluated
Shipment approved:	Not evaluated
Pollution name:	Not evaluated
Pollution category:	Not evaluated
Ship Type:	Not evaluated

15. Regulatory Information

Safety, health and environmental regulations/legislation specific for the substance or mixture

Not applicable

16. Other Information

The data contained in this safety data sheet are based on our current knowledge and experience and describe the product only with regard to safety requirements. This safety data sheet is neither a Certificate of Analysis (CoA) nor technical data sheet and shall not be mistaken for a specification agreement. Identified uses in this safety data sheet do neither represent an agreement on the corresponding contractual quality of the substance/mixture nor a contractually designated use. It is the responsibility of the recipient of the product to ensure any proprietary rights and existing laws and legislation are observed.

Vertical lines in the left hand margin indicate an amendment from the previous version.

We create chemistry

Safety data sheet

BASF Safety data sheet according to UN GHS 4th rev.
Date / Revised: 08.12.2017 Version: 3.0
Product: **OASE white**

(ID no. 30544780/SDS_GEN_00/EN)
Date of print 12.12.2019

1. Identification

Product identifier

OASE white

Relevant identified uses of the substance or mixture and uses advised against

Relevant identified uses: Chemical used in synthesis and/or formulation of industrial products
Recommended use: Chemical

Details of the supplier of the safety data sheet

Company:
BASF SE
67056 Ludwigshafen
GERMANY
Operating Division Intermediates

Telephone: +49 621 60-0
E-mail address: ci-qshe-request@basf.com

Emergency telephone number

International emergency number:
Telephone: +49 180 2273-112

2. Hazards Identification

Classification of the substance or mixture

According to UN GHS criteria

Acute Tox. 5 (oral)
Eye Dam./Irrit. 1

Resp. Sens. 1
Skin Sens. 1B
Repr. 2 (fertility)
Repr. 2 (unborn child)
Aquatic Acute 3

For the classifications not written out in full in this section the full text can be found in section 16.

Label elements

Globally Harmonized System (GHS)

Pictogram:

Signal Word:
Danger

Hazard Statement:

H318	Causes serious eye damage.
H334	May cause allergy or asthma symptoms or breathing difficulties if inhaled.
H317	May cause an allergic skin reaction.
H361	Suspected of damaging fertility. Suspected of damaging the unborn child.

Precautionary Statements (Prevention):

P280	Wear protective gloves/protective clothing/eye protection/face protection.
P261	Avoid breathing dust/fume/gas/mist/vapours/spray.
P284	In case of inadequate ventilation wear respiratory protection.
P202	Do not handle until all safety precautions have been read and understood.
P272	Contaminated work clothing should not be allowed out of the workplace.

Precautionary Statements (Response):

P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310	Immediately call a POISON CENTER or doctor/physician.
P304 + P341 + P311	IF INHALED: If breathing is difficult, remove to fresh air and keep at rest in a position comfortable for breathing. Call a POISON CENTER or doctor/physician.
P303 + P352	IF ON SKIN (or hair): Wash with plenty of soap and water.
P362 + P364	Take off contaminated clothing and wash it before reuse.

Precautionary Statements (Storage):

P405 Store locked up.

Precautionary Statements (Disposal):
P501 Dispose of contents/container to hazardous or special waste collection point.

Labeling of special preparations (GHS):
Classification is based on existing data for this particular mixture.

Other hazards

According to UN GHS criteria

If applicable information is provided in this section on other hazards which do not result in classification but which may contribute to the overall hazards of the substance or mixture.

3. Composition/Information on Ingredients

Substances

Not applicable

Mixtures

Chemical nature

preparation

Contains: Water

Hazardous ingredients (GHS)
According to UN GHS criteria

2,2'-(methylimino)diethanol; N-methyldiethanolamine

Content (W/W): >= 70 %	Acute Tox. 5 (oral)
CAS Number: 105-59-9	Eye Dam./Irrit. 2A
EC-Number: 203-312-7	Aquatic Acute 3
INDEX-Number: 603-079-00-5	H319, H303, H402

Piperazine

Content (W/W): <= 18 % CAS Number: 110-85-0 EC-Number: 203-808-3 INDEX-Number: 612-057-00-4	Flam. Sol. 1 Acute Tox. 5 (oral) Skin Corr./Irrit. 1B Eye Dam./Irrit. 1 Resp. Sens. 1 Skin Sens. 1B Repr. 2 (fertility) Repr. 2 (unborn child) Aquatic Acute 3 H228, H303, H334, H317, H361, H314, H402

For the classifications not written out in full in this section the full text can be found in section 16.

4. First-Aid Measures

Description of first aid measures

Remove contaminated clothing.

If inhaled:
If difficulties occur after vapour/aerosol has been inhaled, remove to fresh air and seek medical attention.

On skin contact:
Wash off thoroughly with ample water.

On contact with eyes:
Immediately wash affected eyes for at least 15 minutes under running water with eyelids held open, consult an eye specialist.

On ingestion:
Rinse mouth immediately and then drink plenty of water, seek medical attention.

Most important symptoms and effects, both acute and delayed

Symptoms: The most important known symptoms and effects are described in the labelling (see section 2) and/or in section 11., Further symptoms are possible

Indication of any immediate medical attention and special treatment needed

Treatment: Treat according to symptoms (decontamination, vital functions), no known specific antidote.

5. Fire-Fighting Measures

Extinguishing media

Suitable extinguishing media:
water spray, dry powder, alcohol-resistant foam, carbon dioxide

Special hazards arising from the substance or mixture

nitrogen oxides, carbon oxides
The substances/groups of substances mentioned can be released in case of fire. Under certain conditions in case of fire other hazardous combustion products may be generated.

Advice for fire-fighters

Special protective equipment:
Wear self-contained breathing apparatus and chemical-protective clothing.

Further information:
Collect contaminated extinguishing water separately, do not allow to reach sewage or effluent systems.

6. Accidental Release Measures

Personal precautions, protective equipment and emergency procedures

Avoid inhalation. Avoid contact with the skin, eyes and clothing.

Environmental precautions

Discharge into the environment must be avoided.

Methods and material for containment and cleaning up

For large amounts: Pump off product.
For residues: Pick up with suitable absorbent material (e.g. sand, sawdust, general-purpose binder, kieselguhr).
Clean contaminated floors and objects thoroughly with water and detergents, observing environmental regulations. Collect waste in suitable containers, which can be labeled and sealed. Incinerate or take to a special waste disposal site in accordance with local authority regulations.

7. Handling and Storage

Precautions for safe handling

Ensure thorough ventilation of stores and work areas. Handle in accordance with good industrial hygiene and safety practice. When using do not eat, drink or smoke. Hands and/or face should be washed before breaks and at the end of the shift.

Protection against fire and explosion:
Prevent electrostatic charge - sources of ignition should be kept well clear - fire extinguishers should be kept handy.

Conditions for safe storage, including any incompatibilities

Segregate from acids and acid forming substances.

Suitable materials for containers: glass, Stainless steel 1.4301 (V2), Stainless steel 1.4401, High density polyethylene (HDPE), Carbon steel (Iron), tinned carbon steel (Tinplate)
Further information on storage conditions: Store protected against freezing.

Specific end use(s)

For the relevant identified use(s) listed in Section 1 the advice mentioned in this section 7 is to be observed.

8. Exposure Controls/Personal Protection

Control parameters

Components with occupational exposure limits

105-59-9: 2,2'-(methylimino)diethanol; N-methyldiethanolamine
110-85-0: Piperazine

Exposure controls

Personal protective equipment

Respiratory protection:
Suitable respiratory protection for lower concentrations or short-term effect: Combination filter for gases/vapours of organic compounds and solid and liquid particles (f.e. EN 14387 Type A-P2)
Suitable respiratory protection for higher concentrations or long-term effect: Self-contained breathing apparatus.

Hand protection:
Chemical resistant protective gloves (EN 374)
e.g. nitrile rubber (0.4 mm), chloroprene rubber (0.5 mm), polyvinylchloride (0.7 mm) and other
Supplementary note: The specifications are based on tests, literature data and information of glove manufacturers or are derived from similar substances by analogy. Due to many conditions (e.g. temperature) it must be considered, that the practical usage of a chemical-protective glove in practice may be much shorter than the permeation time determined through testing.

Eye protection:
Tightly fitting safety goggles (splash goggles) (e.g. EN 166)

Body protection:
chemical-protection suit (f.e. according to EN 14605)

General safety and hygiene measures
Avoid contact with eyes. Avoid inhalation of vapour. Wearing of closed work clothing is required additionally to the stated personal protection equipment. Females of childbearing age should not come into contact with the product. Take off immediately all contaminated clothing. Store work clothing separately.

9. Physical and Chemical Properties

Information on basic physical and chemical properties

Form:	liquid

Colour:	colourless to yellow	
Odour:	amine-like	
Odour threshold:		
	Not determined due to respiratory tract sensitizing properties.	
pH value:	11 - 12 (100 g/l, 20 °C)	
Melting point:	< -10 °C	
Boiling point:	> 100 °C	
Flash point:	approx. 118 °C The product has not been tested. The statement has been derived from substances/products of a similar structure or composition.	(DIN ISO 2592)
Evaporation rate:		
	Value can be approximated from Henry's Law Constant or vapor pressure.	
Flammability:	not flammable	
Lower explosion limit:		
	For liquids not relevant for classification and labelling., The lower explosion point may be 5 - 15 °C below the flash point.	

Information on: 2,2'-(methylimino)diethanol; N-methyldiethanolamine

Lower explosion limit:	
	For liquids not relevant for classification and labelling., The lower explosion point may be 5 - 15 °C below the flash point.

Information on: Piperazine

Lower explosion limit:	
	For solids not relevant for classification and labelling.

Upper explosion limit:	
	For liquids not relevant for classification and labelling.

Information on: 2,2'-(methylimino)diethanol; N-methyldiethanolamine

Upper explosion limit:	
	For liquids not relevant for classification and labelling.

Information on: Piperazine

Upper explosion limit:	
	For solids not relevant for classification and labelling.

Ignition temperature:	265 °C The product has not been tested. The statement has been derived from the properties of the individual components.	
Information on: 2,2'-(methylimino)diethanol; N-methyldiethanolamine		
Vapour pressure:	*0,0027 hPa* *(25 °C)* *Literature data.*	*(measured)*
Information on: Piperazine		
Vapour pressure:	*0,392 hPa* *(22,5 °C)*	*(BASF method)*

Density:	1,05 g/cm3 (20 °C)	
Relative density:	1,05 (20 °C)	(calculated)
Information on: 2,2'-(methylimino)diethanol; N-methyldiethanolamine		
Partitioning coefficient n-octanol/water (log Kow):	*-1,08* *(25 °C; pH value: 9,9 - 10,4)*	*(OECD Guideline 107)*
	-1,16 *(23 °C; pH value: 10,5)*	*(OECD Guideline 107)*
Information on: Piperazine		
Partitioning coefficient n-octanol/water (log Kow):	*-1,24* *(25 °C; pH value: 11)*	*(OECD Guideline 107)*

Self ignition:	The value has not be determined because of the low risk of self-ignition in consequence of the high flash-point.	

Thermal decomposition: No decomposition if stored and handled as prescribed/indicated.
Explosion hazard: not explosive (other)
Fire promoting properties: not fire-propagating

Other information

Miscibility with water:
(20 °C)
miscible

Information on: Piperazine		
Adsorption/water - soil:	*KOC:* 507*; log KOC:* 2,71	*(OECD Guideline 106)*

Other Information:
If necessary, information on other physical and chemical parameters is indicated in this section.

10. Stability and Reactivity

Possibility of hazardous reactions

Strong exothermic reaction with acids.

Conditions to avoid
Avoid extreme temperatures.

Incompatible materials

Substances to avoid:
acids, acid chlorides, acid anhydrides

Hazardous decomposition products

Possible thermal decomposition products:
carbon oxides, nitrogen oxides

11. Toxicological Information

Information on toxicological effects

Acute toxicity

Information on: 2,2'-methyliminodiethanol

Experimental/calculated data:
LD50 rat (oral): 4.680 mg/kg (BASF-Test)

Information on: Piperazine

Experimental/calculated data:
LD50 rat (oral): approx. 2.600 mg/kg (BASF-Test)

Information on: 2,2'-methyliminodiethanol
Experimental/calculated data:
rat (by inhalation): 8 h (BASF-Test)
Inhalation-risk test (IRT): No mortality within 8 hours as shown in animal studies. The inhalation of a highly saturated vapor-air mixture represents no acute hazard.

Information on: Piperazine
Experimental/calculated data:
LD50 rabbit (dermal): 8.300 mg/kg (similar to OECD guideline 402)

Irritation

Assessment of irritating effects:
Risk of serious damage to eyes.

Experimental/calculated data:
Skin corrosion/irritation rabbit: non-irritant (OECD Guideline 404)

Serious eye damage/irritation: Irritant. (BCOP)

Respiratory/Skin sensitization

Information on: Piperazine
Experimental/calculated data:
Mouse Local Lymph Node Assay (LLNA) mouse: skin sensitizing (similar to OECD guideline 429)

Guinea pig maximization test guinea pig: skin sensitizing (similar to OECD guideline 406)

Germ cell mutagenicity

Information on: 2,2'-(methylimino)diethanol; N-methyldiethanolamine
Assessment of mutagenicity:
No mutagenic effect was found in various tests with bacteria and mammalian cell culture. The substance was not mutagenic in a test with mammals. Literature data.

Information on: Piperazine
Assessment of mutagenicity:
In the majority of studies performed with microorganisms and in mammalian cell culture, a mutagenic effect was not found. A mutagenic effect was also not observed in in vivo tests. Literature data.

Carcinogenicity

Information on: 2,2'-(methylimino)diethanol; N-methyldiethanolamine
Assessment of carcinogenicity:
The whole of the information assessable provides no indication of a carcinogenic effect. Under certain conditions the substance can form nitrosamines. Nitrosamines are carcinogenic in animal studies.

Information on: Piperazine
Assessment of carcinogenicity:
Results from poorly documented long-term studies in rats and mice gave no indication of a carcinogenic potential. No data was available concerning carcinogenic activity. Under certain conditions the substance can form nitrosamines. Nitrosamines are carcinogenic in animal studies.

Reproductive toxicity

Information on: 2,2'-(methylimino)diethanol; N-methyldiethanolamine
Assessment of reproduction toxicity:
The potential to impair fertility cannot be excluded when given at maternally toxic doses. The results were determined in a Screening test (OECD 421/422). Because the relevance of the results to human health is unclear, further tests will be initiated. The product has not been fully tested. The statements have been derived in parts from products of a similar structure or composition.

Information on: Piperazine
Assessment of reproduction toxicity:
The results of animal studies suggest a fertility impairing effect.

Developmental toxicity

Information on: 2,2'-(methylimino)diethanol; N-methyldiethanolamine
Assessment of teratogenicity:
In animal studies the substance did not cause malformations. The product has not been tested. The statement has been derived from substances/products of a similar structure or composition.

Information on: Piperazine
Assessment of teratogenicity:
Indications of possible developmental toxicity/teratogenicity were seen in animal studies.

Repeated dose toxicity and Specific target organ toxicity (repeated exposure)

Information on: 2,2'-(methylimino)diethanol; N-methyldiethanolamine
Assessment of repeated dose toxicity:
No adverse effects were observed after repeated dermal exposure in animal studies.

Aspiration hazard

No aspiration hazard expected.

Other relevant toxicity information

No experimental evidence available for genotoxicity in vitro (Ames test negative). The product has not been tested. The statement has been derived from the properties of the individual components.

12. Ecological Information

Toxicity

Information on: 2,2'-methyliminodiethanol
Toxicity to fish:
LC50 (96 h) 1.466 mg/l, Leuciscus idus (DIN 38412 Part 15, static)
Nominal concentration. After neutralization no appreciable reduction in harmful effect can be observed.

Information on: Piperazine
Toxicity to fish:
LC50 (96 h) > 1.800 mg/l, Poecilia reticulata (Directive 84/449/EEC, C.1, semistatic)
Nominal concentration. Literature data.

LC50 (96 h) > 391 mg/l, Cyprinodon variegatus (OECD 203; ISO 7346; 84/449/EEC, C.1, semistatic)
Nominal concentration. Limit concentration test only (LIMIT test).

Information on: 2,2'-methyliminodiethanol
Aquatic invertebrates:
EC50 (48 h) 233 mg/l, Daphnia magna (Directive 79/831/EEC, static)
Nominal concentration.

Information on: 2,2'-methyliminodiethanol
Aquatic plants:
EC50 (72 h) 176 mg/l (growth rate), Scenedesmus subspicatus (DIN 38412 Part 9)
Nominal concentration.

EC10 (72 h) 19 mg/l (growth rate), Scenedesmus subspicatus (DIN 38412 Part 9)
Nominal concentration.

EC50 (72 h) 410 mg/l (growth rate), Skeletonema costatum (ISO/DIS 10253)
Nominal concentration.

EC50 (72 h) 141 mg/l (growth rate), Skeletonema costatum (ISO/DIS 10253)
Nominal concentration.

Information on: 2,2'-methyliminodiethanol
Microorganisms/Effect on activated sludge:
EC20 (30 min) > 1.000 mg/l, activated sludge, domestic (Directive 88/302/EEC, part C, p. 118, aerobic)

Persistence and degradability

Information on: 2,2'-methyliminodiethanol
Elimination information:
96 % DOC reduction (18 d) (OECD 301 A (new version)) (aerobic, activated sludge, domestic)

15 % BOD of the ThOD (63 d) (OECD Guideline 306) (aerobic, Seawater)

< 1 % BOD of the ThOD (28 d) (OECD Guideline 306) (Seawater)

Information on: Piperazine
Elimination information:
65 % BOD of the ThOD (28 d) (OECD Guideline 301 F) (aerobic, activated sludge, domestic)

96 % DOC reduction (52 d) (OECD Guideline 302 A) (aerobic, activated sludge, domestic, non-adapted)

1 % BOD of the ThOD (63 d) (OECD Guideline 306) (aerobic, Seawater)

3 % BOD of the ThOD (28 d) (OECD Guideline 306) (aerobic, Seawater)

Bioaccumulative potential

Information on: 2,2'-methyliminodiethanol
Bioaccumulation potential:
Because of the n-octanol/water distribution coefficient (log Pow) accumulation in organisms is not to be expected.

Mobility in soil

Information on: 2,2'-(methylimino)diethanol; N-methyldiethanolamine
Assessment transport between environmental compartments:
Volatility: The substance will not evaporate into the atmosphere from the water surface. The data refer to the uncharged form of the substance.
Adsorption in soil: Adsorption to solid soil phase is not expected.The data refer to the charged form of the substance.

Information on: Piperazine
Assessment transport between environmental compartments:
Volatility: The substance will not evaporate into the atmosphere from the water surface.
Adsorption in soil: Adsorption to solid soil phase is not expected.

Results of PBT and vPvB assessment

According to Annex XIII of Regulation (EC) No.1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH): Not fulfilling PBT (persistent/bioaccumulative/toxic) criteria.

According to Annex XIII of Regulation (EC) No.1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH): The product does not contain a substance fulfilling the vPvB criteria (very persistent/very bioaccumulative)

Other adverse effects

The product does not contain substances that are listed in Regulation (EC) 1005/2009 on substances that deplete the ozone layer.

Additional information

Adsorbable organically-bound halogen (AOX):
This product contains no organically-bound halogen.

Other ecotoxicological advice:
Due to the pH-value of the product, neutralization is generally required before discharging sewage into treatment plants. The inhibition of the degradation activity of activated sludge is not anticipated when introduced to biological treatment plants in appropriate low concentrations. Do not release

untreated into natural waters. The product has not been tested. The statement has been derived from the properties of the individual components.

13. Disposal Considerations

Waste treatment methods

Incinerate in suitable incineration plant, observing local authority regulations.

Contaminated packaging:
Contaminated packaging should be emptied as far as possible; then it can be passed on for recycling after being thoroughly cleaned.

14. Transport Information

Land transport

ADR

	Not classified as a dangerous good under transport regulations
UN number:	Not applicable
UN proper shipping name:	Not applicable
Transport hazard class(es):	Not applicable
Packing group:	Not applicable
Environmental hazards:	Not applicable
Special precautions for user	None known

RID

	Not classified as a dangerous good under transport regulations
UN number:	Not applicable
UN proper shipping name:	Not applicable
Transport hazard class(es):	Not applicable
Packing group:	Not applicable
Environmental hazards:	Not applicable
Special precautions for user	None known

Inland waterway transport

ADN

	Not classified as a dangerous good under transport regulations
UN number:	Not applicable
UN proper shipping name:	Not applicable
Transport hazard class(es):	Not applicable

Packing group:	Not applicable
Environmental hazards:	Not applicable
Special precautions for user:	None known

Transport in inland waterway vessel
Not evaluated

Sea transport

IMDG

	Not classified as a dangerous good under transport regulations
UN number:	Not applicable
UN proper shipping name:	Not applicable
Transport hazard class(es):	Not applicable
Packing group:	Not applicable
Environmental hazards:	Not applicable
Special precautions for user	None known

Air transport

IATA/ICAO

	Not classified as a dangerous good under transport regulations
UN number:	Not applicable
UN proper shipping name:	Not applicable
Transport hazard class(es):	Not applicable
Packing group:	Not applicable
Environmental hazards:	Not applicable
Special precautions for user	None known

Transport in bulk according to Annex II of MARPOL and the IBC Code

Regulation:	Not evaluated
Shipment approved:	Not evaluated
Pollution name:	Not evaluated
Pollution category:	Not evaluated
Ship Type:	Not evaluated

15. Regulatory Information

Safety, health and environmental regulations/legislation specific for the substance or mixture

If other regulatory information applies that is not already provided elsewhere in this safety data sheet, then it is described in this subsection.

16. Other Information

Work limitations for pregnant woman and for woman nursing babies should be observed. Work limitations for youth should be observed.

The product contains a CWC (Chemical Weapon Convention)- relevant substance (schedule 2 or 3). This may result in obligations for your company due to national authority requirements relevant for CWC controlled operations.

Full text of classifications, hazard symbols and hazard statements, if mentioned in section 2 or 3:

Acute Tox.	Acute toxicity
Eye Dam./Irrit.	Serious eye damage/eye irritation
Resp. Sens.	Respiratory sensitization
Skin Sens.	Skin sensitization
Repr.	Reproductive toxicity
Aquatic Acute	Hazardous to the aquatic environment - acute
Flam. Sol.	Flammable solids
Skin Corr./Irrit.	Skin corrosion/irritation
H319	Causes serious eye irritation.
H303	May be harmful if swallowed.
H402	Harmful to aquatic life.
H228	Flammable solid.
H334	May cause allergy or asthma symptoms or breathing difficulties if inhaled.
H317	May cause an allergic skin reaction.
H361	Suspected of damaging fertility. Suspected of damaging the unborn child.
H314	Causes severe skin burns and eye damage.

The data contained in this safety data sheet are based on our current knowledge and experience and describe the product only with regard to safety requirements. This safety data sheet is neither a Certificate of Analysis (CoA) nor technical data sheet and shall not be mistaken for a specification agreement. Identified uses in this safety data sheet do neither represent an agreement on the corresponding contractual quality of the substance/mixture nor a contractually designated use. It is the responsibility of the recipient of the product to ensure any proprietary rights and existing laws and legislation are observed.

Vertical lines in the left hand margin indicate an amendment from the previous version.

Johnson Matthey
Inspiring science, enhancing life

SAFETY DATA SHEET

Conforms to Hazard Communication Standard 2012 (HCS 2012)

PURASPEC 2020

Version	:	1
Date of issue/ Date of revision	:	08/01/2018
Date of previous issue	:	No previous validation

Section 1. Identification

Product identifier	:	**PURASPEC™** 2020
Product type	:	Solid.

Relevant identified uses of the substance or mixture and uses advised against

Specific uses	:	Removal of sulfur compounds
Supplier's details	:	Johnson Matthey Inc, Two TransAm Plaza Drive, Suite 230 Oakbrook Terrace, IL 60181 - 4296 +(1)-630-268-6300
Business address	:	Johnson Matthey PO Box No 1,Belasis Avenue, Billingham, Stockton on Tees, TS23 1LB, UK +44 (0) 1642 523343
e-mail address of person responsible for this SDS	:	jmsds1@matthey.com

In case of emergency

For Chemical Emergency ONLY (spill, leak, fire, exposure or accident) call :

Chemical Emergency	:	1-800-424-9300 CHEMTREC +(1) 703-527-3887 CHEMTREC International	**(24 hours)**
Medical Emergency	:	PROSAR: +(1)-877-630-4584	**(24 hours)**
Information limitations	:	For emergency calls only. Non-emergency calls cannot be serviced at this number.	
CHEMTREC Customer Number (CCN)	:	CCN12026 (International) CCN614056 (USA, Canada & Mexico Only)	

Section 2. Hazards identification

OSHA/HCS status : While this material is not considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200), this SDS contains valuable information critical to the safe handling and proper use of the product. This SDS should be retained and available for employees and other users of this product.

Classification of the substance or mixture : Not classified.

GHS label elements

Signal word : No signal word.

Hazard statements : No known significant effects or critical hazards.

Precautionary statements

Prevention : Not applicable.

Response : Not applicable.

Storage : Not applicable.

Disposal : Not applicable.

Hazards not otherwise classified : None known.

Environmental hazards : Very toxic to aquatic life with long lasting effects.

Environmental hazard categories are not mandatory under OSHA's Hazard Communication Standard 2012, as OSHA does not have the authority to address environmental concerns.
Likewise there is no requirement to classify for Environmental toxicity under DOT.
However, both OSHA and DOT recognise that, for many countries, Environmental hazard classification is mandatory under GHS, and is also mandatory for compliance with International Transport regulations.
As such any Environmental hazards associated with this product are addressed in this safety data sheet.

Section 3. Composition/information on ingredients

Product definition : Mixture

Ingredient name	%	CAS number
zinc oxide	≥75 - ≤90	1314-13-2

Any concentration shown as a range is to protect confidentiality or is due to batch variation.

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Get medical attention if irritation occurs.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. Get medical attention if symptoms occur.

Skin contact : Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Get medical attention if symptoms occur.

Section 4. First aid measures

Ingestion : Wash out mouth with water. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. Do not induce vomiting unless directed to do so by medical personnel. Get medical attention if symptoms occur.

Most important symptoms/effects, acute and delayed

Potential acute health effects

Eye contact : Dust may cause irritation to eyes.

Inhalation : Unlikely to be hazardous by inhalation unless present as a dust. High concentrations of dust may be irritant to the upper respiratory tract. Dust may enter the lung and be slow to clear. In the metals industry, high concentrations of very finely divided dust containing copper and/or zinc compounds have been known to produce the symptoms of metal fume fever. This condition is characterized by influenza type symptoms occurring a few hours after exposure and lasting for up to 48 hours. However, the handling and use of this product in line with Section 7 is not expected to pose such a risk.

Skin contact : Repeated or prolonged skin contact may cause irritation. May cause physical abrasion in contact with skin.

Ingestion : Ingestion may cause irritation of the gastrointestinal tract.

Over-exposure signs/symptoms

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Ingestion : No specific data.

Indication of immediate medical attention and special treatment needed, if necessary

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media : Use an extinguishing agent suitable for the surrounding fire.

Unsuitable extinguishing media : None known.

Specific hazards arising from the chemical : No specific fire or explosion hazard.

Hazardous thermal decomposition products : Decomposition products may include the following materials: metal oxide/oxides

Section 5. Fire-fighting measures

Special protective actions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Additional information : Discharged material may be pyrophoric (see Process Hazards).

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Put on appropriate personal protective equipment.

For emergency responders : If specialized clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Environmental precautions : Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods and materials for containment and cleaning up

Small spill : Move containers from spill area. Vacuum or sweep up material and place in a designated, labeled waste container. Dispose of via a licensed waste disposal contractor.

Large spill : Move containers from spill area. Prevent entry into sewers, water courses, basements or confined areas. Vacuum or sweep up material and place in a designated, labeled waste container. Dispose of via a licensed waste disposal contractor. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8).

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Process hazards : Prior to discharge the material may contain residual hydrocarbons. The material should be purged free of hydrocarbons and cooled with an inert gas before it is discharged. The material may also contain deposited carbon and should be regarded as potentially pyrophoric when hot. As a minimum, water sprays should be available to cool the material.

Section 7. Handling and storage

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a dry place. Keep only in the original container. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabeled containers. Use appropriate containment to avoid environmental contamination. Store away from incompatible materials (see Section 10). See Section 10 for incompatible materials before handling or use.

Additional information : Further advice given in the Puraspec Operating Manual.

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

Ingredient name	Exposure limits
zinc oxide	**NIOSH REL (United States, 10/2016).** CEIL: 15 mg/m³ Form: Dust TWA: 5 mg/m³ 10 hours. Form: Dust and fumes STEL: 10 mg/m³ 15 minutes. Form: Fume **OSHA PEL 1989 (United States, 3/1989).** TWA: 5 mg/m³ 8 hours. Form: Fume STEL: 10 mg/m³ 15 minutes. Form: Fume TWA: 5 mg/m³ 8 hours. Form: Respirable fraction TWA: 10 mg/m³ 8 hours. Form: Total dust **OSHA PEL (United States, 6/2016).** TWA: 5 mg/m³ 8 hours. Form: Fume TWA: 5 mg/m³ 8 hours. Form: Respirable fraction TWA: 15 mg/m³ 8 hours. Form: Total dust **ACGIH TLV (United States, 3/2017).** TWA: 2 mg/m³ 8 hours. Form: Respirable fraction STEL: 10 mg/m³ 15 minutes. Form: Respirable fraction
Inhalable fraction	***[Air contaminant]*** **ACGIH TLV (United States).** TWA: 10 mg/m³ 8 hours. **OSHA PEL Z3 (United States).** TWA: 10 mg/m³ 8 hours.
Respirable dust	***[Air contaminant]*** **ACGIH TLV (United States).** TWA: 3 mg/m³ 8 hours. **OSHA PEL (United States).** TWA: 5 mg/m³ 8 hours.

Appropriate engineering controls : Good general ventilation should be sufficient to control worker exposure to airborne contaminants.

Section 8. Exposure controls/personal protection

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

General information : All personal protective equipment (PPE) should be selected and used under the direction of a trained health and safety professional. PPE should be in compliance with 29 CFR 1910 Subpart I – Personal Protective Equipment. It remains the responsibility of the user to ensure that this product is used safely within the context of their site conditions.

Eye/face protection : Safety eyewear complying with an approved standard (29 CFR 1910.133) is required during loading and unloading of reactors, cleaning and maintenance operations, and sampling, where exposure to dust, powder or liquid splashes is possible.

Skin protection

Hand protection : Chemical/bio-chemical resistant, impervious gloves complying with an approved chemical standard (29 CFR 1910.138) should be worn at all times when handling chemical products. For tasks involving physical or mechanical hazards, gloves should be abrasion resistant and comply with 29 CFR 1910. 138.
Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties.
In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Safety shoes complying with an approved standard (29 CFR 1910.136) and a hard hat complying with an approved standard (29 CFR 1910.135) is required during loading and unloading of reactors, cleaning and maintenance operations and sampling.

Other skin protection : Wear protective coveralls. For dusty tasks where dermal contact is possible a protective suit complying with an approved standard may be worn.

Respiratory protection : Respiratory Protective Equipment (RPE) should be used during loading and unloading of reactors, cleaning and maintenance operations, and sampling, where exposure is possible, if a risk-assessment indicates this is necessary. Respirators should be selected by and used under the direction of a trained health and safety professional following requirements found in OSHA's Respiratory Protection Standard 29 CFR 1910.134. A written respiratory protection program, including provisions for medical certification, training, fit testing, exposure assessment's, maintenance, inspection, cleaning and convenient sanitary storage must be implemented.

Section 9. Physical and chemical properties

Appearance		
Physical state	:	Solid. [Granular solid.]
Color	:	White.
Odor	:	Odorless.
Odor threshold	:	Not applicable.
pH	:	Not applicable.
Melting point	:	Not determined.
Boiling point	:	Not applicable.
Flash point	:	Not applicable.
Evaporation rate	:	Not available.
Flammability (solid, gas)	:	Discharged material may be pyrophoric (see Process Hazards).
Lower and upper explosive (flammable) limits	:	Not applicable.
Vapor pressure	:	Not applicable.
Vapor density	:	Not applicable.
Relative density	:	Not applicable.
Bulk Density (g/ml)	:	0.8 - 0.9
Solubility	:	Soluble in the following materials: strong acids
Solubility in water	:	insoluble in water.
Partition coefficient: n-octanol/water	:	Not applicable.
Auto-ignition temperature	:	Not applicable.
Decomposition temperature	:	Not available.
Viscosity	:	Not applicable.
Flow time (ISO 2431)	:	Not available.

Section 10. Stability and reactivity

Reactivity	:	No specific test data related to reactivity available for this product or its ingredients.
Chemical stability	:	The product is stable.
Possibility of hazardous reactions	:	Under normal conditions of storage and use, hazardous reactions will not occur. See Process Hazards section for hazards associated with the discharged material resulting from its intended use.
Conditions to avoid	:	No specific data.
Incompatible materials	:	No specific data.

Section 10. Stability and reactivity

Hazardous decomposition products : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

Product/ingredient name	Result	Species	Dose	Exposure
zinc oxide	LC50 Inhalation Dusts and mists LD50 Oral	Rat - Male, Female Rat	5.7 mg/l Continuous >5000 mg/kg Single dose	4 hours -

Conclusion/Summary : Not classified.

Irritation/Corrosion

Conclusion/Summary

Skin : Not classified.

Eyes : Not classified.

Respiratory : Not classified.

Sensitization

Product/ingredient name	Route of exposure	Species	Result
zinc oxide	skin	Guinea pig	Not sensitizing

Conclusion/Summary

Skin : Not classified.

Respiratory : Not classified.

Mutagenicity

Product/ingredient name	Test	Experiment	Result
zinc oxide	OECD 471 Bacterial Reverse Mutation Test	Experiment: In vitro Subject: Bacteria	Negative

Conclusion/Summary : Not classified.

Carcinogenicity

Conclusion/Summary : Not classified.

Reproductive toxicity

Conclusion/Summary : Not classified.

Teratogenicity

Conclusion/Summary : Not classified.

Specific target organ toxicity (single exposure)

Not available.

Section 11. Toxicological information

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not applicable.

Information on the likely routes of exposure : Routes of entry anticipated: Dermal, Inhalation.

Potential acute health effects

Eye contact : Dust may cause irritation to eyes.

Inhalation : Unlikely to be hazardous by inhalation unless present as a dust. High concentrations of dust may be irritant to the upper respiratory tract. Dust may enter the lung and be slow to clear. In the metals industry, high concentrations of very finely divided dust containing copper and/or zinc compounds have been known to produce the symptoms of metal fume fever. This condition is characterized by influenza type symptoms occurring a few hours after exposure and lasting for up to 48 hours. However, the handling and use of this product in line with Section 7 is not expected to pose such a risk.

Skin contact : Repeated or prolonged skin contact may cause irritation. May cause physical abrasion in contact with skin.

Ingestion : Ingestion may cause irritation of the gastrointestinal tract.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Ingestion : No specific data.

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Not available.

Conclusion/ Summary : Not classified.

Section 11. Toxicological information

General : No known significant effects or critical hazards.
Carcinogenicity : No known significant effects or critical hazards.
Mutagenicity : No known significant effects or critical hazards.
Teratogenicity : No known significant effects or critical hazards.
Developmental effects : No known significant effects or critical hazards.
Fertility effects : No known significant effects or critical hazards.

Numerical measures of toxicity

Acute toxicity estimates

Not available.

Section 12. Ecological information

Toxicity

Product/ingredient name	Result	Species	Exposure
zinc oxide	Acute EC50 0.83 mg/l Fresh water	Daphnia - Ceriodaphnia Dubnia - Neonate	48 hours
	Acute EC50 5.2 mg/l Fresh water	Micro-organism - Activated sludge	3 hours
	Acute IC50 0.27 mg/l Fresh water	Algae - Pseudokirchnerella subcapitata - Exponential growth phase	72 hours
	Acute LC50 0.338 mg/l Fresh water	Fish - Oncorrhynchus mykiss - Juvenile (Fledgling, Hatchling, Weanling)	96 hours
	Acute NOEC 0.025 mg/l Marine water	Fish - Clupea harengus - Atlantic Herring - Embryo	27 days
	Acute NOEC 0.044 mg/l Fresh water	Fish - Lowest NOEC from 7 species	5 days (minimum)
	Chronic NOEC 0.019 mg/l Fresh water	Algae - Pseudokirchnerella subcapitata - Exponential growth phase	72 hours
	Chronic NOEC 0.0078 mg/l Marine water	Algae - lowest NOEC from 12 species - Exponential growth phase	72 hours
	Chronic NOEC 0.037 mg/l Fresh water	Daphnia - Lowest NOEC from 13 invertebrate species	7 days (minimum)
	Chronic NOEC 0.056 mg/l Marine water	Daphnia - Lowest NOEC from 26 invertebrate species	7 days (minimum)
	Chronic NOEC 0.4 mg/l Fresh water	Daphnia - Daphnia magna - Neonate	48 hours

Conclusion/Summary : Very toxic to aquatic life with long lasting effects.

Persistence and degradability

Conclusion/Summary : The bioaccumulative criteria are not applicable to inorganic metals

Section 12. Ecological information

Product/ingredient name	Aquatic half-life	Photolysis	Biodegradability
zinc oxide	-	-	Not readily

Bioaccumulative potential

Not available.

Mobility in soil

Soil/water partition coefficient (K_{OC}) : Not available.

Other adverse effects : No known significant effects or critical hazards.

Section 13. Disposal considerations

Used material may have different hazards or properties from the new material. This safety data sheet does not apply to the used material.

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Empty containers or liners may retain some product residues. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

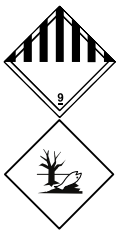
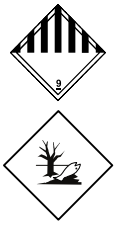
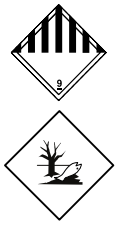
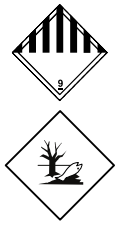
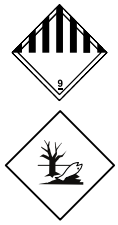
Dispose of through the metal recovery industry.

Container information: : Since the emptied container retains product residue, follow label warnings even after it has been emptied.

Section 14. Transport information

	DOT Classification	TDG Classification	Mexico Classification	ADR/RID	IMDG	IATA
UN number	UN3077	UN3077	UN3077	UN3077	UN3077	UN3077
UN proper shipping name	Environmentally hazardous substance, solid, n.o.s. (zinc oxide)	Environmentally hazardous substance, solid, n.o.s. (zinc oxide)	Environmentally hazardous substance, solid, n.o.s. (zinc oxide)	Environmentally hazardous substance, solid, n.o.s. (zinc oxide)	Environmentally hazardous substance, solid, n.o.s. (zinc oxide)	Environmentally hazardous substance, solid, n.o.s. (zinc oxide)

Section 14. Transport information

Transport hazard class (es)	9 	9 	9 	9 	9	9 
Packing group	III	III	III	III	III	III
Environmental hazards	Yes.	Yes.	Yes.	Yes.	Yes.	Yes.

Additional information

DOT Classification : Non-bulk packages of this product are not regulated as hazardous materials unless transported by inland waterway. This product is not regulated as a hazardous material when transported in sizes of ≤5 L or ≤5 kg, provided the packagings meet the general provisions of §§ 173.24 and 173.24a.
Limited quantity Yes.
Packaging instruction Exceptions: 155. Non-bulk: 213. Bulk: 240.
Special provisions 8, 146, 335, 384, A112, B54, B120, IB8, IP3, N20, N91, T1, TP33

TDG Classification : Product classified as per the following sections of the Transportation of Dangerous Goods Regulations: 2.43-2.45 (Class 9), 2.7 (Marine pollutant mark).
Non-bulk packages of this product are not regulated as dangerous goods when transported by road or rail.
Explosive Limit and Limited Quantity Index 5
Special provisions 16, 99

Mexico Classification : The environmentally hazardous substance mark is not required when transported in sizes of ≤5 L or ≤5 kg.
Special provisions 274, 331, 335

ADR/RID : This product is not regulated as a dangerous good when transported in sizes of ≤5 L or ≤5 kg, provided the packagings meet the general provisions of 4.1.1.1, 4.1.1.2 and 4.1.1.4 to 4.1.1.8.
Hazard identification number 90
Limited quantity 5 kg
Special provisions 274, 335, 601, 375

IMDG : This product is not regulated as a dangerous good when transported in sizes of ≤5 L or ≤5 kg, provided the packagings meet the general provisions of 4.1.1.1, 4.1.1.2 and 4.1.1.4 to 4.1.1.8.
Emergency schedules F-A, S-F
Special provisions 274, 335, 966, 967, 969
IMDG Code Segregation group 7 - Heavy metals and their salts (including their organometallic compounds)

IATA : This product is not regulated as a dangerous good when transported in sizes of ≤5 L or ≤5 kg, provided the packagings meet the general provisions of 5.0.2.4.1, 5.0.2.6.1.1 and 5.0.2.8.
Quantity limitation Passenger and Cargo Aircraft: 400 kg. Packaging instructions: 956. Cargo Aircraft Only: 400 kg. Packaging instructions: 956. Limited Quantities - Passenger Aircraft: 30 kg. Packaging instructions: Y956.
Special provisions A97, A158, A179, A197

Section 14. Transport information

Special precautions for user : Not applicable.

Transport in bulk according to Annex II of MARPOL and the IBC Code : Not available.

Section 15. Regulatory information

U.S. Federal regulations : **TSCA 8(a) CDR Exempt/Partial exemption**: All components are listed or exempted.

Clean Water Act (CWA) 307: zinc oxide

Clean Air Act Section 112(b) Hazardous Air Pollutants (HAPs) : Not listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 302/304

Composition/information on ingredients

No products were found.

SARA 304 RQ : Not applicable.

SARA 311/312

Classification : Not applicable.

Composition/information on ingredients

No products were found.

SARA 313

	Product name	CAS number	%
Form R - Reporting requirements	zinc oxide	1314-13-2	≥75 - ≤90
Supplier notification	zinc oxide	1314-13-2	≥75 - ≤90

SARA 313 notifications must not be detached from the SDS and any copying and redistribution of the SDS shall include copying and redistribution of the notice attached to copies of the SDS subsequently redistributed.

State regulations

Massachusetts : The following components are listed: ZINC OXIDE FUME

New York : None of the components are listed.

New Jersey : The following components are listed: ZINC OXIDE

Section 15. Regulatory information

Pennsylvania : The following components are listed: ZINC OXIDE; ZINC OXIDE FUME

International regulations

Chemical Weapon Convention List Schedules I, II & III Chemicals

Not listed.

Montreal Protocol (Annexes A, B, C, E)

Not listed.

Stockholm Convention on Persistent Organic Pollutants

Not listed.

Rotterdam Convention on Prior Informed Consent (PIC)

Not listed.

UNECE Aarhus Protocol on POPs and Heavy Metals

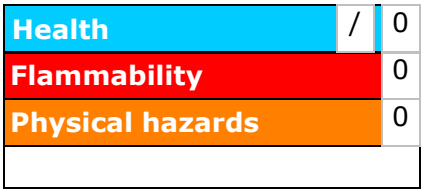
Not listed.

Inventory list

Australia	:	All components are listed or exempted.
Canada	:	All components are listed or exempted.
China	:	All components are listed or exempted.
Europe	:	All components are listed or exempted.
Japan	:	**Japan inventory (ENCS)**: All components are listed or exempted. **Japan inventory (ISHL)**: All components are listed or exempted.
Malaysia	:	All components are listed or exempted.
New Zealand	:	All components are listed or exempted.
Philippines	:	All components are listed or exempted.
Republic of Korea	:	All components are listed or exempted.
Taiwan	:	All components are listed or exempted.
Thailand	:	Not determined.
Turkey	:	All components are listed or exempted.
United States	:	All components are listed or exempted.
Viet Nam	:	Not determined.

Section 16. Other information

Hazardous Material Information System (U.S.A.)

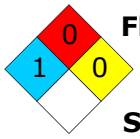


Caution: HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks. Although HMIS® ratings and the associated label are not required on SDSs or products leaving a facility under 29 CFR 1910. 1200, the preparer may choose to provide them. HMIS® ratings are to be used with a fully implemented HMIS® program. HMIS® is a registered trademark and service mark of the American Coatings Association, Inc.

The customer is responsible for determining the PPE code for this material. For more information on HMIS® Personal Protective Equipment (PPE) codes, consult the HMIS® Implementation Manual.

Section 16. Other information

National Fire Protection Association (U.S.A.)



Flammability
Health
Instability/Reactivity
Special

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Copyright ©2001, National Fire Protection Association, Quincy, MA 02269. This warning system is intended to be interpreted and applied only by properly trained individuals to identify fire, health and reactivity hazards of chemicals. The user is referred to certain limited number of chemicals with recommended classifications in NFPA 49 and NFPA 325, which would be used as a guideline only. Whether the chemicals are classified by NFPA or not, anyone using the 704 systems to classify chemicals does so at their own risk.

Procedure used to derive the classification

Classification	Justification
Not classified.	

History

Date of issue/ Date of revision (United States) : 08/01/2018

Date of issue/ Date of revision (Europe) : 01/08/2018

Date of previous issue (United States) : No previous validation

Date of previous issue (Europe) : No previous validation

Version : 1

Key to abbreviations : ATE = Acute Toxicity Estimate
BCF = Bioconcentration Factor
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
UN = United Nations

References : Not available.

Indicates information that has changed from previously issued version.

Notice to reader

Section 16. Other information

Information in this publication is believed to be accurate and is given in good faith, but it is for the Customer to satisfy itself of the suitability for its own particular purpose. Accordingly, Johnson Matthey gives no warranty as to the fitness of the Product for any particular purpose and any implied warranty or condition (statutory or otherwise) is excluded except to the extent that such exclusion is prevented by law. Freedom under Patent, Copyright and Designs cannot be assumed.
It is the policy of Johnson Matthey to update this information regularly. You are therefore advised to check that this sheet is the most recent issue.

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Johnson Matthey

PURASPEC$_{JM}$™ 2571

Puraspec

SAFETY DATA SHEET

Version	:	4
Date of issue/ Date of revision	:	20/06/2017
Date of previous issue	:	20/06/2017
Prepared by	:	Johnson Matthey Process Technologies Regulatory Affairs Department

SECTION 1: Identification of the substance/mixture and of the company/ undertaking

1.1 Product identifier

Product name	:	PURASPEC$_{JM}$ 2571
Product type	:	Solid.
Product definition	:	Mixture Classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]

1.2 Relevant identified uses of the substance or mixture and uses advised against

Specific uses	:	Hydrodesulphurisation catalyst

1.3 Details of the supplier of the safety data sheet

Supplier	:	Johnson Matthey Process Technologies PO Box No 1, Billingham Stockton on Tees, TS23 1LB UNITED KINGDOM +44 (0) 1642 523343
e-mail address of person responsible for this SDS	:	protechsds.enquiries@matthey.com

1.4 Emergency telephone number

For Chemical Emergency ONLY (spill, leak, fire, exposure or accident) call :

Emergency telephone number (with hours of operation)	:	+44 (0) 870 8200418 CHEMTREC UK (London)	(24 hours)
		+(1) 703-527-3887 CHEMTREC International	(24 hours)
Country information	:	000-800-100-7141 CHEMTREC India (local)	(24 hours)
Information limitations	:	For emergency calls only. Non-emergency calls cannot be serviced at this number.	
CHEMTREC Customer Number (CCN)	:	CCN12026	

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

Product definition : Mixture

Classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]

Self-heat. 1, H251
Eye Dam. 1, H318
Skin Sens. 1, H317
Muta. 2, H341
Carc. 1A, H350i (inhalation)
STOT RE 2, H373 (lungs) (inhalation)
Aquatic Chronic 2, H411

See Section 16 for the full text of the H statements declared above.

See Section 11 for more detailed information on health effects and symptoms.

SECTION 2: Hazards identification

2.2 Label elements

Hazard pictograms :

Signal word : Danger

Hazard statements : Self-heating: may catch fire.
Causes serious eye damage.
May cause an allergic skin reaction.
May cause cancer by inhalation.
Suspected of causing genetic defects.
May cause damage to organs through prolonged or repeated exposure if inhaled. (lungs)
Toxic to aquatic life with long lasting effects.

Precautionary statements

Prevention : Obtain special instructions before use. Do not breathe dust. Use personal protective equipment as required. In case of inadequate ventilation wear respiratory protection. Keep cool. Protect from sunlight. Wear protective gloves/clothing and eye/face protection. Avoid release to the environment.

Response : IF exposed or concerned: Get medical attention. IF IN EYES: Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER or physician.

Storage : Store away from other materials.

Disposal : Dispose of contents and container in accordance with all local, regional, national and international regulations.

Annex XVII - Restrictions on the manufacture, placing on the market and use of certain dangerous substances, mixtures and articles : Restricted to professional users.

Special packaging requirements

Containers to be fitted with child-resistant fastenings : Not applicable.

Tactile warning of danger : Not applicable.

2.3 Other hazards

Other hazards which do not result in classification : None known.

SECTION 3: Composition/information on ingredients

3.2 Mixtures

Substance/mixture : Mixture

Product/ingredient name	Identifiers	%	Classification Regulation (EC) No. 1272/2008 [CLP]	Type

SECTION 3: Composition/information on ingredients

aluminium oxide	REACH #: 01-2119529248-35 EC: 215-691-6 CAS: 1344-28-1	≥50 - ≤75	Not classified.	[2]
trinickel disulfide	REACH #: 01-2119485381-36 EC: 234-829-6 CAS: 12035-72-2 Index: 028-007-00-4	≤5	Acute Tox. 4, H332 Skin Sens. 1, H317 Muta. 2, H341 (inhalation) Carc. 1A, H350i (inhalation) STOT RE 1, H372 (lungs) (inhalation) Aquatic Acute 1, H400 (M=1) Aquatic Chronic 1, H410 (M=1)	[1] [2]
molybdenum trioxide	REACH #: 01-2119488038-30 EC: 215-204-7 CAS: 1313-27-5 Index: 042-001-00-9	≤5	Eye Irrit. 2, H319 Carc. 2, H351 (inhalation) STOT SE 3, H335	[1] [2]
Silicic acid, aluminum salt	REACH #: 01-2119519214-48 EC: 215-628-2 CAS: 1335-30-4	≤5	Eye Dam. 1, H318	[1]
nickel monoxide	REACH #: 01-2119467172-41 EC: 215-215-7 CAS: 1313-99-1 Index: 028-003-00-2	<1	Skin Sens. 1, H317 Carc. 1A, H350i (inhalation) STOT RE 1, H372 (lungs) (inhalation) Aquatic Chronic 4, H413 **See Section 16 for the full text of the H statements declared above.**	[1] [2]

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment, are PBTs or vPvBs or have been assigned a workplace exposure limit and hence require reporting in this section.

Type

[1] Substance classified with a health or environmental hazard
[2] Substance with a workplace exposure limit
[3] Substance meets the criteria for PBT according to Regulation (EC) No. 1907/2006, Annex XIII
[4] Substance meets the criteria for vPvB according to Regulation (EC) No. 1907/2006, Annex XIII
[5] Substance of equivalent concern

Occupational exposure limits, if available, are listed in Section 8.

SECTION 4: First aid measures

4.1 Description of first aid measures

Eye contact : Get medical attention immediately. Call a poison center or physician. Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Continue to rinse for at least 10 minutes. Chemical burns must be treated promptly by a physician.

Inhalation : Get medical attention immediately. Call a poison center or physician. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Skin contact : Get medical attention immediately. Call a poison center or physician. Wash with plenty of soap and water. Remove contaminated clothing and shoes. Wash contaminated clothing thoroughly with water before removing it, or wear gloves. Continue to rinse for at least 10 minutes. Chemical burns must be treated promptly by a physician. In the event of any complaints or symptoms, avoid further exposure. Wash clothing before reuse. Clean shoes thoroughly before reuse.

SECTION 4: First aid measures

Ingestion : Get medical attention immediately. Call a poison center or physician. Wash out mouth with water. Remove dentures if any. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. Stop if the exposed person feels sick as vomiting may be dangerous. Do not induce vomiting unless directed to do so by medical personnel. If vomiting occurs, the head should be kept low so that vomit does not enter the lungs. Chemical burns must be treated promptly by a physician. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Wash contaminated clothing thoroughly with water before removing it, or wear gloves.

4.2 Most important symptoms and effects, both acute and delayed

Potential acute health effects

Inhalation : Unlikely to be hazardous by inhalation unless present as a dust. High concentrations of dust may be irritant to the upper respiratory tract. Dust may enter the lung and be slow to clear.

Ingestion : Ingestion may cause irritation of the gastrointestinal tract.

Skin contact : May cause an allergic skin reaction.

Eye contact : Causes serious eye damage.

Over-exposure signs/symptoms

Eye contact : Adverse symptoms may include the following:
pain
watering
redness

Inhalation : No specific data.

Skin contact : Adverse symptoms may include the following:
pain or irritation
redness
blistering may occur

Ingestion : Adverse symptoms may include the following:
stomach pains

4.3 Indication of any immediate medical attention and special treatment needed

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

SECTION 5: Firefighting measures

5.1 Extinguishing media

Suitable extinguishing media : Use water spray or fog.

Unsuitable extinguishing media : Do not use water jet.

5.2 Special hazards arising from the substance or mixture

Hazards from the substance or mixture : Self-heating material. May catch fire. Liable to self-heating in contact with air, without energy supply. Self heating at (Deg C): >50 Discharged material may be liable to self heating (See Process Hazards) This material is toxic to aquatic life with long lasting effects. Fire water contaminated with this material must be contained and prevented from being discharged to any waterway, sewer or drain.

SECTION 5: Firefighting measures

Hazardous combustion products : Decomposition products may include the following materials:
sulfur oxides
phosphorus oxides
metal oxide/oxides

Thermal decomposition will evolve toxic, irritant and flammable vapours.

5.3 Advice for firefighters

Special precautions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode. Clothing for fire-fighters (including helmets, protective boots and gloves) conforming to European standard EN 469 will provide a basic level of protection for chemical incidents.

SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilt material. Shut off all ignition sources. No flares, smoking or flames in hazard area. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

For emergency responders : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

6.2 Environmental precautions : Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air). Water polluting material. May be harmful to the environment if released in large quantities. Collect spillage.

6.3 Methods and material for containment and cleaning up

Small spill : Move containers from spill area. Use spark-proof tools and explosion-proof equipment. Avoid dust generation. Do not dry sweep. Vacuum dust with equipment fitted with a HEPA filter and place in a closed, labeled waste container. Place spilled material in a designated, labeled waste container. Dispose of via a licensed waste disposal contractor.

Large spill : Move containers from spill area. Use spark-proof tools and explosion-proof equipment. Approach the release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Avoid dust generation. Do not dry sweep. Vacuum dust with equipment fitted with a HEPA filter and place in a closed, labeled waste container. Dispose of via a licensed waste disposal contractor.

6.4 Reference to other sections : See Section 1 for emergency contact information.
See Section 8 for information on appropriate personal protective equipment.
See Section 13 for additional waste treatment information.

SECTION 7: Handling and storage

7.1 Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8). Persons with a history of skin sensitization problems should not be employed in any process in which this product is used. Avoid exposure - obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Do not get in eyes or on skin or clothing. Do not ingest. Avoid release to the environment. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Do not enter storage areas and confined spaces unless adequately ventilated. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Store and use away from heat, sparks, open flame or any other ignition source. Use only non-sparking tools. Empty containers retain product residue and can be hazardous. Do not reuse container.

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Process hazards : The charging of self-heating materials requires particular care. Charging should be done quickly and if possible controlled from outside the vessel. Excessive vibration or disturbances should be avoided since this could cause dust to form. The material may also be self-heating if exposed to air-streams during loading. During discharge it is recommended that foam or dry powder fire extinguishers are available to blanket the material if it self-heats. Nitrogen blanketing is recommended when reactors have been loaded. Prior to discharge the material may contain residual hydrocarbons. The material should be purged free of hydrocarbons and cooled with an inert gas before it is discharged. The material may also contain deposited carbon and should be regarded as potentially pyrophoric when hot. Pyrophoric and self-heating materials can act as sources of ignition and should be kept away from combustible materials. As a minimum, water sprays should be available to cool the material. The material should not be exposed to gases containing carbon monoxide at temperatures between 50 deg C and 200 deg C because of the danger of formation of nickel carbonyl under these conditions.

7.2 Conditions for safe storage, including any incompatibilities

: Store in accordance with local regulations. Store in a segregated and approved area. Eliminate all ignition sources. Store away from other materials. Keep product dry. Keep away from heat and direct sunlight. Keep container in a cool, well-ventilated area. Maintain air gap between stacks/pallets. Keep only in the original container. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabelled containers. Use appropriate containment to avoid environmental contamination. Contact with combustible material may cause fire. Store away from incompatible materials (see Section 10).

Can react with mineral acids to liberate hydrogen sulphide and sulphur dioxide.

Additional information : Further advice given in the Puraspec Operating Manual.

7.3 Specific end use(s)

Recommendations : Not available.

Industrial sector specific solutions : Not available.

SECTION 8: Exposure controls/personal protection

8.1 Control parameters

Occupational exposure limits

Product/ingredient name	Exposure limit values
aluminium oxide	**EH40/2005 WELs (United Kingdom (UK), 12/2011).** TWA: 10 mg/m³ 8 hours. Form: inhalable dust
trinickel disulfide	**EH40-MEL (United Kingdom (UK), 2002). Notes: UK COSHH Approved Maximum Exposure Limits (Table1)** TWA: 0.5 mg/m³ 8 hours. **EH40/2005 WELs (United Kingdom (UK), 12/2011). Absorbed through skin. Inhalation sensitiser.** TWA: 0.5 mg/m³, (as Ni) 8 hours.
molybdenum trioxide	**EH40/2005 WELs (United Kingdom (UK), 12/2011).** STEL: 20 mg/m³, (as Mo) 15 minutes. TWA: 10 mg/m³, (as Mo) 8 hours.
nickel monoxide	**EH40/2005 WELs (United Kingdom (UK), 12/2011). Absorbed through skin. Inhalation sensitiser.** TWA: 0.5 mg/m³, (as Ni) 8 hours.
Inhalable fraction	***[Air contaminant]*** **EH40/2005 WELs (United Kingdom (UK)).** TWA: 10 mg/m³ 8 hours.
Respirable dust	***[Air contaminant]*** **EH40/2005 WELs (United Kingdom (UK)).** TWA: 4 mg/m³ 8 hours.

Recommended monitoring procedures : If this product contains ingredients with exposure limits, personal, workplace atmosphere or biological monitoring may be required to determine the effectiveness of the ventilation or other control measures and/or the necessity to use respiratory protective equipment. Reference should be made to monitoring standards, such as the following: European Standard EN 689 (Workplace atmospheres - Guidance for the assessment of exposure by inhalation to chemical agents for comparison with limit values and measurement strategy) European Standard EN 14042 (Workplace atmospheres - Guide for the application and use of procedures for the assessment of exposure to chemical and biological agents) European Standard EN 482 (Workplace atmospheres - General requirements for the performance of procedures for the measurement of chemical agents) Reference to national guidance documents for methods for the determination of hazardous substances will also be required.

DNELs/DMELs

Product/ingredient name	Type	Exposure	Value	Population	Effects
trinickel disulfide	DNEL	Long term Dermal	0.004 mg/cm² skin	Workers	Local
	DNEL	Long term Inhalation	0.05 mg/m³	Workers	Systemic
molybdenum trioxide	DNEL	Long term Inhalation	16.8 mg/m³	Workers	Systemic
	DNEL	Long term Inhalation	3.33 mg/m³	Workers	Local
nickel monoxide	DNEL	Long term Dermal	0.012 mg/cm²	Workers	Local
	DNEL	Long term Inhalation	0.05 mg/m³	Workers	Systemic

PNECs

SECTION 8: Exposure controls/personal protection

Product/ingredient name	Type	Compartment Detail	Value	Method Detail
trinickel disulfide	-	Fresh water	0.0071 mg/l	Assessment Factors
	-	Marine water	0.0086 mg/l	Assessment Factors
	-	Soil	29.9 mg/kg	Assessment Factors
	-	Sewage Treatment Plant	0.033 mg/l	Assessment Factors
molybdenum trioxide	-	Fresh water	19.05 mg/l	Sensitivity Distribution
	-	Marine water	2.85 mg/l	Sensitivity Distribution
	-	Fresh water sediment	33900 mg/kg dwt	Equilibrium Partitioning
	-	Marine water sediment	2970 mg/kg dwt	Equilibrium Partitioning
	-	Soil	14.25 mg/kg dwt	Sensitivity Distribution
	-	Sewage Treatment Plant	32.55 mg/l	Assessment Factors
nickel monoxide	-	Fresh water	7.1 µg/l	Assessment Factors
	-	Marine water	8.6 µg/l	Assessment Factors
	-	Soil	29.9 mg/kg dwt	Assessment Factors
	-	Sewage Treatment Plant	0.33 mg/l	Assessment Factors
	-	Fresh water sediment	109 mg/kg dwt	Assessment Factors
	-	Marine water sediment	109 mg/kg dwt	Assessment Factors

8.2 Exposure controls

Appropriate engineering controls : Use only with adequate ventilation. Engineering controls may be required to control the primary or secondary risks associated with this product. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits. The engineering controls also need to keep gas, vapour or dust concentrations below any lower explosive limits. Use explosion-proof ventilation equipment.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Contaminated work clothing should not be allowed out of the workplace. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

General information : All personal protective equipment (PPE) should be selected and used under the direction of a trained health and safety professional. PPE should be in compliance with any relevant local or national standard. Where no local or national standards apply, compliance with the relevant EU standard is recommended.
It remains the responsibility of the user to ensure that this product is used safely within the context of their site conditions.

Eye/face protection : Safety eyewear complying with an approved standard (EN 166 or local equivalent) is required during loading and unloading of reactors, cleaning and maintenance operations, and sampling, where exposure to dust, powder or liquid splashes is possible. Goggles, face shield or other full-face protection should be worn if there is a risk of direct exposure to dust. If inhalation hazards exist, a full-face respirator may be required instead.

Skin protection

Hand protection : Chemical/bio-chemical resistant, impervious gloves complying with an approved chemical standard (EN 374 or local equivalent) should be worn at all times when handling chemical products. For tasks involving physical or mechanical hazards, gloves should also comply with an approved physical standard (EN 388 or local equivalent).
Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties.
In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

SECTION 8: Exposure controls/personal protection

Body protection : Safety shoes complying with an approved standard (EN 20346 or equivalent) and a hard hat complying with an approved standard (EN 297 or equivalent) is required during loading and unloading of reactors, cleaning and maintenance operations and sampling.

Other skin protection : A protective suit complying with an approved standard (EN 13982-1 Type 5 or equivalent) should be worn during loading and unloading or reactors, sampling and cleaning and maintenance operations where dermal contact is possible.

Respiratory protection : Use of Respiratory Protective Equipment (RPE) (Particle filter with high efficiency for solid particles (EN 143 or 149, Type P3 or FFP3, Associated Protection Factor (APF) = 20) or local equivalent as a minimum) is required during loading and unloading of reactors, cleaning and maintenance operations, and sampling, where exposure to dust or powder is possible. Air-fed Respiratory Protective Equipment may be used if entry to the reactor is required.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

SECTION 9: Physical and chemical properties

9.1 Information on basic physical and chemical properties

Appearance

Physical state : Solid. [extrudates]

Colour : Black.

Odour : Odourless.

Odour threshold : Not applicable.

pH : Not applicable.

Melting point/freezing point : Not determined.

Initial boiling point and boiling range : Not applicable.

Flash point : Not applicable.

Evaporation rate (butyl acetate = 1) : Not applicable.

Flammability (solid, gas) : Not classified.

Upper/lower flammability or explosive limits : Not applicable.

Vapour pressure (mm Hg) : Not applicable.

Vapour density : Not applicable.

Relative density : Not applicable.

Bulk Density (g/ml) : 0.6 - 0.8

Solubility(ies) : Not applicable.

Solubility - Water : insoluble in water.

Partition coefficient: n-octanol/water : Not applicable.

Auto-ignition temperature : Not applicable.

Decomposition temperature : Not available.

Viscosity (m.Pa.s) : Not applicable.

Explosive properties : Not available.

Oxidising properties : Not available.

9.2 Other information

No additional information.

SECTION 10: Stability and reactivity

10.1 Reactivity : This product, by reaction with air and without energy supply, is liable to self-heat and will ignite when in large amounts and after long periods of time. The spontaneous ignition temperature will be ≤ 50°C for a volume of 450 litres.

10.2 Chemical stability : The product is stable.

10.3 Possibility of hazardous reactions : Hazardous reactions or instability may occur under certain conditions of storage or use.
Conditions may include the following:
extended contact with air in bulk storage
Reactions may include the following:
risk of causing fire
spontaneous flammability
See Process Hazards section for hazards associated with the discharged material resulting from its intended use.

10.4 Conditions to avoid : Avoid all possible sources of ignition (spark or flame).

10.5 Incompatible materials : Reactive or incompatible with the following materials:
oxidising agents

10.6 Hazardous decomposition products : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

SECTION 11: Toxicological information

11.1 Information on toxicological effects

Acute toxicity

Product/ingredient name	Result	Species	Dose	Exposure
trinickel disulfide	LC50 Inhalation Dusts and mists	Rat	1.14 mg/l	4 hours
	LD50 Oral	Rat	>5 g/kg	-
molybdenum trioxide	LC50 Inhalation Dusts and mists	Rat	>5.05 mg/l	4 hours
	LD50 Dermal	Rat	>2 g/kg	-
	LD50 Dermal	Rat	>2000 mg/kg	-
	LD50 Oral	Rat	2689 mg/kg	-

Conclusion/Summary : Not classified.

Acute toxicity estimates

Route	ATE value
Inhalation (dusts and mists)	23.27 mg/l

Irritation/Corrosion

Conclusion/Summary

Skin : Not classified.

Eyes : Causes serious eye damage.

Respiratory : Not classified.

Sensitiser

Conclusion/Summary

Skin : May cause an allergic skin reaction.

Respiratory : Not classified.

Mutagenicity

Conclusion/Summary : Suspected of causing genetic defects.

Carcinogenicity

SECTION 11: Toxicological information

Conclusion/Summary : May cause cancer by inhalation.

Reproductive toxicity

Conclusion/Summary : Not classified.

Teratogenicity

Conclusion/Summary : Not classified.

Specific target organ toxicity (single exposure)

Product/ingredient name	Category	Route of exposure	Target organs
molybdenum trioxide	Category 3	Not applicable.	Respiratory tract irritation

Specific target organ toxicity (repeated exposure)

Product/ingredient name	Category	Route of exposure	Target organs
PURASPEC 2571 trinickel disulfide nickel monoxide	Category 2 Category 1 Category 1	Inhalation Inhalation Inhalation	lungs lungs lungs

Aspiration hazard

Not available.

Information on likely routes of exposure : Routes of entry anticipated: Dermal, Inhalation.

Potential acute health effects

Inhalation : Unlikely to be hazardous by inhalation unless present as a dust. High concentrations of dust may be irritant to the upper respiratory tract. Dust may enter the lung and be slow to clear.

Ingestion : Ingestion may cause irritation of the gastrointestinal tract.

Skin contact : May cause an allergic skin reaction.

Eye contact : Causes serious eye damage.

Symptoms related to the physical, chemical and toxicological characteristics

Inhalation : No specific data.

Ingestion : Adverse symptoms may include the following:
stomach pains

Skin contact : Adverse symptoms may include the following:
pain or irritation
redness
blistering may occur

Eye contact : Adverse symptoms may include the following:
pain
watering
redness

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Conclusion/Summary : May cause damage to organs through prolonged or repeated exposure if inhaled.

SECTION 11: Toxicological information

General : May cause damage to organs through prolonged or repeated exposure if inhaled. Once sensitized, a severe allergic reaction may occur when subsequently exposed to very low levels.

Carcinogenicity : May cause cancer by inhalation. Risk of cancer depends on duration and level of exposure.

Mutagenicity : Suspected of causing genetic defects.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Other information : Not available.

SECTION 12: Ecological information

12.1 Toxicity

Product/ingredient name	Result	Species	Exposure
molybdenum trioxide	Acute LC50 203.2 mg/l Fresh water Acute LC50 70000 µg/l Fresh water	Daphnia - Daphnia magna - Neonate Fish - Pimephales promelas	48 hours 96 hours

Conclusion/Summary : Toxic to aquatic life with long lasting effects.

12.2 Persistence and degradability

Conclusion/Summary : The bioaccumulative criteria are not applicable to essential metals.

12.3 Bioaccumulative potential

Product/ingredient name	$LogP_{ow}$	BCF	Potential
trinickel disulfide	-	270	low
nickel monoxide	-	270	low

12.4 Mobility in soil

Soil/water partition coefficient (K_{OC}) : Not available.

Mobility : Not available.

12.5 Results of PBT and vPvB assessment

PBT : Not applicable.

vPvB : Not applicable.

12.6 Other adverse effects : No known significant effects or critical hazards.

SECTION 13: Disposal considerations

Used material may have different hazards or properties from the new material. This safety data sheet does not apply to the used material.

In all cases where a EWC code is given, this applies to the material under normal conditions of use and may not be appropriate for used material where the properties may have changed. It is the responsibility of the user to check that any waste code recommendation is appropriate to their material in accordance with the recommendation of the European Waste Catalogue.

13.1 Waste treatment methods

Product

SECTION 13: Disposal considerations

Methods of disposal : The generation of waste should be avoided or minimised wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction.

Container information: : Since the emptied container retains product residue, follow label warnings even after it has been emptied.

Hazardous waste : The classification of the product may meet the criteria for a hazardous waste.

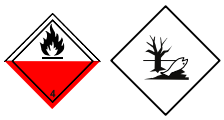
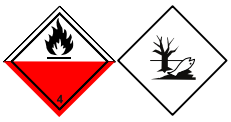
European waste catalogue (EWC) : The user should assign a waste code to the material in accordance with the recommendations of the European Waste Catalogue.

Packaging

Methods of disposal : The generation of waste should be avoided or minimised wherever possible. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible.

Special precautions : This material and its container must be disposed of in a safe way. Care should be taken when handling emptied containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers.

SECTION 14: Transport information

	ADR/RID	ADN	IMDG	IATA
14.1 UN number	UN3190	UN3190	UN3190	UN3190
14.2 UN proper shipping name	Self-heating solid, inorganic, n.o.s. (Molybdenum sulfide)	Self-heating solid, inorganic, n.o.s. (Molybdenum sulfide)	Self-heating solid, inorganic, n.o.s. (Molybdenum sulfide)	Self-heating solid, inorganic, n.o.s. (Molybdenum sulfide)
14.3 Transport hazard class(es)	4.2	4.2 	4.2 	4.2
14.4 Packing group	II	II	II	II
14.5 Environmental hazards	Yes.	Yes.	Yes.	No.
Additional information	The environmentally hazardous substance mark is not required when transported in sizes of ≤5 L or ≤5 kg. **Hazard identification number** 40 **Limited quantity** 0 **Special provisions** 274 **Tunnel code**	The environmentally hazardous substance mark is not required when transported in sizes of ≤5 L or ≤5 kg. **Special provisions** 274	The marine pollutant mark is not required when transported in sizes of ≤5 L or ≤5 kg. **Emergency schedules (EmS)** F-A, S-J **Special provisions** 274 **IMDG Code Segregation group** 7 - Heavy metals and their salts (including their organometallic	The environmentally hazardous substance mark may appear if required by other transportation regulations. **Passenger and Cargo Aircraft** Quantity limitation: 15 kg Packaging instructions: 467 **Cargo Aircraft Only** Quantity limitation: 50 kg Packaging instructions: 470

SECTION 14: Transport information

	(D/E)		compounds)	**Limited Quantities - Passenger Aircraft** Quantity limitation: Forbidden Packaging instructions: Forbidden **Special provisions** A3, A803

14.6 Special precautions for user : Not applicable.

14.7 Transport in bulk according to Annex II of Marpol and the IBC Code : Not available.

SECTION 15: Regulatory information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

EU Regulation (EC) No. 1907/2006 (REACH)

Annex XIV - List of substances subject to authorisation

Annex XIV

None of the components are listed.

Substances of very high concern

None of the components are listed.

Annex XVII - Restrictions on the manufacture, placing on the market and use of certain dangerous substances, mixtures and articles : Restricted to professional users.

Other EU regulations

Europe inventory : All components are listed or exempted.

Product/ingredient name	Carcinogenic effects	Mutagenic effects	Developmental effects	Fertility effects
trinickel disulfide	Carc. 1A, H350i (inhalation)	Muta. 2, H341 (inhalation)	-	-
molybdenum trioxide	Carc. 2, H351 (inhalation)	-	-	-
nickel monoxide	Carc. 1A, H350i (inhalation)	-	-	-

Ozone depleting substances (1005/2009/EU)

Not listed.

Prior Informed Consent (PIC) (649/2012/EU)

Not listed.

National regulations

SECTION 15: Regulatory information

Product/ingredient name	List name	Name on list	Classification	Notes
trinickel disulfide	UK Occupational Exposure Limits EH40 - WEL	inorganic nickel compounds Insoluble in water Except nickel carbonyl	Carc.	-
nickel monoxide	UK Occupational Exposure Limits EH40 - WEL	inorganic nickel compounds Insoluble in water Except nickel carbonyl	Carc.	-

International lists

National inventory

Australia : Not determined.

Canada : Not determined.

China : Not determined.

Japan : **Japan inventory (ENCS)**: All components are listed or exempted.
Japan inventory (ISHL): All components are listed or exempted.

Malaysia : At least one component is not listed.

New Zealand : Not determined.

Philippines : Not determined.

Republic of Korea : All components are listed or exempted.

Taiwan : Not determined.

Turkey : Not determined.

United States : All components are listed or exempted.

15.2 Chemical safety assessment : This product contains substances for which Chemical Safety Assessments are still required.

SECTION 16: Other information

Indicates information that has changed from previously issued version.

Abbreviations and acronyms : ATE = Acute Toxicity Estimate
CLP = Classification, Labelling and Packaging Regulation [Regulation (EC) No. 1272/2008]
DNEL = Derived No Effect Level
EUH statement = CLP-specific Hazard statement
PNEC = Predicted No Effect Concentration
RRN = REACH Registration Number

Procedure used to derive the classification according to Regulation (EC) No. 1272/2008 [CLP/GHS]

Classification	Justification
Self-heat. 1, H251	Expert judgment
Eye Dam. 1, H318	Calculation method
Skin Sens. 1, H317	Calculation method
Muta. 2, H341	Calculation method
Carc. 1A, H350i (inhalation)	According to package
STOT RE 2, H373 (lungs) (inhalation)	According to package
Aquatic Chronic 2, H411	Calculation method

Full text of abbreviated H statements :

H251	Self-heating: may catch fire.
H317	May cause an allergic skin reaction.
H318	Causes serious eye damage.
H319	Causes serious eye irritation.
H332	Harmful if inhaled.
H335	May cause respiratory irritation.
H341 (inhalation)	Suspected of causing genetic defects if inhaled.
H341	Suspected of causing genetic defects.
H350i (inhalation)	May cause cancer by inhalation.
H351 (inhalation)	Suspected of causing cancer if inhaled.

SECTION 16: Other information

H372 (lungs) (inhalation)	Causes damage to organs through prolonged or repeated exposure if inhaled. (lungs)
H373 (lungs) (inhalation)	May cause damage to organs through prolonged or repeated exposure if inhaled. (lungs)
H400	Very toxic to aquatic life.
H410	Very toxic to aquatic life with long lasting effects.
H411	Toxic to aquatic life with long lasting effects.
H413	May cause long lasting harmful effects to aquatic life.

Full text of classifications [CLP/GHS] :

Acute Tox. 4, H332	ACUTE TOXICITY (inhalation) - Category 4
Aquatic Acute 1, H400	ACUTE AQUATIC HAZARD - Category 1
Aquatic Chronic 1, H410	LONG-TERM AQUATIC HAZARD - Category 1
Aquatic Chronic 2, H411	LONG-TERM AQUATIC HAZARD - Category 2
Aquatic Chronic 4, H413	LONG-TERM AQUATIC HAZARD - Category 4
Carc. 1A, H350i (inhalation)	CARCINOGENICITY (inhalation) - Category 1A
Carc. 2, H351 (inhalation)	CARCINOGENICITY (inhalation) - Category 2
Eye Dam. 1, H318	SERIOUS EYE DAMAGE/ EYE IRRITATION - Category 1
Eye Irrit. 2, H319	SERIOUS EYE DAMAGE/ EYE IRRITATION - Category 2
Muta. 2, H341 (inhalation)	GERM CELL MUTAGENICITY (inhalation) - Category 2
Muta. 2, H341	GERM CELL MUTAGENICITY - Category 2
Self-heat. 1, H251	SELF-HEATING SUBSTANCES AND MIXTURES - Category 1
Skin Sens. 1, H317	SKIN SENSITIZATION - Category 1
STOT RE 1, H372 (lungs) (inhalation)	SPECIFIC TARGET ORGAN TOXICITY (REPEATED EXPOSURE) (lungs) (inhalation) - Category 1
STOT RE 2, H373 (lungs) (inhalation)	SPECIFIC TARGET ORGAN TOXICITY (REPEATED EXPOSURE) (lungs) (inhalation) - Category 2
STOT SE 3, H335	SPECIFIC TARGET ORGAN TOXICITY (SINGLE EXPOSURE) (Respiratory tract irritation) - Category 3

Notice to reader

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SAFETY DATA SHEET

Creation Date 21-May-2012 **Revision Date** 24-Apr-2019 **Revision Number** 7

SECTION 1: IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING

1.1. Product identification

Product Description: **Sodium hydroxide 2M (free from carbonate)**
Cat No. : **J/7610/PB15, J/7610/17, J/7610/2, J/7610/PC24**

1.2. Relevant identified uses of the substance or mixture and uses advised against

Recommended Use Laboratory chemicals.
Uses advised against No Information available

1.3. Details of the supplier of the safety data sheet

Company

UK entity/business name
Fisher Scientific UK
Bishop Meadow Road, Loughborough,
Leicestershire LE11 5RG, United Kingdom

EU entity/business name
Acros Organics BVBA
Janssen Pharmaceuticalaan 3a
2440 Geel, Belgium

E-mail address begel.sdsdesk@thermofisher.com

1.4. Emergency telephone number

Tel: 01509 231166
Chemtrec US: (800) 424-9300
Chemtrec EU: 001 (202) 483-7616

SECTION 2: HAZARDS IDENTIFICATION

2.1. Classification of the substance or mixture

CLP Classification - Regulation (EC) No 1272/2008

Physical hazards

Substances/mixtures corrosive to metal	Category 1 (H290)

Health hazards

Skin Corrosion/irritation	Category 1 A (H314)
Serious Eye Damage/Eye Irritation	Category 1 (H318)

Environmental hazards
Based on available data, the classification criteria are not met

2.2. Label elements

Signal Word **Danger**

Hazard Statements

H290 - May be corrosive to metals
H314 - Causes severe skin burns and eye damage

Precautionary Statements

P280 - Wear protective gloves/ protective clothing/ eye protection/ face protection
P301 + P330 + P331 - IF SWALLOWED: rinse mouth. Do NOT induce vomiting
P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P310 - Immediately call a POISON CENTER or doctor/ physician
P234 - Keep only in original container

2.3. Other hazards

No information available

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

3.2. Mixtures

Component	CAS-No	EC-No.	Weight %	CLP Classification - Regulation (EC) No 1272/2008
Sodium hydroxide	1310-73-2	EEC No. 215-185-5	8	Met. Corr. 1 (H290) Skin Corr. 1A (H314) Eye Dam. 1 (H318)
Water	7732-18-5	231-791-2	92	-

Full text of Hazard Statements: see section 16

SECTION 4: FIRST AID MEASURES

4.1. Description of first aid measures

General Advice Show this safety data sheet to the doctor in attendance. Immediate medical attention is required.

Eye Contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Immediate medical attention is required.

Skin Contact	Wash off immediately with plenty of water for at least 15 minutes. Remove and wash contaminated clothing before re-use. Call a physician immediately.
Ingestion	Do not induce vomiting. Clean mouth with water. Never give anything by mouth to an unconscious person. Call a physician immediately.
Inhalation	If not breathing, give artificial respiration. Remove from exposure, lie down. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Call a physician immediately.
Self-Protection of the First Aider	Ensure that medical personnel are aware of the material(s) involved, take precautions to protect themselves and prevent spread of contamination.

4.2. Most important symptoms and effects, both acute and delayed

Causes burns by all exposure routes. Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated: Ingestion causes severe swelling, severe damage to the delicate tissue and danger of perforation

4.3. Indication of any immediate medical attention and special treatment needed

Notes to Physician Treat symptomatically.

SECTION 5: FIREFIGHTING MEASURES

5.1. Extinguishing media

Suitable Extinguishing Media
CO_2, dry chemical, dry sand, alcohol-resistant foam.

Extinguishing media which must not be used for safety reasons
No information available.

5.2. Special hazards arising from the substance or mixture

Thermal decomposition can lead to release of irritating gases and vapors. The product causes burns of eyes, skin and mucous membranes.

Hazardous Combustion Products
Sodium oxides.

5.3. Advice for firefighters

As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear. Thermal decomposition can lead to release of irritating gases and vapors.

SECTION 6: ACCIDENTAL RELEASE MEASURES

6.1. Personal precautions, protective equipment and emergency procedures

Use personal protective equipment. Ensure adequate ventilation. Evacuate personnel to safe areas. Keep people away from and upwind of spill/leak.

6.2. Environmental precautions

Should not be released into the environment.

6.3. Methods and material for containment and cleaning up

Keep in suitable, closed containers for disposal. Soak up with inert absorbent material.

6.4. Reference to other sections

Refer to protective measures listed in Sections 8 and 13.

SECTION 7: HANDLING AND STORAGE

7.1. Precautions for safe handling

Do not get in eyes, on skin, or on clothing. Wear personal protective equipment. Use only in well-ventilated areas. Do not breathe vapors or spray mist. Do not ingest.

Hygiene Measures
Handle in accordance with good industrial hygiene and safety practice. Keep away from food, drink and animal feeding stuffs. Do not eat, drink or smoke when using this product. Remove and wash contaminated clothing before re-use. Wash hands before breaks and at the end of workday.

7.2. Conditions for safe storage, including any incompatibilities

Keep in a dry, cool and well-ventilated place. Keep container tightly closed. Corrosives area. Store in original container.

7.3. Specific end use(s)

Use in laboratories

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1. Control parameters

Exposure limits
List source(s): **UK** - EH40/2005 Containing the workplace exposure limits (WELs) for use with the Control of Substances Hazardous to Health Regulations (COSHH) 2002 (as amended). Updated by September 2006 official press release and October 2007 Supplement. **IRE -** 2010 Code of Practice for the Safety, Health and Welfare at Work (Chemical Agents) Regulations 2001. Published by the Health and Safety Authority.

Component	The United Kingdom	European Union	Ireland
Sodium hydroxide	2 mg/m³ STEL		STEL: 2 mg/m³ 15 min

Biological limit values
This product, as supplied, does not contain any hazardous materials with biological limits established by the region specific regulatory bodies

Monitoring methods
BS EN 14042:2003 Title Identifier: Workplace atmospheres. Guide for the application and use of procedures for the assessment of exposure to chemical and biological agents.
MDHS14/3 General methods for sampling and gravimetric analysis of respirable and inhalable dust

Derived No Effect Level (DNEL) See table for values

Route of exposure	Acute effects (local)	Acute effects (systemic)	Chronic effects (local)	Chronic effects (systemic)
Oral				
Dermal				
Inhalation	1 mg/m³			

Predicted No Effect Concentration (PNEC) No information available.

8.2. Exposure controls

Engineering Measures
Ensure that eyewash stations and safety showers are close to the workstation location.
Wherever possible, engineering control measures such as the isolation or enclosure of the process, the introduction of process or equipment changes to minimise release or contact, and the use of properly designed ventilation systems, should be adopted to control hazardous materials at source

Personal protective equipment

Eye Protection Goggles (European standard - EN 166)

Hand Protection Protective gloves

Glove material	Breakthrough time	Glove thickness	EU standard	Glove comments
Neoprene	> 480 minutes	0.45 mm	Level 6	As tested under EN374-3 Determination of
Butyl rubber	> 480 minutes	0.35 mm	EN 374	Resistance to Permeation by Chemicals
Nitrile rubber	> 480 minutes	0.35 mm		
Viton (R)	> 480 minutes	0.30 mm		

Skin and body protection Long sleeved clothing

Inspect gloves before use.
Please observe the instructions regarding permeability and breakthrough time which are provided by the supplier of the gloves. (Refer to manufacturer/supplier for information)
Ensure gloves are suitable for the task: Chemical compatability, Dexterity, Operational conditions, User susceptibility, e.g. sensitisation effects, also take into consideration the specific local conditions under which the product is used, such as the danger of cuts, abrasion.
Remove gloves with care avoiding skin contamination.

Respiratory Protection When workers are facing concentrations above the exposure limit they must use appropriate certified respirators.
To protect the wearer, respiratory protective equipment must be the correct fit and be used and maintained properly

Large scale/emergency use Use a NIOSH/MSHA or European Standard EN 136 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced
Recommended Filter type: Particulates filter conforming to EN 143

Small scale/Laboratory use Use a NIOSH/MSHA or European Standard EN 149:2001 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.
Recommended half mask:- Particle filtering: EN149:2001
When RPE is used a face piece Fit Test should be conducted

Environmental exposure controls Prevent product from entering drains.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

9.1. Information on basic physical and chemical properties

Appearance	Clear Colorless	
Physical State	Liquid	
Odor	No information available	
Odor Threshold	No data available	
pH	Strongly basic 14	
Melting Point/Range	-10 °C / 14 °F	
Softening Point	No data available	
Boiling Point/Range	105 - 140 °C / 221 - 284 °F	
Flash Point	Not applicable	**Method -** No information available
Evaporation Rate	No data available	
Flammability (solid,gas)	Not applicable	Liquid
Explosion Limits	No data available	
Vapor Pressure	No data available	
Vapor Density	No data available	(Air = 1.0)
Specific Gravity / Density	1.08	
Bulk Density	Not applicable	Liquid
Water Solubility	Miscible	
Solubility in other solvents	No information available	
Partition Coefficient (n-octanol/water)		
Autoignition Temperature	No data available	
Decomposition Temperature	No data available	
Viscosity	No data available	
Explosive Properties	No information available	
Oxidizing Properties	No information available	

9.2. Other information

SECTION 10: STABILITY AND REACTIVITY

10.1. Reactivity

None known, based on information available

10.2. Chemical stability

Stable under recommended storage conditions.

10.3. Possibility of hazardous reactions

Hazardous Polymerization	Hazardous polymerization does not occur.
Hazardous Reactions	None under normal processing.

10.4. Conditions to avoid

Exposure to air. Incompatible products.

10.5. Incompatible materials

Acids. Organic materials. Metals. Aluminium. copper. . Zinc.

10.6. Hazardous decomposition products

Sodium oxides.

SECTION 11: TOXICOLOGICAL INFORMATION

11.1. Information on toxicological effects

Product Information

(a) acute toxicity;

Oral	Based on available data, the classification criteria are not met
Dermal	Based on ATE data, the classification criteria are not met ATE = >5000 mg/kg
Inhalation	Based on available data, the classification criteria are not met

Toxicology data for the components

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Sodium hydroxide	140 - 340 mg/kg (Rat)	1350 mg/kg (Rabbit)	
Water	-		

(b) skin corrosion/irritation; Category 1 A

(c) serious eye damage/irritation; Category 1

(d) respiratory or skin sensitization;

Respiratory	Based on available data, the classification criteria are not met
Skin	Based on available data, the classification criteria are not met

(e) germ cell mutagenicity; Based on available data, the classification criteria are not met

(f) carcinogenicity; Based on available data, the classification criteria are not met

There are no known carcinogenic chemicals in this product

(g) reproductive toxicity; Based on available data, the classification criteria are not met

(h) STOT-single exposure; Not Classified
Bridging principle "Dilution"

(i) STOT-repeated exposure; Not Classified
Bridging principle "Dilution"

Target Organs None known.

(j) aspiration hazard; Based on available data, the classification criteria are not met

Symptoms / effects,both acute and delayed Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated: Ingestion causes severe swelling, severe damage to the delicate tissue and danger of perforation

SECTION 12: ECOLOGICAL INFORMATION

12.1. Toxicity

Ecotoxicity effects Contains no substances known to be hazardous to the environment or that are not degradable in waste water treatment plants. Large amounts will affect pH and harm aquatic organisms.

Component	Freshwater Fish	Water Flea	Freshwater Algae	Microtox
Sodium hydroxide	LC50: = 45.4 mg/L, 96h			

	static (Oncorhynchus mykiss)			

12.2. Persistence and degradability

Persistence	Soluble in water, Persistence is unlikely, based on information available, Miscible with water.
Degradability	Not relevant for inorganic substances.
Degradation in sewage treatment plant	Neutralization is normally necessary before waste water is discharged into water treatment plants.

12.3. Bioaccumulative potential Bioaccumulation is unlikely

12.4. Mobility in soil The product is water soluble, and may spread in water systems . Will likely be mobile in the environment due to its water solubility. Highly mobile in soils

12.5. Results of PBT and vPvB assessment No data available for assessment.

12.6. Other adverse effects

Endocrine Disruptor Information	This product does not contain any known or suspected endocrine disruptors
Persistent Organic Pollutant	This product does not contain any known or suspected substance
Ozone Depletion Potential	This product does not contain any known or suspected substance

SECTION 13: DISPOSAL CONSIDERATIONS

13.1. Waste treatment methods

Waste from Residues / Unused Products	Waste is classified as hazardous. Dispose of in accordance with the European Directives on waste and hazardous waste. Dispose of in accordance with local regulations.
Contaminated Packaging	Dispose of this container to hazardous or special waste collection point.
European Waste Catalogue (EWC)	According to the European Waste Catalogue, Waste Codes are not product specific, but application specific.
Other Information	Do not dispose of waste into sewer. Waste codes should be assigned by the user based on the application for which the product was used. Do not empty into drains. Large amounts will affect pH and harm aquatic organisms. Solutions with high pH-value must be neutralized before discharge.

SECTION 14: TRANSPORT INFORMATION

IMDG/IMO

14.1. UN number	UN1824
14.2. UN proper shipping name	SODIUM HYDROXIDE SOLUTION
14.3. Transport hazard class(es)	8
14.4. Packing group	II

ADR

14.1. UN number	UN1824
14.2. UN proper shipping name	SODIUM HYDROXIDE SOLUTION
14.3. Transport hazard class(es)	8
14.4. Packing group	II

IATA

14.1. UN number	UN1824
14.2. UN proper shipping name	SODIUM HYDROXIDE SOLUTION
14.3. Transport hazard class(es)	8
14.4. Packing group	II

14.5. Environmental hazards No hazards identified

14.6. Special precautions for user No special precautions required

14.7. Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code Not applicable, packaged goods

SECTION 15: REGULATORY INFORMATION

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

International Inventories
X = listed, Europe (EINECS/ELINCS/NLP), U.S.A. (TSCA), Canada (DSL/NDSL), Philippines (PICCS), China (IECSC), Japan (ENCS), Australia (AICS), Korea (ECL).

Component	EINECS	ELINCS	NLP	TSCA	DSL	NDSL	PICCS	ENCS	IECSC	AICS	KECL
Sodium hydroxide	215-185-5	-		X	X	-	X	X	X	X	KE-31487
Water	231-791-2	-		X	X	-	X	-	X	X	KE-35400

National Regulations

WGK Classification Water endangering class = 1

Component	Germany - Water Classification (VwVwS)	Germany - TA-Luft Class
Sodium hydroxide	WGK 1	

Take note of Control of Substances Hazardous to Health Regulations (COSHH) 2002 and 2005 Amendment.

15.2. Chemical safety assessment

A Chemical Safety Assessment/Report (CSA/CSR) has been conducted by the manufacturer/importer Chemical Safety Assessment/Reports (CSA/CSR) are not required for mixtures

SECTION 16: OTHER INFORMATION

Full text of H-Statements referred to under sections 2 and 3
H290 - May be corrosive to metals
H314 - Causes severe skin burns and eye damage
H318 - Causes serious eye damage

Legend

CAS - Chemical Abstracts Service

EINECS/ELINCS - European Inventory of Existing Commercial Chemical

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory

Substances/EU List of Notified Chemical Substances
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List
PICCS - Philippines Inventory of Chemicals and Chemical Substances
ENCS - Japanese Existing and New Chemical Substances
IECSC - Chinese Inventory of Existing Chemical Substances
AICS - Australian Inventory of Chemical Substances
KECL - Korean Existing and Evaluated Chemical Substances
NZIoC - New Zealand Inventory of Chemicals

WEL - Workplace Exposure Limit
TWA - Time Weighted Average
ACGIH - American Conference of Governmental Industrial Hygienists
IARC - International Agency for Research on Cancer
DNEL - Derived No Effect Level
PNEC - Predicted No Effect Concentration
RPE - Respiratory Protective Equipment
LD50 - Lethal Dose 50%
LC50 - Lethal Concentration 50%
EC50 - Effective Concentration 50%
NOEC - No Observed Effect Concentration
POW - Partition coefficient Octanol:Water
PBT - Persistent, Bioaccumulative, Toxic
vPvB - very Persistent, very Bioaccumulative

ADR - European Agreement Concerning the International Carriage of Dangerous Goods by Road
ICAO/IATA - International Civil Aviation Organization/International Air Transport Association
IMO/IMDG - International Maritime Organization/International Maritime Dangerous Goods Code
MARPOL - International Convention for the Prevention of Pollution from Ships
OECD - Organisation for Economic Co-operation and Development
ATE - Acute Toxicity Estimate
BCF - Bioconcentration factor
VOC - Volatile Organic Compounds

Key literature references and sources for data
Suppliers safety data sheet, Chemadvisor - LOLI, Merck index, RTECS

Classification and procedure used to derive the classification for mixtures according to Regulation (EC) 1272/2008 [CLP]:

Physical hazards	On basis of test data
Health Hazards	Calculation method
Environmental hazards	Calculation method

Training Advice
Chemical hazard awareness training, incorporating labelling, Safety Data Sheets (SDS), Personal Protective Equipment (PPE) and hygiene.
Use of personal protective equipment, covering appropriate selection, compatibility, breakthrough thresholds, care, maintenance, fit and standards.
First aid for chemical exposure, including the use of eye wash and safety showers.

Creation Date	21-May-2012
Revision Date	24-Apr-2019
Revision Summary	Not applicable.

This safety data sheet complies with the requirements of Regulation (EC) No. 1907/2006

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

End of Safety Data Sheet

SAFETY DATA SHEET

Creation Date 25-Aug-2010 **Revision Date** 01-Apr-2021 **Revision Number** 15

SECTION 1: IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING

1.1. Product identifier

Product Description: **Sodium hypochlorite solution**
Cat No. : **S/5042/15**
Synonyms Antiformin
CAS-No 7681-52-9
EC-No. 231-668-3
Molecular Formula Cl Na O

Unique Formula Identifier (UFI) **DQGJ-STT3-CW0F-UQVR**

1.2. Relevant identified uses of the substance or mixture and uses advised against

Recommended Use Laboratory chemicals.
Uses advised against No Information available

1.3. Details of the supplier of the safety data sheet

Company

UK entity/business name
Fisher Scientific UK
Bishop Meadow Road, Loughborough,
Leicestershire LE11 5RG, United Kingdom

EU entity/business name
Acros Organics BVBA
Janssen Pharmaceuticalaan 3a
2440 Geel, Belgium

E-mail address begel.sdsdesk@thermofisher.com

1.4. Emergency telephone number

Tel: 01509 231166
Chemtrec US: (800) 424-9300
Chemtrec EU: 001 (202) 483-7616

Poison Centre - Emergency information services

Ireland : National Poisons Information Centre (NPIC) -
01 809 2166 (8am-10pm, 7 days a week)
Malta : +356 2395 2000
Cyprus : +357 2240 5611

SECTION 2: HAZARDS IDENTIFICATION

2.1. Classification of the substance or mixture

CLP Classification - Regulation (EC) No 1272/2008

Physical hazards

Substances/mixtures corrosive to metal	Category 1 (H290)
Health hazards	
Skin Corrosion/Irritation	Category 1 B (H314)
Serious Eye Damage/Eye Irritation	Category 1 (H318)
Environmental hazards	
Acute aquatic toxicity	Category 1 (H400)
Chronic aquatic toxicity	Category 2 (H411)

Full text of Hazard Statements: see section 16

2.2. Label elements

Signal Word **Danger**

Hazard Statements

H290 - May be corrosive to metals
H314 - Causes severe skin burns and eye damage
H400 - Very toxic to aquatic life
H411 - Toxic to aquatic life with long lasting effects
EUH031 - Contact with acids liberates toxic gas

Precautionary Statements

P280 - Wear protective gloves/protective clothing/eye protection/face protection
P301 + P330 + P331 - IF SWALLOWED: Rinse mouth. Do NOT induce vomiting
P303 + P361 + P353 - IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water or shower
P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P310 - Immediately call a POISON CENTER or doctor/physician

2.3. Other hazards

Substance is not considered persistent, bioaccumulative and toxic (PBT) / very persistent and very bioaccumulative (vPvB)

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

3.2. Mixtures

Component	CAS-No	EC-No.	Weight %	CLP Classification - Regulation (EC) No 1272/2008
Sodium hypochlorite	7681-52-9	231-668-3	> 5 - < 16	Met. Corr. 1 (H290)

				Skin Corr. 1B (H314) Eye Dam. 1 (H318) STOT SE 3 (H335) Aquatic Acute 1 (H400) Aquatic Chronic 1 (H410) EUH031
Water	7732-18-5	231-791-2	> 84 - < 95	-

Component	Specific concentration limits (SCL's)	M-Factor	Component notes
Sodium hypochlorite	EUH031: C >=5%	10 (acute) 1 (chronic)	-

Components	Reach Registration Number	
Sodium hypochlorite	01-2119488154-34	

Full text of Hazard Statements: see section 16

SECTION 4: FIRST AID MEASURES

4.1. Description of first aid measures

General Advice Show this safety data sheet to the doctor in attendance. Immediate medical attention is required.

Eye Contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Immediate medical attention is required.

Skin Contact Wash off immediately with plenty of water for at least 15 minutes. Remove and wash contaminated clothing and gloves, including the inside, before re-use. Call a physician immediately.

Ingestion Do NOT induce vomiting. Clean mouth with water. Never give anything by mouth to an unconscious person. Call a physician immediately.

Inhalation If not breathing, give artificial respiration. Remove from exposure, lie down. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Call a physician immediately.

Self-Protection of the First Aider Ensure that medical personnel are aware of the material(s) involved, take precautions to protect themselves and prevent spread of contamination.

4.2. Most important symptoms and effects, both acute and delayed

Causes burns by all exposure routes. Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated: Ingestion causes severe swelling, severe damage to the delicate tissue and danger of perforation

4.3. Indication of any immediate medical attention and special treatment needed

Notes to Physician Treat symptomatically.

SECTION 5: FIREFIGHTING MEASURES

5.1. Extinguishing media

Suitable Extinguishing Media
CO_2, dry chemical, dry sand, alcohol-resistant foam.

Extinguishing media which must not be used for safety reasons
No information available.

5.2. Special hazards arising from the substance or mixture

Thermal decomposition can lead to release of irritating gases and vapors. The product causes burns of eyes, skin and mucous membranes. Do not allow run-off from fire-fighting to enter drains or water courses.

Hazardous Combustion Products
Chlorine, Oxygen.

5.3. Advice for firefighters

As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear. Thermal decomposition can lead to release of irritating gases and vapors.

SECTION 6: ACCIDENTAL RELEASE MEASURES

6.1. Personal precautions, protective equipment and emergency procedures

Ensure adequate ventilation. Use personal protective equipment as required. Evacuate personnel to safe areas. Keep people away from and upwind of spill/leak.

6.2. Environmental precautions

Do not flush into surface water or sanitary sewer system. Do not allow material to contaminate ground water system. Prevent product from entering drains. Local authorities should be advised if significant spillages cannot be contained.

6.3. Methods and material for containment and cleaning up

Soak up with inert absorbent material. Keep in suitable, closed containers for disposal.

6.4. Reference to other sections

Refer to protective measures listed in Sections 8 and 13.

SECTION 7: HANDLING AND STORAGE

7.1. Precautions for safe handling

Wear personal protective equipment/face protection. Do not get in eyes, on skin, or on clothing. Use only under a chemical fume hood. Do not breathe mist/vapors/spray. Do not ingest. If swallowed then seek immediate medical assistance.

Hygiene Measures
Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities

Corrosives area. Protect from direct sunlight. Do not store in metal containers. Keep containers tightly closed in a dry, cool and well-ventilated place. Keep at temperatures below 30°C.

Technical Rules for Hazardous Substances (TRGS) 510 Storage Class (LGK) (Germany) Class 8B

7.3. Specific end use(s)

Use in laboratories

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1. Control parameters

Exposure limits
This product, as supplied, does not contain any hazardous materials with occupational exposure limits established by the region specific regulatory bodies

Biological limit values
This product, as supplied, does not contain any hazardous materials with biological limits established by the region specific regulatory bodies

Derived No Effect Level (DNEL) / Derived Minimum Effect Level (DMEL)
See table for values; SODIUM HYPOCHLORITE SOLUTION, ... % Cl ACTIVE

Component	Acute effects local (Dermal)	Acute effects systemic (Dermal)	Chronic effects local (Dermal)	Chronic effects systemic (Dermal)
Sodium hypochlorite 7681-52-9 (> 5 - < 16)			DNEL = 0.5% in mixture (weight basis)	

Component	Acute effects local (Inhalation)	Acute effects systemic (Inhalation)	Chronic effects local (Inhalation)	Chronic effects systemic (Inhalation)
Sodium hypochlorite 7681-52-9 (> 5 - < 16)	DNEL = 3.1mg/m³	DNEL = 3.1mg/m³	DNEL = 1.55mg/m³	DNEL = 1.55mg/m³

Predicted No Effect Concentration (PNEC)
See values below. SODIUM HYPOCHLORITE SOLUTION, ... % Cl ACTIVE.

Component	Fresh water	Fresh water sediment	Water Intermittent	Microorganisms in sewage treatment	Soil (Agriculture)
Sodium hypochlorite 7681-52-9 (> 5 - < 16)	PNEC = 0.21µg/L		PNEC = 0.26µg/L	PNEC = 4.69mg/L	

Component	Marine water	Marine water sediment	Marine water intermittent	Food chain	Air
Sodium hypochlorite 7681-52-9 (> 5 - < 16)	PNEC = 0.042µg/L			PNEC = 11.1mg/kg food	

8.2. Exposure controls

Engineering Measures
Use only under a chemical fume hood. Ensure that eyewash stations and safety showers are close to the workstation location. Wherever possible, engineering control measures such as the isolation or enclosure of the process, the introduction of process or equipment changes to minimise release or contact, and the use of properly designed ventilation systems, should be adopted to control hazardous materials at source

Personal protective equipment

Eye Protection Goggles (European standard - EN 166)

Hand Protection Protective gloves

Glove material	Breakthrough time	Glove thickness	EU standard	Glove comments
Butyl rubber PVC	See manufacturers recommendations	-	EN 374	(minimum requirement)

Skin and body protection Long sleeved clothing.

Inspect gloves before use.
Please observe the instructions regarding permeability and breakthrough time which are provided by the supplier of the gloves. (Refer to manufacturer/supplier for information)
Ensure gloves are suitable for the task: Chemical compatability, Dexterity, Operational conditions, User susceptibility, e.g. sensitisation effects, also take into consideration the specific local conditions under which the product is used, such as the danger of cuts, abrasion.
Remove gloves with care avoiding skin contamination.

Respiratory Protection When workers are facing concentrations above the exposure limit they must use appropriate certified respirators.
To protect the wearer, respiratory protective equipment must be the correct fit and be used and maintained properly

Large scale/emergency use Use a NIOSH/MSHA or European Standard EN 136 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced
Recommended Filter type: Particulates filter conforming to EN 143

Small scale/Laboratory use Use a NIOSH/MSHA or European Standard EN 149:2001 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.
Recommended half mask:- Particle filtering: EN149:2001
When RPE is used a face piece Fit Test should be conducted

Environmental exposure controls Prevent product from entering drains. Do not allow material to contaminate ground water system. Local authorities should be advised if significant spillages cannot be contained.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

9.1. Information on basic physical and chemical properties

Physical State	Liquid	
Appearance	Yellow	
Odor	pungent Chlorine	
Odor Threshold	No data available	
Melting Point/Range	-16 °C / 3.2 °F	
Softening Point	No data available	
Boiling Point/Range	No information available	
Flammability (liquid)	No data available	
Flammability (solid,gas)	Not applicable	Liquid
Explosion Limits	No data available	
Flash Point	No information available	**Method -** No information available
Autoignition Temperature	No data available	
Decomposition Temperature	No data available	
pH	11-13	
Viscosity	No data available	
Water Solubility	Soluble	
Solubility in other solvents	No information available	
Partition Coefficient (n-octanol/water)		
Vapor Pressure	No data available	
Density / Specific Gravity	1.2 - 1.3	
Bulk Density	Not applicable	Liquid
Vapor Density	No data available	(Air = 1.0)
Particle characteristics	Not applicable (liquid)	

9.2. Other information

Molecular Formula Cl Na O
Molecular Weight 74.44

SECTION 10: STABILITY AND REACTIVITY

10.1. Reactivity

Yes - Contact with acids liberates toxic gas

10.2. Chemical stability

Stable under normal conditions, Sensitivity to light.

10.3. Possibility of hazardous reactions

Hazardous Polymerization Hazardous polymerization does not occur.
Hazardous Reactions None under normal processing.

10.4. Conditions to avoid

Incompatible products. Excess heat.

10.5. Incompatible materials

Acids. Strong oxidizing agents. Metals. Amines.

10.6. Hazardous decomposition products

Chlorine. Oxygen.

SECTION 11: TOXICOLOGICAL INFORMATION

11.1. Information on hazard classes as defined in Regulation (EC) No 1272/2008

Product Information

(a) acute toxicity;
Oral Based on available data, the classification criteria are not met
Dermal Based on available data, the classification criteria are not met
Inhalation Based on available data, the classification criteria are not met

Toxicology data for the components

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Sodium hypochlorite	LD50 = 8.91 g/kg (Rat)	LD50 > 20000 mg/kg (Rabbit)	> 10500 mg/l (Rat) 1h
Water	-	-	-

(b) skin corrosion/irritation; Category 1 B
Bridging principle "Dilution"

(c) serious eye damage/irritation; Category 1
Bridging principle "Dilution"

(d) respiratory or skin sensitization;
Respiratory No data available
Skin No data available

Component	Test method	Test species	Study result
Sodium hypochlorite 7681-52-9 (> 5 - < 16)	OECD Test Guideline 406	guinea pig	non-sensitising

(e) germ cell mutagenicity; No data available

(f) carcinogenicity; No data available

There are no known carcinogenic chemicals in this product

(g) reproductive toxicity; No data available

(h) STOT-single exposure; No data available

(i) STOT-repeated exposure; No data available

Target Organs No information available.

(j) aspiration hazard; No data available

Symptoms / effects,both acute and delayed Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated. Ingestion causes severe swelling, severe damage to the delicate tissue and danger of perforation.

11.2. Information on other hazards

Endocrine Disrupting Properties Assess endocrine disrupting properties for human health. This product does not contain any known or suspected endocrine disruptors.

SECTION 12: ECOLOGICAL INFORMATION

12.1. Toxicity

Ecotoxicity effects The product contains following substances which are hazardous for the environment. Very toxic to aquatic organisms.

Component	Freshwater Fish	Water Flea	Freshwater Algae
Sodium hypochlorite	Clupea pallasi: LC50=0.065 mg/L 96h	0.032 mg/L LC50 = 48 h	EC50: = 0.05 mg/L, 72h (Pseudokirchnerella subcapitata)

Component	Microtox	M-Factor
Sodium hypochlorite	-	10 (acute) 1 (chronic)

12.2. Persistence and degradability

Persistence Soluble in water, Persistence is unlikely, based on information available, Miscible with water.

Degradation in sewage treatment plant Contains substances known to be hazardous to the environment or not degradable in waste water treatment plants.

12.3. Bioaccumulative potential Bioaccumulation is unlikely

12.4. Mobility in soil The product is water soluble, and may spread in water systems Will likely be mobile in the environment due to its water solubility. Highly mobile in soils

12.5. Results of PBT and vPvB assessment Substance is not considered persistent, bioaccumulative and toxic (PBT) / very persistent and very bioaccumulative (vPvB).

12.6. Endocrine disrupting properties

Endocrine Disruptor Information This product does not contain any known or suspected endocrine disruptors

12.7. Other adverse effects

Persistent Organic Pollutant This product does not contain any known or suspected substance

Ozone Depletion Potential This product does not contain any known or suspected substance

SECTION 13: DISPOSAL CONSIDERATIONS

13.1. Waste treatment methods

Waste from Residues/Unused Products Should not be released into the environment. Waste is classified as hazardous. Dispose of in accordance with the European Directives on waste and hazardous waste. Dispose of in accordance with local regulations.

Contaminated Packaging Dispose of this container to hazardous or special waste collection point.

European Waste Catalogue (EWC) According to the European Waste Catalog, Waste Codes are not product specific, but application specific.

Other Information Do not flush to sewer. Waste codes should be assigned by the user based on the application for which the product was used. Do not empty into drains. Large amounts will affect pH and harm aquatic organisms. Do not let this chemical enter the environment.

SECTION 14: TRANSPORT INFORMATION

IMDG/IMO

14.1. UN number	UN1791
14.2. UN proper shipping name	HYPOCHLORITE SOLUTION
14.3. Transport hazard class(es)	8
14.4. Packing group	III

ADR

14.1. UN number	UN1791
14.2. UN proper shipping name	HYPOCHLORITE SOLUTION
14.3. Transport hazard class(es)	8
14.4. Packing group	III

IATA

14.1. UN number	UN1791
14.2. UN proper shipping name	HYPOCHLORITE SOLUTION
14.3. Transport hazard class(es)	8
14.4. Packing group	III

14.5. Environmental hazards Dangerous for the environment

Product is a marine pollutant according to the criteria set by IMDG/IMO

14.6. Special precautions for user No special precautions required

14.7. Maritime transport in bulk according to IMO instruments Not applicable, packaged goods

SECTION 15: REGULATORY INFORMATION

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

International Inventories
X = listed, Europe (EINECS/ELINCS/NLP), U.S.A. (TSCA), Canada (DSL/NDSL), Philippines (PICCS), China (IECSC), Japan (ENCS), Australia (AICS), Korea (ECL).

Component	EINECS	ELINCS	NLP	TSCA	DSL	NDSL	PICCS	ENCS	IECSC	AICS	KECL
Sodium hypochlorite	231-668-3	-		X	X	-	X	X	X	X	KE-31506
Water	231-791-2	-		X	X	-	X	X	X	X	KE-35400

Regulation (EC) No 649/2012 of the European Parliament and of the Council of 4 July 2012 concerning the export and import of dangerous chemicals
Not applicable

National Regulations

WGK Classification Water endangering class = 2 (self classification)

Component	Germany - Water Classification (VwVwS)	Germany - TA-Luft Class
Sodium hypochlorite	WGK2	

Component	France - INRS (Tables of occupational diseases)
Sodium hypochlorite	Tableaux des maladies professionnelles (TMP) - RG 65

UK - Take note of Control of Substances Hazardous to Health Regulations (COSHH) 2002 and 2005 Amendment

15.2. Chemical safety assessment

A Chemical Safety Assessment/Report (CSA/CSR) has been conducted by the manufacturer/importer Chemical Safety Assessment/Reports (CSA/CSR) are not required for mixtures

SECTION 16: OTHER INFORMATION

Full text of H-Statements referred to under sections 2 and 3
H290 - May be corrosive to metals
H314 - Causes severe skin burns and eye damage
H318 - Causes serious eye damage
H400 - Very toxic to aquatic life
H411 - Toxic to aquatic life with long lasting effects
EUH031 - Contact with acids liberates toxic gas
H335 - May cause respiratory irritation
H410 - Very toxic to aquatic life with long lasting effects

Legend

CAS - Chemical Abstracts Service
EINECS/ELINCS - European Inventory of Existing Commercial Chemical Substances/EU List of Notified Chemical Substances
PICCS - Philippines Inventory of Chemicals and Chemical Substances
IECSC - Chinese Inventory of Existing Chemical Substances
KECL - Korean Existing and Evaluated Chemical Substances
TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List
ENCS - Japanese Existing and New Chemical Substances
AICS - Australian Inventory of Chemical Substances
NZIoC - New Zealand Inventory of Chemicals

WEL - Workplace Exposure Limit
ACGIH - American Conference of Governmental Industrial Hygienists
DNEL - Derived No Effect Level
RPE - Respiratory Protective Equipment
LC50 - Lethal Concentration 50%
NOEC - No Observed Effect Concentration
PBT - Persistent, Bioaccumulative, Toxic
TWA - Time Weighted Average
IARC - International Agency for Research on Cancer
Predicted No Effect Concentration (PNEC)
LD50 - Lethal Dose 50%
EC50 - Effective Concentration 50%
POW - Partition coefficient Octanol:Water
vPvB - very Persistent, very Bioaccumulative

ADR - European Agreement Concerning the International Carriage of Dangerous Goods by Road
IMO/IMDG - International Maritime Organization/International Maritime Dangerous Goods Code
OECD - Organisation for Economic Co-operation and Development
BCF - Bioconcentration factor
ICAO/IATA - International Civil Aviation Organization/International Air Transport Association
MARPOL - International Convention for the Prevention of Pollution from Ships
ATE - Acute Toxicity Estimate
VOC - (Volatile Organic Compound)

Key literature references and sources for data
https://echa.europa.eu/information-on-chemicals
Suppliers safety data sheet, Chemadvisor - LOLI, Merck index, RTECS

Classification and procedure used to derive the classification for mixtures according to Regulation (EC) 1272/2008 [CLP]:

Physical hazards	On basis of test data
Health Hazards	Calculation method
Environmental hazards	Calculation method

Training Advice
Chemical incident response training.

Creation Date	25-Aug-2010
Revision Date	01-Apr-2021
Revision Summary	SDS sections updated, 7.

This safety data sheet complies with the requirements of Regulation (EC) No. 1907/2006 COMMISSION REGULATION (EU) 2020/878 amending Annex II to Regulation (EC) No 1907/2006

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

End of Safety Data Sheet

SAFETY DATA SHEET

Creation Date 08-Sep-2006 **Revision Date** 25-Apr-2019 **Revision Number** 5

1. Identification

Product Name **Sodium phosphate, monobasic**

Cat No. : **AC389870000; AC389870010; AC389870025; AC389870100; AC389872500**

CAS-No 7558-80-7
Synonyms Sodium dihydrogen phosphate, anhydrous; Dihydrogen sodium phosphate, anhydrous

Recommended Use Laboratory chemicals.
Uses advised against Food, drug, pesticide or biocidal product use.

Details of the supplier of the safety data sheet

Company

Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Acros Organics
One Reagent Lane
Fair Lawn, NJ 07410

Emergency Telephone Number
For information **US** call: 001-800-ACROS-01 / **Europe** call: +32 14 57 52 11
Emergency Number **US:**001-201-796-7100 / **Europe:** +32 14 57 52 99
CHEMTREC Tel. No.**US:**001-800-424-9300 / **Europe:**001-703-527-3887

2. Hazard(s) identification

Classification
Classification under 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

This chemical is not considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Label Elements

Hazard Statements

Precautionary Statements
Hazards not otherwise classified (HNOC)
None identified

3. Composition/Information on Ingredients

Component	CAS-No	Weight %
Sodium phosphate, monobasic	7558-80-7	>95

4. First-aid measures

Eye Contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Get medical attention.

Skin Contact Wash off immediately with plenty of water for at least 15 minutes. Get medical attention immediately if symptoms occur.

Inhalation Remove to fresh air. Get medical attention immediately if symptoms occur.

Ingestion Clean mouth with water and drink afterwards plenty of water. Get medical attention if symptoms occur.

Most important symptoms and effects None reasonably foreseeable.

Notes to Physician Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media Water spray, carbon dioxide (CO2), dry chemical, alcohol-resistant foam.

Unsuitable Extinguishing Media No information available

Flash Point No information available
Method - No information available

Autoignition Temperature Not applicable
Explosion Limits
Upper No data available
Lower No data available
Sensitivity to Mechanical Impact No information available
Sensitivity to Static Discharge No information available

Specific Hazards Arising from the Chemical
Non-combustible, substance itself does not burn but may decompose upon heating to produce corrosive and/or toxic fumes.

Hazardous Combustion Products
Oxides of phosphorus. Sodium oxides.
Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

NFPA

Health	Flammability	Instability	Physical hazards
0	0	0	N/A

6. Accidental release measures

Personal Precautions Use personal protective equipment as required. Ensure adequate ventilation. Avoid dust formation.
Environmental Precautions Should not be released into the environment.

Methods for Containment and Clean Sweep up and shovel into suitable containers for disposal. Avoid dust formation.

Up

7. Handling and storage

Handling Wear personal protective equipment/face protection. Ensure adequate ventilation. Avoid contact with skin, eyes or clothing. Avoid ingestion and inhalation. Avoid dust formation.

Storage Keep in a dry, cool and well-ventilated place. Refer product specification and/or product label for specific storage temperature requirement. Keep container tightly closed.

8. Exposure controls / personal protection

Exposure Guidelines This product does not contain any hazardous materials with occupational exposure limitsestablished by the region specific regulatory bodies.

Engineering Measures Ensure adequate ventilation, especially in confined areas. Ensure that eyewash stations and safety showers are close to the workstation location.

Personal Protective Equipment

Eye/face Protection Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin and body protection Wear appropriate protective gloves and clothing to prevent skin exposure.

Respiratory Protection Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Hygiene Measures Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Powder Solid
Appearance	White
Odor	No information available
Odor Threshold	No information available
pH	4.1 - 4.7 (5 %)
Melting Point/Range	No data available
Boiling Point/Range	No information available
Flash Point	No information available
Evaporation Rate	Not applicable
Flammability (solid,gas)	No information available
Flammability or explosive limits	
Upper	No data available
Lower	No data available
Vapor Pressure	No information available
Vapor Density	Not applicable
Specific Gravity	No information available
Solubility	Soluble in water
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	Not applicable
Decomposition Temperature	> 170°C
Viscosity	Not applicable
Molecular Formula	H2 Na P O4
Molecular Weight	119.98

10. Stability and reactivity

Reactive Hazard None known, based on information available

Stability Stable under normal conditions.

Conditions to Avoid Avoid dust formation. Incompatible products. Excess heat. Exposure to moisture.

Incompatible Materials Strong acids, Strong bases

Hazardous Decomposition Products Oxides of phosphorus, Sodium oxides

Hazardous Polymerization Hazardous polymerization does not occur.

Hazardous Reactions None under normal processing.

11. Toxicological information

Acute Toxicity

Product Information

Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Sodium phosphate, monobasic	LD50 = 8290 mg/kg (Rat)	LD50 > 7940 mg/kg (Rabbit)	Not listed

Toxicologically Synergistic Products No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation No information available

Sensitization No information available

Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS-No	IARC	NTP	ACGIH	OSHA	Mexico
Sodium phosphate, monobasic	7558-80-7	Not listed	Not listed	Not listed	Not listed	Not listed

Mutagenic Effects No information available

Reproductive Effects No information available.

Developmental Effects No information available.

Teratogenicity No information available.

STOT - single exposure None known

STOT - repeated exposure None known

Aspiration hazard No information available

Symptoms / effects,both acute and delayed No information available

Endocrine Disruptor Information No information available

Other Adverse Effects The toxicological properties have not been fully investigated.

12. Ecological information

Ecotoxicity

Do not empty into drains. .

Persistence and Degradability Soluble in water Persistence is unlikely based on information available.

Bioaccumulation/ Accumulation No information available.

Mobility Will likely be mobile in the environment due to its water solubility.

13. Disposal considerations

Waste Disposal Methods Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. Transport information

DOT Not regulated
TDG Not regulated
IATA Not regulated
IMDG/IMO Not regulated

15. Regulatory information

United States of America Inventory

Component	CAS-No	TSCA	TSCA Inventory notification - Active/Inactive	TSCA - EPA Regulatory Flags
Sodium phosphate, monobasic	7558-80-7	X	ACTIVE	-

Legend:
TSCA - Toxic Substances Control Act, (40 CFR Part 710)
X - Listed
'-' - Not Listed

TSCA 12(b) - Notices of Export Not applicable

International Inventories
Canada (DSL/NDSL), Europe (EINECS/ELINCS/NLP), Philippines (PICCS), Japan (ENCS), Australia (AICS), China (IECSC), Korea (ECL).

Component	CAS-No	DSL	NDSL	EINECS	PICCS	ENCS	AICS	IECSC	KECL
Sodium phosphate, monobasic	7558-80-7	X	-	231-449-2	X	X	X	X	KE-31577

U.S. Federal Regulations

SARA 313 Not applicable

SARA 311/312 Hazard Categories See section 2 for more information

CWA (Clean Water Act) Not applicable

Clean Air Act Not applicable

OSHA - Occupational Safety and Health Administration Not applicable

CERCLA Not applicable

California Proposition 65 This product does not contain any Proposition 65 chemicals.

U.S. State Right-to-Know Regulations Not applicable

U.S. Department of Transportation

Reportable Quantity (RQ):	N
DOT Marine Pollutant	N
DOT Severe Marine Pollutant	N

U.S. Department of Homeland Security This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade No information available

16. Other information

Prepared By
Regulatory Affairs
Thermo Fisher Scientific
Email: EMSDS.RA@thermofisher.com

Creation Date	08-Sep-2006
Revision Date	25-Apr-2019
Print Date	25-Apr-2019
Revision Summary	This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

Disclaimer

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End of SDS

SAFETY DATA SHEET

Creation Date 12-Nov-2010 **Revision Date** 06-Jul-2018 **Revision Number** 7

1. Identification

Product Name **Sulfuric Acid (Certified ACS Plus)**

Cat No. : **A300-212; A300-225LB; A300-500; A300-612GAL; A300-700LB; A300C212; A300C212EA; A300P500; A300S212; A300S212EA; A300S500; A300SI212;**

Synonyms Hydrogen sulfate; Vitriol brown oil; Oil of vitriol

Recommended Use Laboratory chemicals.
Uses advised against Food, drug, pesticide or biocidal product use

Details of the supplier of the safety data sheet

Company
Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Emergency Telephone Number
CHEMTREC®, Inside the USA: 800-424-9300
CHEMTREC®, Outside the USA: 001-703-527-3887

2. Hazard(s) identification

Classification
This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Corrosive to metals	Category 1
Skin Corrosion/irritation	Category 1 A
Serious Eye Damage/Eye Irritation	Category 1
Specific target organ toxicity (single exposure)	Category 3
Target Organs - Respiratory system.	

Label Elements

Signal Word
Danger

Hazard Statements
May be corrosive to metals
Causes severe skin burns and eye damage
May cause respiratory irritation

Precautionary Statements
Prevention
Do not breathe dust/fume/gas/mist/vapors/spray
Wear protective gloves/protective clothing/eye protection/face protection
Wash face, hands and any exposed skin thoroughly after handling
Use only outdoors or in a well-ventilated area
Keep only in original container
Response
Immediately call a POISON CENTER or doctor/physician
Inhalation
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Skin
IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower
Wash contaminated clothing before reuse
Eyes
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
Ingestion
IF SWALLOWED: Rinse mouth. DO NOT induce vomiting
Storage
Store locked up
Store in a well-ventilated place. Keep container tightly closed
Disposal
Dispose of contents/container to an approved waste disposal plant
Hazards not otherwise classified (HNOC)
None identified
WARNING. Cancer - https://www.p65warnings.ca.gov/.

3. Composition/Information on Ingredients

Component	CAS-No	Weight %
Sulfuric acid	7664-93-9	90 - 98
Water	7732-18-5	2 - 10

4. First-aid measures

General Advice Show this safety data sheet to the doctor in attendance. Immediate medical attention is required.

Eye Contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Immediate medical attention is required.

Skin Contact Wash off immediately with plenty of water for at least 15 minutes. Remove and wash contaminated clothing before re-use. Immediate medical attention is required.

Inhalation Move to fresh air. If breathing is difficult, give oxygen. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Immediate medical attention is required.

Ingestion Do not induce vomiting. Never give anything by mouth to an unconscious person. Call a

physician or Poison Control Center immediately.

Most important symptoms and effects Causes burns by all exposure routes. Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated: Ingestion causes severe swelling, severe damage to the delicate tissue and danger of perforation

Notes to Physician Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media CO_2, dry chemical, dry sand, alcohol-resistant foam.

Unsuitable Extinguishing Media DO NOT USE WATER

Flash Point Not applicable
Method - No information available

Autoignition Temperature No information available
Explosion Limits
Upper No data available
Lower No data available
Sensitivity to Mechanical Impact No information available
Sensitivity to Static Discharge No information available

Specific Hazards Arising from the Chemical
Thermal decomposition can lead to release of irritating gases and vapors. The product causes burns of eyes, skin and mucous membranes.

Hazardous Combustion Products
Sulfur oxides Hydrogen
Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear. Thermal decomposition can lead to release of irritating gases and vapors.

NFPA

Health	Flammability	Instability	Physical hazards
3	0	2	W

6. Accidental release measures

Personal Precautions Ensure adequate ventilation. Use personal protective equipment. Evacuate personnel to safe areas. Keep people away from and upwind of spill/leak.

Environmental Precautions Should not be released into the environment.

Methods for Containment and Clean Up Soak up with inert absorbent material. Keep in suitable, closed containers for disposal.

7. Handling and storage

Handling Wear personal protective equipment. Do not get in eyes, on skin, or on clothing. Use only under a chemical fume hood. Do not breathe vapors or spray mist. Do not ingest.

Storage Keep containers tightly closed in a dry, cool and well-ventilated place. Keep away from water. Corrosives area.

8. Exposure controls / personal protection

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH	Mexico OEL (TWA)
Sulfuric acid	TWA: 0.2 mg/m³	(Vacated) TWA: 1 mg/m³ TWA: 1 mg/m³	IDLH: 15 mg/m³ TWA: 1 mg/m³	TWA: 1 mg/m³

Legend

ACGIH - American Conference of Governmental Industrial Hygienists
OSHA - Occupational Safety and Health Administration
NIOSH IDLH: The National Institute for Occupational Safety and Health Immediately Dangerous to Life or Health

Engineering Measures Use only under a chemical fume hood. Ensure adequate ventilation, especially in confined areas. Ensure that eyewash stations and safety showers are close to the workstation location.

Personal Protective Equipment

Eye/face Protection Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin and body protection Wear appropriate protective gloves and clothing to prevent skin exposure.

Respiratory Protection Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Hygiene Measures Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Liquid
Appearance	Clear, Colorless to brown
Odor	Odorless
Odor Threshold	No information available
pH	0.3 (1N)
Melting Point/Range	10 °C / 50 °F
Boiling Point/Range	290 - 338 °C / 554 - 640.4 °F
Flash Point	Not applicable
Evaporation Rate	Slower than ether
Flammability (solid,gas)	Not applicable
Flammability or explosive limits	
Upper	No data available
Lower	No data available
Vapor Pressure	< 0.001 mmHg @ 20 °C
Vapor Density	3.38 (Air = 1.0)
Specific Gravity	1.84
Solubility	Soluble in water
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	No information available
Decomposition Temperature	340°C
Viscosity	No information available
Molecular Formula	H2SO4
Molecular Weight	98.08

10. Stability and reactivity

Reactive Hazard Yes

Stability Reacts violently with water. Hygroscopic.

Conditions to Avoid Incompatible products. Excess heat. Exposure to moist air or water.

Incompatible Materials Water, Organic materials, Strong acids, Strong bases, Metals, Alcohols, Cyanides, Sulfides

Hazardous Decomposition Products Sulfur oxides, Hydrogen

Hazardous Polymerization Hazardous polymerization does not occur.

Hazardous Reactions None under normal processing.

11. Toxicological information

Acute Toxicity

Product Information

Oral LD50 Based on ATE data, the classification criteria are not met. ATE > 2000 mg/kg.

Dermal LD50 Based on ATE data, the classification criteria are not met. ATE > 2000 mg/kg.

Vapor LC50 Based on ATE data, the classification criteria are not met. ATE > 20 mg/l.

Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Sulfuric acid	2140 mg/kg (Rat)	Not listed	LC50 85 - 103 mg/m³ (Rat) 1 h
Water	-	Not listed	Not listed

Toxicologically Synergistic Products No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation Causes severe burns by all exposure routes

Sensitization No information available

Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen. Exposure to strong inorganic mists containing sulfuric acid may cause cancer by inhalation.

Component	CAS-No	IARC	NTP	ACGIH	OSHA	Mexico
Sulfuric acid	7664-93-9	Group 1	Known	A2	X	A2
Water	7732-18-5	Not listed	Not listed	Not listed	Not listed	Not listed

IARC: (International Agency for Research on Cancer)

NTP: (National Toxicity Program)

ACGIH: (American Conference of Governmental Industrial Hygienists)

Mexico - Occupational Exposure Limits - Carcinogens

IARC: (International Agency for Research on Cancer)
Group 1 - Carcinogenic to Humans
Group 2A - Probably Carcinogenic to Humans
Group 2B - Possibly Carcinogenic to Humans

NTP: (National Toxicity Program)
Known - Known Carcinogen
Reasonably Anticipated - Reasonably Anticipated to be a Human Carcinogen

A1 - Known Human Carcinogen
A2 - Suspected Human Carcinogen
A3 - Animal Carcinogen
ACGIH: (American Conference of Governmental Industrial Hygienists)

Mexico - Occupational Exposure Limits - Carcinogens
A1 - Confirmed Human Carcinogen
A2 - Suspected Human Carcinogen
A3 - Confirmed Animal Carcinogen
A4 - Not Classifiable as a Human Carcinogen
A5 - Not Suspected as a Human Carcinogen

Mutagenic Effects No information available

Reproductive Effects No information available.

Developmental Effects No information available.

Teratogenicity No information available.

STOT - single exposure Respiratory system
STOT - repeated exposure None known

Aspiration hazard No information available

Symptoms / effects,both acute and delayed Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated: Ingestion causes severe swelling, severe damage to the delicate tissue and danger of perforation

Endocrine Disruptor Information No information available

Other Adverse Effects The toxicological properties have not been fully investigated.

12. Ecological information

Ecotoxicity
This product contains the following substance(s) which are hazardous for the environment. .

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Sulfuric acid	-	LC50: > 500 mg/L, 96h static (Brachydanio rerio)	-	EC50: 29 mg/L/24h

Persistence and Degradability No information available

Bioaccumulation/ Accumulation No information available.

Mobility No information available.

13. Disposal considerations

Waste Disposal Methods Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. Transport information

DOT
UN-No UN1830
Proper Shipping Name Sulfuric acid
Hazard Class 8
Packing Group II

TDG
UN-No UN1830
Proper Shipping Name SULFURIC ACID
Hazard Class 8
Packing Group II

IATA
UN-No UN1830
Proper Shipping Name SULFURIC ACID
Hazard Class 8
Packing Group II

IMDG/IMO
UN-No UN1830
Proper Shipping Name SULFURIC ACID
Hazard Class 8
Packing Group II

15. Regulatory information

All of the components in the product are on the following Inventory lists: X = listed

International Inventories

Component	TSCA	DSL	NDSL	EINECS	ELINCS	NLP	PICCS	ENCS	AICS	IECSC	KECL
Sulfuric acid	X	X	-	231-639-5	-		X	X	X	X	X
Water	X	X	-	231-791-2	-		X	-	X	X	X

Legend:
X - Listed
E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA.
F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.
N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.
P - Indicates a commenced PMN substance
R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.
S - Indicates a substance that is identified in a proposed or final Significant New Use Rule
T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.
XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B).
Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.
Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.

U.S. Federal Regulations

TSCA 12(b) Not applicable

SARA 313

Component	CAS-No	Weight %	SARA 313 - Threshold Values %
Sulfuric acid	7664-93-9	90 - 98	1.0

SARA 311/312 Hazard Categories See section 2 for more information

CWA (Clean Water Act)

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
Sulfuric acid	X	1000 lb	-	-

Clean Air Act Not applicable

OSHA Occupational Safety and Health Administration
Not applicable

CERCLA This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
Sulfuric acid	1000 lb	1000 lb

California Proposition 65 This product contains the following proposition 65 chemicals

Component	CAS-No	California Prop. 65	Prop 65 NSRL	Category
Sulfuric acid	7664-93-9	Carcinogen	-	Carcinogen

U.S. State Right-to-Know Regulations

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Sulfuric acid	X	X	X	X	X
Water	-	-	X	-	-

U.S. Department of Transportation

Reportable Quantity (RQ): Y
DOT Marine Pollutant N
DOT Severe Marine Pollutant N

U.S. Department of Homeland Security
This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade No information available

16. Other information

Prepared By
Regulatory Affairs
Thermo Fisher Scientific
Email: EMSDS.RA@thermofisher.com

Creation Date 12-Nov-2010
Revision Date 06-Jul-2018
Print Date 06-Jul-2018
Revision Summary SDS sections updated. 2.

Disclaimer
The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

End of SDS

SAFETY DATA SHEET

Creation Date 17-Nov-2009 **Revision Date** 17-Jan-2018 **Revision Number** 3

1. Identification

Product Name **Triethylene glycol**

Cat No. : **T346-4**

CAS-No 112-27-6
Synonyms TEG; Trigen; Triglycol (Laboratory)

Recommended Use Laboratory chemicals.
Uses advised against Food, drug, pesticide or biocidal product use.

Details of the supplier of the safety data sheet

Company
Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Emergency Telephone Number
CHEMTREC®, Inside the USA: 800-424-9300
CHEMTREC®, Outside the USA: 001-703-527-3887

2. Hazard(s) identification

Classification
Classification under 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

This chemical is not considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Label Elements
None required

Hazards not otherwise classified (HNOC)
None identified

3. Composition/Information on Ingredients

Component	CAS-No	Weight %

Triethylene glycol	112-27-6	>95

4. First-aid measures

Eye Contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Get medical attention.

Skin Contact Wash off immediately with plenty of water for at least 15 minutes. Get medical attention immediately if symptoms occur.

Inhalation Remove to fresh air. Get medical attention immediately if symptoms occur.

Ingestion Clean mouth with water and drink afterwards plenty of water. Get medical attention if symptoms occur.

Most important symptoms and effects None reasonably foreseeable.

Notes to Physician Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media Water spray, carbon dioxide (CO2), dry chemical, alcohol-resistant foam.

Unsuitable Extinguishing Media No information available

Flash Point 165 °C / 329 °F

Method - No information available

Autoignition Temperature 371 °C / 699.8 °F

Explosion Limits

Upper 9.2 vol %
Lower 0.9 vol %
Sensitivity to Mechanical Impact No information available
Sensitivity to Static Discharge No information available

Specific Hazards Arising from the Chemical
Thermal decomposition can lead to release of irritating gases and vapors. Keep product and empty container away from heat and sources of ignition.

Hazardous Combustion Products
Carbon monoxide (CO). Carbon dioxide (CO_2).
Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

NFPA

Health	Flammability	Instability	Physical hazards
1	1	1	N/A

6. Accidental release measures

Personal Precautions Use personal protective equipment as required. Ensure adequate ventilation.
Environmental Precautions Should not be released into the environment.

Methods for Containment and Clean Up Sweep up and shovel into suitable containers for disposal.

7. Handling and storage

Handling Wear personal protective equipment/face protection. Ensure adequate ventilation. Avoid contact with skin, eyes or clothing. Avoid ingestion and inhalation.

Storage Keep containers tightly closed in a dry, cool and well-ventilated place. Protect from moisture.

8. Exposure controls / personal protection

Exposure Guidelines This product does not contain any hazardous materials with occupational exposure limitsestablished by the region specific regulatory bodies.

Engineering Measures None under normal use conditions.

Personal Protective Equipment

Eye/face Protection Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin and body protection Wear appropriate protective gloves and clothing to prevent skin exposure.

Respiratory Protection No protective equipment is needed under normal use conditions.

Hygiene Measures Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Liquid
Appearance	Light yellow
Odor	Slight
Odor Threshold	No information available
pH	No information available
Melting Point/Range	-7 °C / 19.4 °F
Boiling Point/Range	285 °C / 545 °F
Flash Point	165 °C / 329 °F
Evaporation Rate	< 0.001
Flammability (solid,gas)	Not applicable
Flammability or explosive limits	
Upper	9.2 vol %
Lower	0.9 vol %
Vapor Pressure	<0.01 mbar @ 20 °C
Vapor Density	5.17
Specific Gravity	1.120
Solubility	Soluble in water
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	371 °C / 699.8 °F
Decomposition Temperature	No information available
Viscosity	48 mPa.s @ 20 °C
Molecular Formula	C6 H14 O4
Molecular Weight	150.17

10. Stability and reactivity

Reactive Hazard None known, based on information available

Stability Hygroscopic.

Conditions to Avoid Incompatible products. Excess heat. Exposure to moist air or water.

Incompatible Materials Strong oxidizing agents

Hazardous Decomposition Products Carbon monoxide (CO), Carbon dioxide (CO_2)

Hazardous Polymerization Hazardous polymerization does not occur.

Hazardous Reactions None under normal processing.

11. Toxicological information

Acute Toxicity

Product Information

Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Triethylene glycol	LD50 = 17 g/kg (Rat)	LD50 > 20 mL/kg (Rabbit)	LC50 > 3.9 mg/L (Rat) 4 h

Toxicologically Synergistic Products No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation No information available

Sensitization No information available

Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS-No	IARC	NTP	ACGIH	OSHA	Mexico
Triethylene glycol	112-27-6	Not listed	Not listed	Not listed	Not listed	Not listed

Mutagenic Effects No information available

Reproductive Effects No information available.

Developmental Effects No information available.

Teratogenicity No information available.

STOT - single exposure None known

STOT - repeated exposure None known

Aspiration hazard No information available

Symptoms / effects,both acute and delayed No information available

Endocrine Disruptor Information No information available

Other Adverse Effects The toxicological properties have not been fully investigated.

12. Ecological information

Ecotoxicity

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Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Triethylene glycol	Not listed	LC50: = 61000 mg/L, 96h flow-through (Lepomis macrochirus) LC50: = 10000 mg/L, 96h	EC50 = 850 mg/L 5 min	EC50: 42426 mg/L/48h

		static (Lepomis macrochirus) LC50: 56200 - 63700 mg/L, 96h flow-through (Pimephales promelas)		

Persistence and Degradability Persistence is unlikely

Bioaccumulation/ Accumulation No information available.

Mobility . Will likely be mobile in the environment due to its water solubility.

Component	log Pow
Triethylene glycol	-1.98

13. Disposal considerations

Waste Disposal Methods Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. Transport information

DOT Not regulated
TDG Not regulated
IATA Not regulated
IMDG/IMO Not regulated

15. Regulatory information

United States of America Inventory

Component	CAS-No	TSCA	TSCA Inventory notification - Active/Inactive	TSCA - EPA Regulatory Flags
Triethylene glycol	112-27-6	X	ACTIVE	-

Legend:
TSCA - Toxic Substances Control Act, (40 CFR Part 710)
X - Listed
'-' - Not Listed

TSCA 12(b) - Notices of Export Not applicable

International Inventories
Canada (DSL/NDSL), Europe (EINECS/ELINCS/NLP), Philippines (PICCS), Japan (ENCS), Australia (AICS), China (IECSC), Korea (ECL).

Component	CAS-No	DSL	NDSL	EINECS	PICCS	ENCS	AICS	IECSC	KECL
Triethylene glycol	112-27-6	X	-	203-953-2	X	X	X	X	KE-13201

U.S. Federal Regulations

SARA 313 Not applicable

SARA 311/312 Hazard Categories See section 2 for more information

CWA (Clean Water Act) Not applicable

Clean Air Act Not applicable

OSHA - Occupational Safety and Health Administration Not applicable

CERCLA Not applicable

California Proposition 65 This product does not contain any Proposition 65 chemicals.

U.S. State Right-to-Know Regulations

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Triethylene glycol	-	-	X	-	X

U.S. Department of Transportation

Reportable Quantity (RQ): N
DOT Marine Pollutant N
DOT Severe Marine Pollutant N

U.S. Department of Homeland Security This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade Slight risk, Grade 1

16. Other information

Prepared By
Regulatory Affairs
Thermo Fisher Scientific
Email: EMSDS.RA@thermofisher.com

Creation Date 17-Nov-2009
Revision Date 17-Jan-2018
Print Date 17-Jan-2018
Revision Summary This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

Disclaimer

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End of SDS