Permit Variation
BAT Assessment – Plant 5.1

Permit Number: EPR/BT9844IK

Chemoxy International Limited

Billingham Site

Project Number: 60609533

Project number: TERP 60609533-002

Quality information

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1. Introduction

Chemoxy International Limited ("Chemoxy") is a wholly owned subsidiary of Seqens and they operate chemical production facilities at both Middlesbrough and Billingham. The Billingham facility is located on the CF Fertilisers Billingham complex, and operates under an Environmental Permit (ref EPR/BT9844IK) for the toll manufacture of organic chemicals and also for the recovery of waste solvents by distillation.

The Billingham site wish to apply for an Environmental Permit variation for the installation. The permit variation is to include the addition of a new multi-purpose processing unit – known as Plant 5.1.

Plant 5.1 consists of the following:

- A new reactor;
- A new distillation column over the new reactor;
- A new dedicated vent scrubber servicing reactor and distillation column units;
- A new release point to atmosphere (Release Point A5) from the new scrubber;
- A new dedicated cooling tower to service the new plant;
- A new liquid/liquid extraction column
- A new multi-purpose tank farm – consisting of fourteen new tanks (between 61m^3 and 200m^3) which will contain bulk feedstocks and bulk products;
- A road tanker offloading / loading area; and
- A new storage area for portable drums and IBCs (containing hazardous / non-hazardous materials, empty used containers and unused new containers).

In addition to the installation and operation of Plant 5.1, the Environmental Permit variation will also cover an extension to the site boundary, to incorporate a newly purchased area of land. The land will not be used for the prescribed operations, and its potential future use (e.g. warehousing) will be subject to discussion with the Environment Agency.

At this juncture, the site only intends to construct Plant 5.1 and to connect the Plant 5.1 combined process / surface water drains into the existing site effluent system. The existing site effluent system discharges effluent (from tanks TK001/TK002) as emission point S1, into the CF Fertiliser complex sewer system, which report in the RTO1 discharge from the complex.

The RTO1 discharge from the CF Fertilisers complex is regulated by the Environment Agency through a Discharge Consent, held by CF Fertilisers.

The new tank farm is fully bunded and the process area (reactor, distillation plant, scrubber etc.) are contained in a bunded process area.

Plant 5 .1 does not have segregated drains, the rainwater falling on the process and non-process areas will be treated as a combined effluent and sent to the sites effluent tanks (TK001/TK002) for disposal.

The intention is for two new effluent storage tanks to be installed at the site. The new tanks (TK004 and TK005) will have a capacity of 250m^3 each and will be installed to the east of the existing effluent storage tanks (TK001 and TK002) in the area of the old methanol storage tank plinths (to the north of the new portable container storage areas).

The new tanks will replace the existing effluent storage tanks TK001 and TK002. However, there may be a period when Plant 5.1 becomes operational, during which the existing effluent tanks will continue to be used, with Plant 5.1 effluent being pumped to the existing effluent tanks. The construction of the new effluent tanks (TK004 and TK005) will be a future development.

Two additional release points to controlled waters are requested to be added to the Environmental Permit as a result of this application. These are release points S2 and S3.

Release point S2 is an existing release of rainwater, which is not currently captured within the current Environmental Permit. This release is rainwater to the site storm drains from a remote bund serving a tank of

methyl chloride. The rainwater is visually tested before opening an isolation valve to allow the rainwater discharge.

Release point S3 is a release of rainwater from the newly built portable container storage area. This consists of three storage areas for drums and intermediate bulk containers (IBC's). One area is for hazardous / non-hazardous material small containers. The second area is for empty used containers. The third area is for empty new containers. All areas have bunds or closed containment drainage. Rainwater will be released to the site storm drains by opening isolation valves once the rainwater has been identified as clean.

There will be no change to the current Environmental Permit emission limits for discharges to the CF Fertiliser sewer drainage system (emission S1) as a result of the application to vary the permit.

The site has an emergency isolation ('flapstopper') valve installed in the storm water drainage system. The isolation valve will contain any spilt materials onsite and also holdback firewater in the event of a fire.

This Best Available Techniques (BAT) assessment has been undertaken to support the permit variation.

The guidance documents used to undertake the BAT assessment are:

- Speciality Organic Chemicals EPR 4.02 (SOC) – March 2009;
- Selected BAT Conclusions from the Waste Treatment BREF (WT August 2018) relating to waste solvent storage, blending and recovery by distillation; and
- CIRIA C736 - Containment systems for the prevention of pollution: Secondary, tertiary and other measures for industrial and commercial premises (2014).

The Common Waste Water and Waste Gas Treatment / Management in the Chemical Sector BREF (CWW June 2016) is likely to be applied alongside the Waste Gas BREF, which is currently in preparation (at first draft stage – November 2019), when they apply to the Fine Organic Chemicals Sector. The CWW BAT Conclusions have been included for completeness within the BAT assessment.

2. BAT Assessment

The specific BAT requirements of the sector guidance and applicable BREF Notes / BAT Conclusions are summarised in tabular form within this section.

Table 1 covers the BAT requirements specified within the Speciality Organic Chemicals (SOC) Sector Guidance – March 2009.

Table 2 covers the specific BAT requirements within the Waste Treatment BREF (WT August 2018), which cover the storage of waste solvents, the blending of waste solvents and the recovery of waste solvents. These are the only waste activities undertaken at the site and they heavily overlap with the normal functions undertaken as section 4.1 processes, i.e. distillation recovery within the organic chemicals synthesis routes. The generic BAT requirements within the WT BREF are essentially common to all BREF notes, including the CWW BREF (see below).

Table 3 covers the requirements of CIRIA C736 - Containment systems for the prevention of pollution - secondary, tertiary and other measures for industrial and commercial premises, 2014.

Table 4 covers the BAT requirements specified within the Common Waste Water and Waste Gas Treatment / Management in the Chemical Sector BREF and associated BAT Conclusions (CWW BREF) – June 2016. As stated earlier, the CWW BREF is likely be applied alongside the Waste Gas BREF, which is currently in preparation at the first draft stage (November 2019).

Table 1: Speciality Organic Chemicals (SOC) Sector Guidance– March 2009

BAT No.	BAT Justification	Operating to BAT	Operator Comments
Scope	Section 4.1 - Organic Chemicals, Part A(1) (a) Producing organic chemicals such as: (i) hydrocarbons (linear or cyclic, saturated or unsaturated, aliphatic or aromatic) (ii) organic compounds containing oxygen, such as alcohols, aldehydes, ketones, carboxylic acids, esters, ethers, peroxides, phenols, epoxy resins (iii) organic compounds containing sulphur, such as sulphides, mercaptans, sulphonic acids, sulphonates, sulphates and sulphones and sulphur heterocyclics (iv) organic compounds containing nitrogen, such as amines, amides, nitrous, nitro- or azocompounds, nitrates, nitriles, nitrogen heterocyclics, cyanates, isocyanates, di-isocyanates and diisocyanate prepolymers (v) organic compounds containing phosphorus, such as substituted phosphines and phosphate esters (vi) organic compounds containing halogens, such as halocarbons, halogenated aromatic compounds and acid halides (vii) organometallic compounds, such as lead alkyls, Grignard reagents and lithium alkyls (viii) plastic materials, such as polymers, synthetic fibres and cellulose-based fibres (ix) synthetic rubbers (x) dyes and pigments (xi) surface-active agents	-	The sector guidance applies as the permitted activities are defined under 4.1 Part A(1)(a)(i)(ii)(iv)(viii) of Schedule 1 to the Environmental Permitting Regulations 2016, namely: • Section 4.1 A (1) (a) (i) – producing organic chemicals such as hydrocarbons (linear or cyclic, saturated or unsaturated, aliphatic or aromatic), subject to the Multi Product Protocol; • Section 4.1 A (1) (a) (ii) – producing organic chemicals containing oxygen, such as esters, organic salts, aldols, and ethers subject to the requirements of the Multi Product Protocol; • Section 4.1 A (1) (a) (iv) – producing organic chemicals containing nitrogen, such as quaternary salts, amine oxides and amides subject to the requirements of the Multi Product Protocol; • Section 4.1 A (1) (a) (viii) – producing organic chemicals such as plastic materials (for example polymers, synthetic fibres and cellulose-based fibres).
Other BREF	**Interface with other BAT Guidance and BREF Notes** The following cross sector guidance and BREF's also apply to site operations: • The Emissions from Storage BREF (EFS July 2006); • The Energy Efficiency BREF (ENE February 2009); • The Economics and Cross Media Effects BREF (ECM July 2006); • The Industrial Cooling Systems BREF (ICS December 2001); • The Monitoring of Emissions BREF (ROM July 2018); and • The Organic Fine Chemicals BREF (OFC) August 2006.		
1.1	**Environmental Performance Indicators** Monitor and benchmark your environmental performance; and review this at least once a year. Your plans for minimising environmental impacts should be incorporated into on-going Improvement Programmes. Indicators can be derived using the Horizontal Guidance Note H1 Environmental Risk Assessment. It is suggested that indicators are based on tonnes of organics produced (tOP) as they provide a good basis for measuring performance within an installation or a single company year on year.	Yes	The site is continually striving to improve environmental performance. There are a number of environmental performance criteria that are monitored and tracked. The site is iso-14001 (2015) accredited and KPI's are contained within the EMS. The site has a Resource Efficiency Team that meets quarterly to set and monitor targets. Performance criteria are tracked and monitored. Waste generation is tracked and monitored as a specific metric (as tonnes waste/tonne product) and waste minimisation projects may be initiated if deemed appropriate.
1.2	**Accident Management** Provisions in place for accident management, i.e. to reduce risks and the environmental consequences of accidents.	Yes	The installation is regulated as an Upper Tier Control of Major Accident Hazards (COMAH) site and has recently undertaken a Five (5) Year Review of the sites COMAH Safety Report. A Regulation 10 Addendum Report has been prepared covering the COMAH requirements for the new Plant 5.1, for submission to the Competent Authority (Plant 5.1 COMAH Regulation 10 Addendum Report, HFL Consulting Ltd, June 2019). The site's Environmental Permit requires that an Accident Management Plan (AMP) is developed and reviewed periodically. The AMP will be updated to reflect the operation of the new Plant 5.1 and ancillary equipment. An Environmental Risk Assessment has been undertaken as part of the implementation of Plant 5.1 (TERP 60609533-001, Substantial Variation Application – Plant 5.1, AECOM, April 2020).

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1.3	**Energy Efficiency** Optimise energy efficiency.	Yes	Energy efficiency is a key performance indicator for the site and is subject to review by the Resource Efficiency Team that meets quarterly. Plant 5.1 has been designed to be as energy efficient as possible. The site complies with the European Minimum Energy Performance Standard (EU MEPS) scheme. The scheme sets mandatory minimum efficiency levels for electric motors introduced into the European market. Overall, the relative energy consumption per tonne of product will decrease with the installation of the new plant, relative to the existing multipurpose plant onsite.
1.4	**Efficient Use of Raw Materials and Water** Assess the environmental impact of each process and choose the one with the lowest environmental impact. As a general principle, you need to demonstrate the measures you take to: • reduce your use of all raw materials and intermediates. • substitute less harmful materials, or those which can be more readily abated and when abated lead to substances that are more readily dealt with. • understand the fate of by-products and contaminants and their environmental impact.	Yes	The site has a Multi Product Protocol (MPP) and the new equipment is multi-purpose. When any new processes are introduced to the plant, the efficient use of raw materials and energy are key factors that are reviewed and optimised prior to going to full scale production. The site has a Resource Efficiency Team that tracks and monitors key performance indicators with the aim of identifying ongoing process improvements. The aim of the team is to optimise processes operated on site (i.e. maximise yield) and minimise waste generation.
1.5	**Avoidance, Recovery and Disposal of Wastes** 1. Maximise heat transfer between process streams where water is needed for cooling. Use a recirculating system with indirect heat exchangers and a cooling tower in preference to a once-through cooling system. 2. Where water is used in direct contact with process materials, recirculate the water after stripping out the absorbed substances. 3. Use cleaning techniques that reduce the quantity of water needed. 4. Establish opportunities for reuse using pinch analysis.	Yes	1. Cooling water for process vessels is via a closed recirculation system to minimise water usage. A new high efficiency cooling tower is being introduced as part of the new Plant 5.1. 2. Water use is optimised as part of the remit of the Resource Efficiency Team and as part of the new process development optimisation. 3. The site operates production campaigns, where batches of the same material are produced in the process vessels. In general the process vessels only require to be cleaned at the end of the production campaign. This minimises the use of water for cleaning and the generation of process effluent. 4. The site reviews the energy use on site against theoretical mass balances so as to determine whether process improvements are possible.
1.5	**Avoidance, Recovery Disposal of Wastes** 1. Demonstrate that the chosen routes for recovery or disposal represent the best environmental option. Consider avenues for recycling back into the process or reworking for another process wherever possible. 2. Where you cannot avoid disposing of waste, provide a detailed assessment identifying the best environmental options for waste disposal .	Yes	1. New processes are introduced to the site using the New Product Introduction procedures. The procedure requires a review of waste generated as a result of the process. The waste hierarchy is considered to identify the most sustainable disposal route possible. 2. Disposal options for wastes are considered as part of the New Production Introduction procedures and in line with the multi product protocol (MPP). Some of the manufacturing processes undertaken on the site are to recover materials that would otherwise go for waste disposal.
2.1	**Design of a New Process** 1. Consider all potential environmental impacts from the outset in any new project for manufacturing chemicals. 2. Undertake the appropriate stages of a formal HAZOP study as the project progresses through the process design and plant design phases. The HAZOP studies should consider amongst other things the points noted within the SOC guidance.	Yes	1. The potential environmental impacts of new processes are considered as part of the New Product Introduction process and the MPP. An Environmental Risk Assessment and H1 Screening Assessment has been undertaken on the potential impacts from the new Plant 5.1. The potential impacts to air, water and land have been assessed and the impacts found to be insignificant (TERP 60609533-001, Substantial Variation Application – Plant 5.1, AECOM, April 2019). As part of the project, an extensive hardstanding and bunded system has been laid to prevent the loss of materials to the ground and groundwater. The site has many safety systems in place. There are safety instrumented systems on the process vessels and the storage tanks have associated alarms and trips, so as to prevent loss of containment. The site storm water drainage system has an emergency "flapstopper" isolation valve that protects the downstream RTO1 discharge to the River Tees. It can be activated in the event of a loss of containment of a chemical or in a fire, to contain contaminated firewater. Contaminated storm water / fire water can then be removed for offsite disposal. 2. The plant and equipment will be subject to hazard and operability studies (HAZOP) at each stage of the implementation program (i.e. FEED, Detailed Design and As Built). Environmental management aspects and impacts have been reviewed in relation to the sites COMAH report and operational controls to prevent and minimise environmental incidents. In addition, the COMAH accident management plan has been reviewed / updated in relation to the new plant 5.1. An Environmental Risk Assessment (ERA) has been undertaken to identify, characterise and assess all foreseeable release scenarios. The assessment concluded that there are adequate control measures in place to limit the risks to being very low to negligible. A wet scrubber is provided for the abatement of VOC's and other pollutants from Plant 5.1. There are a number of control measures in place to prevent a significant environmental impact arising from scrubber failure. There are safety instrumented systems in place to prevent releases in the event of scrubber failure.
2.2	**Storage and Handling of Raw Materials, Products and Wastes** 1. Store reactive chemicals in such a way that they remain stable, such as under a steady gas stream, for example. If chemical additions are necessary, then tests should be carried out to ensure the required chemical composition is maintained. Inhibitors may also be added to prevent reactions. 2. Vent storage tanks to a safe location. 3. Use measures to reduce the risk of contamination from large storage tanks. In addition to sealed bunds, use double-walled tanks and leak detection channels. 4. Use HAZOP studies to identify risks to the environment for all operations involving the storage and handling of chemicals and wastes. Where the risks are identified as significant, plans and timetables for improvements should be in place.	Yes	1. All material storage is undertaken in line with the guidance to provide adequate segregation. Where appropriate, reactive or sensitive materials are transferred under a nitrogen blanket. Many of the bulk storage tanks have the option for nitrogen to be applied. 2. Although tanks within the new tank farm will aspirate naturally to air, the tanks are multipurpose and can contain materials that would require abatement. In such circumstances, mobile scrubber plant can be added to the tank vents i.e. activated carbon adsorption drums. 3. Plant 5.1 has its own dedicated tank farm. The tank farm is purpose built to be compliant with CIRIA 736. The tanks are located in three bunded compounds. The bunds are compliant with the CIRIA C736 bunding requirements (110% of largest tank and 25% of combined tankage). The bunds are sealed. Each of the storage tanks has level indication with a high level alarm and trip installed. The tanks that are heated have temperature control, indication and trips installed. Except for the hydrogen peroxide tank, all of the tanks are multipurpose tanks and can be used to store a variety of materials. However, when selecting a tank for use the following criteria are considered: • Compatibility of other materials stored in the locality; • Suitability of the materials of construction;

BAT No.	BAT Justification	Operating to BAT	Operator Comments
			• Nitrogen blanketing facility; • Heating capability; and • Venting to a scrubber if necessary. 4. See response for 2.1 above.
2.3	**Plant Systems and Equipment** 1. Formally consider potential emissions from plant systems and equipment and have plans and timetables for improvements, where the potential for substance or noise pollution from plant systems and equipment has been identified. 2. Carry out systematic HAZOP studies on all plant systems and equipment to identify and quantify risks to the environment. 3. Choose vacuum systems that are designed for the load and keep them well maintained. Install sufficient instrumentation to detect reduced performance and to warn that remedial action should be taken.	Yes	1. Emissions from Plant 5.1 have been formally considered. New processes are subject to the New Product Introduction process. The processes are evaluated at laboratory scale prior to scale up to the pant and/or extensive mass balances and reaction thermodynamics are considered. Implementation of a new process must be assessed through the sites MPP, which considers emissions and the acceptability of the impacts. A new scrubber has been installed to address process emissions to atmosphere. A noise assessment has also been undertaken which did not identify any significant noise pollution at sensitive receptors. 2. See response for 2.1 above. 3. Vacuum systems are installed to the guidance requirements.
	Over Pressure Protection Systems 1. Carry out a systematic HAZOP study for all relief systems, to identify and quantify significant risks to the environment from the technique chosen. 2. Identify procedures to protect against overpressure of equipment. This requires the identification of all conceivable over-pressure situations, calculation of relief rates, selection of relief method, design of the vent system, discharge and disposal considerations, and dispersion calculations. In some cases, careful design can provide intrinsic protection against all conceivable over-pressure scenarios, so relief systems and their consequential emissions can be avoided. 3. Maintain in a state of readiness all equipment installed in the venting system even though the system is rarely used.	Yes	1. A full HAZOP assessment has been undertaken for the new plant and processes. High pressure safety instrumented systems have been installed where appropriate. 2. Prior to introduction to new processes, a full evaluation of all potential pressure relief situations is undertaken. The operations undertaken at the site sit within a defined process envelope and chemistry envelopes. The plant is multi-purpose and hence overpressure situations have been considered as part of the design brief for multi-purpose plant. 3. All safety systems are subject to regular planned preventative maintenance and testing to ensure that safety systems are available should they be required.
	Heat Exchangers and Cooling Systems 1. Consider leak detection, corrosion monitoring and materials of construction, preferably in a formal HAZOP study. Plans and timetables for improved procedures or replacement by higher integrity designs should be in place where the risks are identified as significant. 2. If corrosion is likely, ensure methods for rapid detection of leaks are in place and a regime of corrosion monitoring in operation at critical points. Alternatively, use materials of construction that are inert to the process and heating/cooling fluids under the conditions of operation. 3. For cooling water systems, use techniques that compare favourably with relevant techniques described in the Industrial Cooling Systems BREF.	Yes	1. A HAZOP study has been undertaken for the whole of Plant 5.1 and included the heating and cooling systems. 2. Leak detection instrumentation is within the heat exchange and cooling systems. 3. The new cooling tower is a high efficiency design.
	Purging Facilities 1. Assess the potential for the release to air of VOCs and other pollutants along with discharged purge gas and use abatement where necessary.	Yes	The process vessels and storage tanks relating to Plant 5.1 can all be nitrogen purged should it be required to ensure that flammable atmospheres do not form. If necessary, the gases can be vented through the scrubber to provide abatement of VOC's. The plants on the site do not have induced draught fans extracting gases / vapours from the reactors / distillation columns. The plant naturally aspirates and the flow rate emissions through the scrubbers is small, between 2 and 11.5m3/hr on average.
2.4	**Reaction Stage** 1. With a clear understanding of the physical chemistry, evaluate options for suitable reactor types using chemical engineering principles. 2. Select the reactor system from a number of potentially suitable reactor designs - conventional STR, process-intensive or novel-technology - by formal comparison of costs and business risks against the assessment of raw material efficiencies and environmental impacts for each of the options. 3. Undertake studies to review reactor design options based on process-optimisation where the activity is an existing activity and achieved raw material efficiencies and waste generation suggest there is significant potential for improvement. The studies should formally compare the costs and business risks, and raw material efficiencies and environmental impacts of the alternative systems with those of the existing system. The scope and depth of the studies should be in proportion to the potential for environmental improvement over the existing reaction system. 4. Maximise process yields from the selected reactor design, and minimise losses and emissions, by the formalised use of optimised process control and management procedures (both manual and computerised where appropriate). 5. Minimise the potential for the release of vapours to air from pressure relief systems and the potential for emissions of organic solvents into air or water, by formal consideration at the design stage - or formal review of the existing arrangements if that stage has passed	Yes	The physical chemistry of any new process is fully evaluated prior to the introduction to the plant. In many cases, the processes are developed in the laboratory prior to scaling up and using small scale trial batches. Due to the multi-purpose nature of the plant at the site, the best combination of reactor, distillation column and ancillary equipment can be selected for any particular process. The plant and equipment can be configured in relation to the materials being processed. However, the site is restricted to using the equipment available on site and will not seek out novel technology (i.e. pipe reactors as opposed to conventional CSTR reactors). Processes are optimised initially in the laboratory and during small scale trials. The site has a Resource Efficiency Team that meets regularly to review and optimise processes and improve yields. Releases of vapours to air are minimised by the use of a scrubber downstream of a vent condenser. The scrubber liquor can be configured to optimise abatement of the process emissions concerned.
	Minimisation of Liquid Losses from Reaction Systems 1. Use the following features that contribute to a reduction in waste arisings from clean-outs: • low-inventory continuous throughput reactors with minimum surface area for cleaning • minimum internals such as baffles and coils in the reactor • smooth reactor walls, no crevices • flush bottom outlet on reaction vessels • all associated piping to slope back to the reactor or to a drain point • sufficient headroom under the reactor for collection of all concentrated drainings in drums or other suitable vessel, if	Yes	The site is a multi-product site, using multi-purpose plant and equipment. Due to this, products are generated in batch processes and in campaigns. Production campaigns are largely dictated by the customer requirements. However, where ever possible, the site will undertake production campaigns for as long as possible to minimise the volumes of waste and effluent generated due to product changeover and the cleaning out of reactors. The addition of new Plant 5.1 will allow longer dedicated production runs to be undertaken. Where possible, solvents used for cleaning will be stored and reused in later batches. The whole production campaign is considered when processes are transferred onto the plant. The development of a process will also consider the optimisation of the cleaning process to minimise wastes.

BAT No.	BAT Justification	Operating to BAT	Operator Comments
	necessary minimal pipework, designed to eliminate hold-up and to assist drainage • pipework designed to allow air or nitrogen blowing • system kept warm during emptying to facilitate draining • HAZOP studies used to assess the potential for the choking of lines by high-melting-point material • campaigns sequenced so that cleaning between batches is minimised • campaigns made as long as possible to reduce the number of product change-overs • where a complete clean is necessary, use cleaning methods that minimise the use of cleaning agents, (e.g. steam-cleaning, rotating spray jets or high-pressure cleaning) or use a solvent which can be re-used • carry out HAZOP studies to minimise the generation of wastes and to examine their treatment/disposal • consider use of disposable plastic pipe-liners • eliminate or minimise locations for solids to settle-out • consider duplicate or dedicated equipment where it can reduce the need for cleaning that is difficult.		
	Minimisation of Vapour Losses 1. Review your operating practices and review vent flows to see if improvements need to be made. 2. Consider opportunities to enhance the performance of abatement systems.	Yes	1. A wet scrubber is in place, following the use of a vent condenser, to minimise emissions of VOC's to atmosphere. The scrubber is designed to be multipurpose and different scrubbing media can be used to optimise the scrubbing potential. 2. Scrubber liquor is selected to maximise the scrubbing potential and optimise scrubber performance.
2.5	**Separation Stage - Liquid-Vapour Separations** 1. Choose your separation technique following a detailed process design and HAZOP study. Follow formal operating instructions to ensure effective separation and minimisation of losses. Adhere to design conditions such as heat input, reflux flows and ratios, etc. 2. Install instrumentation to warn of faults in the system, such as a temperature, pressure or low coolant-flow.	Yes	1. Condensers are used to minimise releases of vapours to the scrubber. 2. There is a high temperature instrumented safety system trip and alarm in the reactor / distillation column vent condenser to the vent scrubber. This trips the steam to the reactor and will stop material being vaporised and transferred to the condenser.
2.5	**Separation Stage - Liquid-Liquid Separations** 1. Use techniques which maximise physical separation of the phases (and also aim to minimise mutual solubility) where practicable. 2. When the phases are separated, use techniques which prevent (or minimise the probability and size of) breakthrough of the organics phase into a waste-water stream. This is particularly important where the environmental consequences of subsequent releases of organics to air or into controlled waters may be significant (e.g. where the effluent is treated in a DAF unit or some of the organic components are resistant to biological treatment). 3. When a separation is done by hand, use a "dead man's handle", backed-up by good management, to improve the chance of the flow being properly controlled as the phase-boundary approaches. 4. Consider if automatic detection of the interface is practicable. 5. Where you are discharging to drain, consider whether there should be an intermediate holding or "guard" tank to protect against accidental losses from the organics phase.	Yes	Liquid-liquid separations are undertaken in the new plant reactor, the storage tanks and eventually the liquid/liquid extraction column using the techniques specified with the guidance, i.e. interface detection systems, upper and lower take off points and density measurement systems, in addition to experienced operators. All materials from the liquid/liquid separations are run to storage tanks, i.e., 'guard tanks' prior to release from site or to the next stage of processing The new plant has a dedicated small separator vessel for use with the distillation column when carrying out azeotropic distillations.
2.5	**Separation Stage - Solid-Liquid Separations** 1. Use techniques to minimise, re-use and/or recycle rinse water, and to prevent breakthrough of solids. 2. Install instrumentation or other means of detecting malfunction as all of the techniques are vulnerable to solids breakthrough. 3. Consider installing "guard" filters of smaller capacity downstream which, in the event of breakthrough, rapidly 'clog' and prevent further losses. 4. Have good management procedures to minimise loss of solids, escape of volatiles to air and excessive production of waste water.	Not Applicable	There are no new solid-liquid separation systems introduced as a result of this variation on Plant 5.1.
2.6	**Purification Stage - Purification of Liquid Products** Liquid products are usually refined by distillation, with filtration used to remove solid contaminants. Sources of loss are: • Gas entrainment. Gas or vapour flow	Yes	Plant 5.1 has a dedicated distillation column that can be operated with the reactor in series or as a discrete separate distillation column. The distillation column is adaptable and has a wide range of operating temperatures that can be used to optimise the purification stage.
2.6	**Purification Stage - Purification of Solid Products** Washing and crystallising activities have the potential to produce large volumes of dilute liquors so counter-current systems should be used wherever possible. During drying, you should aim to produce the maximum concentration of solvent in the gas to allow recovery of the solvent. The use of vacuum can improve both solvent recovery and energy efficiency.	Not applicable	The products are in liquid form; no solid product purification / drying is undertaken on Plant 5.1.
2.7	**Chemical Process Controls** 1. Monitor the relevant process controls and set with alarms to ensure they do not go out of the required range.	Yes	The processes are monitored constantly from the Control Room using the DCS systems. Processes are under automatic process control. Batch sheets are developed for all new processes prior to being operated on the site. The plant and associated equipment have instrumented safety systems in place with alarms and interlocks configured to provide early warning and trip action in the event of excursion from normal operating ranges. A number of critical to the environmental trips and alarms have been installed on Plant 5.1 and the associated storage vessels. The main plant equipment (reactor and distillation unit) incorporates a number of critical to the environment controls. In summary, these are:

BAT No.	BAT Justification	Operating to BAT	Operator Comments
			• Instrumented safety system trip and alarm as follows: – High level on the reactor that trips the steam to the reactor and reboiler and closing the feed and small additions system block valves. – High level on the distillation column, which trips the steam to the reboiler and closes the column feed emergency block valve. – High temperature on the reactor, which trips the steam to the reactor and the reboiler by closing the steam control and emergency block valves. – High temperature in the vent to the vacuum package and scrubber (vent from the vent condenser). – Low flow in the cooling water return from the vent condenser. – Low speed on the reactor agitator that will trip the Hydrogen Peroxide feed line. – High temperature in the reactor vent condenser to the vent scrubber. – Low flow instrumented in the cooling water return from the condenser. – High temperature in the reactor base, which trips the steam to the reactor by closing the steam control and emergency block valves and trips the Hydrogen Peroxide feed line emergency block valve. – Low temperature in the reactor base, which trips the Hydrogen Peroxide feed line emergency block valve. – High level and high pressure in the liquid/liquid extraction column that closes the feed valves. • There is also flow control on the reflux line to the distillation column. • There is an emergency "flapstopper" isolation valve installed in the storm water drainage system. When activated, the "flapstopper" closes and isolates the drainage system so that any potentially contaminated storm water or firewater remains within the site drains and is not discharged to the River Tees. The flapstopper valve is considered to be a 'critical to the environment' item and is tested and maintained in accordance with site procedures.
2.8	**Analysis** 1. Analyse the components and concentrations of by products and waste streams to ensure correct decisions are made regarding onward treatment or disposal. Keep detailed records of decisions based on this analysis in accordance with management systems.	Yes	All processes on site are subject to Quality Control procedures. Each batch is analysed and a certificate of analysis is generated. Where a product is found to be outside of the specified quality requirements, then it will be reworked wherever possible. Waste materials are analysed prior to offsite disposal with approved third-party contractors. Additional analyses are undertaken by the disposal contractor.
3.1	**Point Source Emissions to Air** 1. Formally consider the information and recommendations in the BREF on Common Waste Water and Waste Gas Treatment/ Management Systems in the Chemical Sector as part of the assessment of BAT for point-source releases to air, in addition to the information in this note. 2. Identify the main chemical constituents of the emissions, including VOC speciation where practicable. 3. Assess vent and chimney heights for dispersion capability and assess the fate of the substances emitted to the environment. 4. Use the following measures to minimise emissions to air: • recover emissions rich in organics by fractionation and then recycle • recover and reuse solvents • continuously monitor off-gas concentration from reaction vessels, dryers, condensers, evaporators and scrubbers where off-gases are shown to be environmentally significant	Yes	1. The emissions to air from the site are expected to meet the benchmarks presented in the CWW BREF. See Table 4 of this document on Common Waste Water and Waste Gas Treatment / Management in the Chemical Sector – BAT Conclusions published June 2016. The Waste Gas BREF for the Chemical sector is in development. This is currently at the first draft stage and is not yet in force and has not been considered. 2. The plant is a multi-purpose plant. Prior to introduction of a new process on plant it is first developed in the laboratory and/or during plant trials. Emissions of VOC's are speciated during the development stage. Emissions of VOC's are limited initially by the use of condensers from the reactor or the distillation column. A wet scrubber is installed to prevent residual releases of VOC's to atmosphere. The scrubber can be configured to optimise the abatement of VOC emissions using the most appropriate scrubber liquor to scrub the particular VOC's. The main VOC constituents are assessed by mass balance for use in the H1 impact assessment (part of the MPP). This identifies emission levels such that the VOC impacts at ground level are "insignificant". Where they are not "insignificant" discussions are held with the regulator to discuss the implementation of the production process in accordance with the rules of the MPP. 3. All of the emissions from the release points to air have been modelled using the Environment Agency's H1 tool as part of the MPP assessment to place the manufacturing processes on the site. It has been demonstrated that the release points provide adequate dispersion of the residual pollutants to render acceptable environmental impacts. It should be recognised that the plants on the site do not have induced draught fans extracting gases / vapours from the reactors / distillation columns. The plant naturally aspirates through the emission points and the flow rate emissions through the scrubbers is small, between 2 and 11.5m^3/hr on average. The mass emissions of VOC pollutants are therefore low, favouring "insignificant" impacts under the H1 assessment tool. 4. VOC are recovered using condensers. Wherever possible the recovered materials will be reused within the process. Monitoring of emissions is undertaken in line with the requirements of the Environmental Permit. However, process parameters are monitored continuously to ensure that a high level of environmental protection is provided. See a list of the critical to the environment trips and alarms in Section 2.7.
3.1	**Point Source Emissions to Water** 1. Control all emissions to avoid a breach of water quality standards as a minimum. Where another technique can deliver better results at reasonable cost it will be considered BAT and should be used. 2. Use the following measures to minimise water use and emissions to water: • Where water is needed for cooling, minimize its use by maximising heat transfer between process streams. Use water in recirculating systems with indirect heat exchangers and a cooling tower rather than a once through system. (A water make-up treatment plant and a concentrated purge stream from the system to avoid the build-up of contaminants are likely to be necessary). • Leaks of process fluids into cooling water in heat exchangers are a frequent source of contamination. Monitoring of the cooling water at relevant points should be appropriate to the nature of the process fluids. In a re-circulatory cooling system, leaks can be identified before significant emission to the environment has occurred. The potential for environmental impact is likely to be greater from a once through system. Planned maintenance can help to avoid such occurrences. • Strip process liquor and treat if necessary, then recycle/reuse.	Yes	1. The majority of the process effluent that will be generated from Plant 5.1 will be removed from site by an approved waste disposal contractor for disposal. However, the final vessel steamings, following tank cleaning, are discharged to the drains on Plant 5.1. Plant 5.1 has combined surface water and plant area drains. The combined effluent in future is to be transferred to two new effluent tanks, each with a 250 m³ capacity (TK004 and TK005). The effluent will be quarantined until it can be analysed and it is demonstrated that it meets the parameters of the discharge consent (emission S1). It should be noted that there may be a period of time when the Plant 5.1 becomes operational that the existing effluent tanks (TK001 and TK002) will be used. The two new effluent tanks (TK004 and TK005) will be constructed at a later date. 2. Water minimisation is an integral part of the development of new processes for the site. The waters used in process report as aqueous wastewater streams. These are sent for offsite disposal. Consequently, water use in process is minimised by design to minimise disposal costs. Closed circuit cooling systems are used, i.e. heat exchangers and cooling tower. The only process effluent sent to process drains is the last steamings, after washing out vessels. The bulk of the effluent is rainwater falling on the Plant 5.1 process areas and non-process areas.

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	• Use wet air oxidation for low volumes of aqueous effluent with high levels of organic content, such as waste streams from condensers and scrubbers. • Neutralise waste streams containing acids or alkalis to achieve the required pH for the receiving water. • Strip chlorinated hydrocarbons in waste streams with air or steam and recycle by returning to process where possible. • Recover co-products for re-use or sale. • Periodically regenerate ion exchange columns. • Pass waste water containing solids through settling tanks, prior to disposal. • Treat waste waters containing chlorinated hydrocarbons separately where possible to ensure proper control and treatment of the chlorinated compounds. Contain released volatile chlorinated hydrocarbons and vent to suitably designed incineration equipment. • Non-biodegradable organic material can be treated by thermal incineration. However, the thermal destruction of mixed liquids can be highly inefficient, and the waste should be dewatered prior to incineration.		
3.1	**Point Source Emissions to Land** 1. Use the following measures to minimise emissions to land: • Use settling ponds to separate out sludge (Note: Sludge can be disposed of to incinerator, encapsulation, land or lagoon depending upon its make-up.) • Chlorinated residues should be incinerated and not released to land. (Chlorinated hydrocarbons are not to be released to the environment due to their high global warming and ozone depletion potentials). • Either recycles off specification product into the process or blend to make lower grade products where possible. • Many catalysts are based on precious metals and these should be recovered, usually by return to the supplier.	Not Applicable	There are no point source emissions to land, i.e. soakaways of effluent.
3.2	**Fugitive emissions – to Air** 1. Identify all potential sources and develop and maintain procedures for monitoring and eliminating or minimising leaks. 2. Choose vent systems to minimise breathing emissions (for example pressure/vacuum valves) and, where relevant, should be fitted with knock-out pots and appropriate abatement equipment. 3. Use the following techniques (together or in any combination) to reduce losses from storage tanks at atmospheric pressure: • Maintenance of bulk storage temperatures as low as practicable, taking into account changes due to solar heating etc. • Tank paint with low solar absorbency. • Temperature control. • Tank insulation. • Inventory management. • Floating roof tanks. • Bladder roof tanks. • Pressure/vacuum valves, where tanks are designed to withstand pressure fluctuations. • Specific release treatment (such as adsorption condensation).	Yes	1. Prior to introducing new products and processes to the site the emissions profile is determined and appropriate control measures implemented. This includes any fugitives from the equipment. 2. It should be recognised that the plant does not have an induced draught fan (ID-fan) pulling high volume flows through the vent scrubber. The flows are low (typically 2 to 11.5m^3/hr) and are aspirated emissions, i.e. due to vessel filling etc. Fugitive emissions, e.g. leaks, in these emission lines will therefore be small. 3. The plant is multi-product / multi-use. Consequently, if volatile materials are used / stored in the tank farm then the tank can, if necessary, be vented through a scrubber. This again will be an integral part of the MPP assessment before introduction of a manufacturing campaign.
3.2	**Fugitive Emissions to Surface Water, Sewer and Groundwater** 1. Provide hard surfacing in areas where accidental spillage or leakage may occur, e.g. beneath prime movers, pumps, in storage areas, and in handling, loading and unloading areas. The surfacing should be impermeable to process liquors. 2. Drain hard surfacing of areas subject to potential contamination so that potentially contaminated surface run-off does not discharge to ground. 3. Hold stocks of suitable absorbents at appropriate locations for use in mopping up minor leaks and spills, and dispose to leak-proof containers. 4. Take particular care in areas of inherent sensitivity to groundwater pollution. Poorly maintained drainage systems are known to be the main cause of groundwater contamination and surface/above-ground drains are preferred to facilitate leak detection (and to reduce explosion risks). 5. Additional measures could be justified in locations of particular environmental sensitivity. Decisions on the measures to be taken should take account of the risk to groundwater. 6. Surveys of plant that may continue to contribute to leakage should also be considered, as part of an overall environmental management system. In particular, you should consider undertaking leakage tests and/or integrity surveys to confirm the containment of underground drains and tanks.	Yes	1. Plant 5.1 has extensive areas of hard standing to prevent losses of material reaching the land beneath the site. The tank farm has its own dedicated bunds that are compliant with CIRIA C736. Storage of portable containers is also in bunded areas / contained drainage areas. Plant 5.1 process area has a containment bund. The surface water drains on the roadways etc. are not connected into the sites storm water drainage system, they are routed to a sump which takes both process and surface water drains on Plant 5.1. Under normal operation the sump is pumped to the site's effluent tanks. In the event of excessive contamination being identified, then the material can be isolated at the sump and removed from site by an authorised waste disposal contractor. 2. The Plant 5.1 drainage systems do not offer a pathway to the soil and groundwater beneath the site. The Plant 5.1 drains are routed to a sump which takes both process and surface water drains on Plant 5.1. Under normal operation the sump is pumped to the site's effluent tanks. The new plant does not have any soakaways for storm water that could potentially be contaminated. 3. Spill kits are located across the whole of the site in strategic places. 4. The site periodically undertakes CCTV inspections of the drainage system. The new hardstanding and drainage systems of the Plant 5.1 assets will be added to the preventative plant maintenance (PPM) system and routine CCTV will be undertaken. 5. The current preventative measures are considered to provide adequate protection for the sensitive receptors in the locality. 6. The site has a planned preventative maintenance (PPM) regime. There are no underground tanks and CCTV inspections of the drainage system is undertaken periodically.
3.3	**Odour** 1. Manage the operations to prevent release of odour at all times. 2. Where odour releases are expected to be acknowledged in the permit, (i.e. contained and treated prior to discharge or discharged for atmospheric dispersion): • For existing installations, the releases should be modelled to demonstrate the odour impact at sensitive receptors. The target should be to minimise the frequency of exposure to ground level concentrations that are likely to cause annoyance. • For new installations, or for significant changes, the releases should be modelled and it is expected that you will achieve the highest level of protection that is achievable with BAT from the outset. • Where there is no history of odour problems then modelling may not be required although it should be remembered	Yes	The site operates to a multi-product protocol (MPP). Any new processes undertaken at the site are also subject to the New Product Introduction process. This procedure considers the risks to health, safety and the environment as a result of bringing new processes online. The potential to generate odour nuisance is considered and, if appropriate an odour management plan is developed in line with the Environmental Permit. The site is however located in a predominantly industrial setting with few residential areas in the locality, therefore the potential for odour nuisance is minimal. For VOC's, condensers are installed on the exit from reactors / distillation columns and emissions are routed through a wet scrubber that is configured for removing specific VOC's. The choice of scrubbing medium can be specified to eliminate a particularly odorous VOC.

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	that there can still be an underlying level of annoyance without complaints being made. • Where, despite all reasonable steps in the design of the plant, extreme weather or other incidents are liable, in our view, to increase the odour impact at receptors, you should take appropriate and timely action, as agreed with us, to prevent further annoyance (these agreed actions will be defined either in the permit or in an odour management statement). 3. Where odour generating activities take place in the open, or potentially odorous materials are stored outside, a high level of management control and use of best practice will be expected. 4. Where an installation releases odours but has a low environmental impact by virtue of its remoteness from sensitive receptors, it is expected that you will work towards achieving the standards described in this guidance note, but the timescales allowed to achieve this might be adjusted according to the perceived risk. **5.** Where further guidance is needed to meet local needs, refer to Horizontal Guidance Note H4 Odour.		
3.4	**Nosie and Vibration** 1. Install particularly noisy machines such as compactors and pelletisers in a noise control booth or encapsulate the noise source. 2. Where possible without compromising safety, fit suitable silencers on safety valves. **3.** Minimise the blow-off from boilers and air compressors, for example during start up, and provide silencers.	Yes	No equipment with the capacity to generate a noise nuisance will be installed as part of the new plant installation. An acoustics survey and assessment was undertaken in line with the guidance contained in BS 4142: 2014 'Methods for rating and assessing industrial and commercial sound'. The noise survey and assessment did not identify a significant increase in noise at the site or at nearest residential receptors as a consequence of adding the Plant 5.1 activities. (Report reference: 60609533_Acoustic_1 - Seqens Billingham Noise Assessment, AECOM, September 2019).
3.5	**Monitoring and Reporting of Emissions to Air and Water** 1. Carry out an analysis covering a broad spectrum of substances to establish that all relevant substances have been taken into account when setting the release limits. The need to repeat such a test will depend upon the potential variability in the process and, for example, the potential for contamination of raw materials. Where there is such potential, tests may be appropriate. 2. Monitor more regularly any substances found to be of concern, or any other individual substances to which the local environment may be susceptible and upon which the operations may impact. This would particularly apply to the common pesticides and heavy metals. Using composite samples is the technique most likely to be appropriate where the concentration does not vary excessively. **3.** If there are releases of substances that are more difficult to measure and whose capacity for harm is uncertain, particularly when combined with other substances, then "whole effluent toxicity" monitoring techniques can be appropriate to provide direct measurements of harm, for example, direct toxicity assessment.	Yes	1. Monitoring of emissions to air is undertaken in line with the site's Environmental Permit. The monitoring programme will be extended to include emissions from the scrubber associated with Plant 5.1 (release point A5). Releases to water are analysed prior to batch release (emission point S1). Effluent is quarantined within the sites effluent tanks (Tanks TK001 and TK002) until it is within the parameters of the discharge consent, as contained in the Environmental Permit. 2. The current monitoring programme is considered adequate. Substances of concern are addressed as part of the New Product Introduction process and the Multi-Product Protocol (which asses impacts through the H1 assessment process). The whole effluent tank is analysed before discharge as emission point S1. 3. Effluent is quarantined in two effluent storage tanks prior to discharge (Tanks TK001 and TK002). Effluent is analysed prior to release and can be quarantined and removed for offsite disposal if required. The effluent discharge consent for emission S1 remains unchanged with the introduction of Plant 5.1.
3.6	**Monitoring and Reporting of Waste Emissions** 1. Monitor and record: • The physical and chemical composition of the waste. • Its hazard characteristics. • Handling precautions and substances with which it cannot be mixed.	Yes	The disposal of waste is undertaken in compliance with the site's waste management policies and procedures. Records of wastes disposed from the site are maintained within the sites waste register. The site identifies the composition of waste and associated hazards as far as reasonably practicable. Material safety datasheets (MSDS) are available for all of the materials used on site. Waste disposal is undertaken by approved third party contractors. A risk-based approach is applied to Duty of Care audits. The site undertakes audits on contractors, waste carriers and disposal sites depending on the quantity and hazards of materials disposed. No new wastes / waste categories are introduced as a function of introducing Plant 5.1.
3.7	**Environmental Monitoring Beyond the Installation** 1. Consider the following in drawing up proposals: • Determinants to be monitored, standard reference methods, sampling protocols. • Monitoring strategy, selection of monitoring points, optimisation of monitoring approach. • Determination of background levels contributed by other sources. • Uncertainty for the employed methodologies and the resultant overall uncertainty of measurement. • Quality assurance (QA) and quality control (QC) protocols, equipment calibration and maintenance, sample storage and chain of custody/audit trail. • Reporting procedures, data storage, interpretation and review of results, reporting format for the provision of information.	Not Applicable	An acoustics survey and assessment was undertaken to determine the effect of the potential increase in noise at sensitive receptors (see Section 3.4). However, no further monitoring beyond the site boundary is deemed necessary.

Table 2: Selected Waste Treatment (WT) BAT Conclusions – August 2018

BAT No.	BAT Justification	Operating to BAT	Operator Comments
Scope	Section 5.3 - Disposal or Recovery of Hazardous Waste, Part A(1) (a) Disposal or recovery of hazardous waste with a capacity exceeding 10 tonnes per day involving one or more of the following: (ii) physio-chemical treatment (iii) blending or mixing prior to submission to any of the activities listed in this section or Section 5.1 Section 5.6 – Temporary or Underground Storage of Hazardous Waste, Part A(1) (a) Temporary storage of hazardous waste with a total capacity exceeding 50 tonnes	-	The sector guidance applies as the permitted activities are defined under 5.3 Part A(1)(a)(ii)(iii) and 5.6 Part A(1) (a) of Schedule 1 to the Environmental Permitting Regulations 2016, namely: • Section 5.3 A (1) (a) (ii) – disposal or recovery of hazardous waste with a capacity exceeding 10 tonnes per day involving physio-chemical treatment. • Section 5.3 A (1) (a) (iii) – disposal or recovery of hazardous waste with a capacity exceeding 10 tonnes per day involving blending or mixing waste prior to submission to the activity described in Section 5.3A(1)(a)(ii).

<table>
<tr><th>BAT No.</th><th>BAT Justification</th><th>Operating to BAT</th><th>Operator Comments</th></tr>
<tr><td></td><td></td><td></td><td>• Section 5.6 A (1) (a) – temporary storage of hazardous waste with a total capacity exceeding 50 tonnes pending any of the activities listed in Section 5.3.</td></tr>
<tr><td>BAT 4</td><td>1. General BAT Conclusions
In order to reduce the environmental risk associated with the storage of waste, BAT is to use all of the following techniques given below.

<table>
<tr><th></th><th>Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>a.</td><td>Optimised storage location</td><td>This includes techniques such as:
• the storage is located as far as technically and economically possible from sensitive receptors, watercourses, etc.;
• the storage is located in such a way so as to eliminate or minimise the unnecessary handling of wastes within the plant (e.g. the same wastes are handled twice or more or the transport distances on site are unnecessarily long).</td><td>Generally applicable to new plants</td></tr>
<tr><td>b.</td><td>Adequate storage capacity</td><td>Measures are taken to avoid accumulation of waste, such as:
• the maximum waste storage capacity is clearly established and not exceeded taking into account the characteristics of the wastes (e.g. regarding the risk of fire) and the treatment capacity;
• the quantity of waste stored is regularly monitored against the maximum allowed storage capacity;
• the maximum residence time of waste is clearly established.</td><td rowspan="3">Generally applicable.</td></tr>
<tr><td>c.</td><td>Safe storage operation</td><td>This includes measures such as:
• equipment used for loading, unloading and storing waste is clearly documented and labelled;
• wastes known to be sensitive to heat, light, air, water, etc. are protected from such ambient conditions;
• containers and drums are fit for purpose and stored securely.</td></tr>
<tr><td>d.</td><td>Separate area for storage and handling of packaged hazardous waste</td><td>When relevant, a dedicated area is used for storage and handling of packaged hazardous waste.</td></tr>
</table></td><td>Yes</td><td>Wastes stored at the site are compliant with the techniques specified in BAT 4.

a) The site and Plant 5.1 are located within the CF Fertilisers Billingham Industrial Complex. This is remote from sensitive receptors and there are protective measures with regards to pathways to receptors, i.e. the storm drains to the River Tees are protected by the use of an emergency “flapstopper” isolation valve system.

b) Waste stored onsite is minimised, owing to the relatively small production plant area. The site has rules regarding waste accumulation and have a policy of disposing of waste as quickly as practical / possible. Waste storage is governed by waste storage and handling procedures.

c) The site segregate wastes based upon character and type. Containers are suitably labelled and documented on the tank and IBC/drum stock sheets. Waste is stored in dedicated, defined storage areas, taking due regard of sensitive wastes, e.g. pyrophoric wastes etc. The site only use fit for purpose drums and containers, and they undergo checks to ensure the portable units are satisfactory prior to use.

d) The site is installing a dedicated area for hazardous materials storage (including waste) for portable containers. This is fully bunded with a closed drainage system. Uncontaminated rainwater will be released to the sites storm drainage system, as and when required, following visual testing of the rainwater (new emission point S3).</td></tr>
<tr><td>BAT 5</td><td>1. General BAT Conditions
In order to reduce the environmental risk associated with the handling and transfer of waste, BAT is to set up and implement handling and transfer procedures.

Description

Handling and transfer procedures aim to ensure that wastes are safely handled and transferred to the respective storage or treatment. They include the following elements:

• handling and transfer of waste are carried out by competent staff;
• handling and transfer of waste are duly documented, validated prior to execution and verified after execution
• measures are taken to prevent, detect and mitigate spills;</td><td>Yes</td><td>The site is compliant with the requirements of BAT 5. Handling and transfer procedures are in place covering each of the elements identified.</td></tr>
</table>

BAT No.	BAT Justification	Operating to BAT	Operator Comments
	• operation and design precautions are taken when mixing or blending wastes (e.g. vacuuming dusty/powdery wastes). Handling and transfer procedures are risk-based considering the likelihood of accidents and incidents and their environmental impact.		
BAT 46	**4.4 BAT Conclusions for the Regeneration of Spent Solvents** 4.4.1. Overall Environmental Performance In order to improve the overall environmental performance of the regeneration of spent solvents, BAT is to use one or both of the techniques given below. a. Material recovery — Solvents are recovered from the distillation residues by evaporation — Applicability may be restricted when the energy demand is excessive with regards to the quantity of solvent recovered. b. Energy recovery — The residues from distillation are used to recover energy — Generally applicable	Yes	Waste solvents are subject to distillation operations to recover clean solvents for re-use. a) The efficient recovery of solvents from residues is a critical part of the process – recovering as much valuable clean solvent material as possible from the residues. As stated in BAT 46, there is an economic breakpoint where excessive energy is expended relative to solvent recovery. The site monitor energy demands per batch to ensure efficient operations. b) The bottoms / residues from solvent recovery operations are sent for off site disposal. Energy is not recovered onsite; however energy is recovered off-site where incineration of the waste residues / bottoms is undertaken.
BAT 47	**4.4 BAT Conclusions for the Regeneration of Spent Solvents** 4.4.2. Emissions to Air In order to reduce emissions of organic compounds to air, BAT is to apply BAT 14d and to use a combination of the techniques given below. a. Recirculation of process off-gases in a steam boiler — The process off-gases from the condensers are sent to the steam boiler supplying the plant. — May not be applicable to the treatment of halogenated solvent wastes, in order to avoid generating and emitting PCBs and/or PCDD/F. b. Adsorption — See Section 6.1 — There may be limitations to the applicability of the technique due to safety reasons (e.g. activated carbon beds tend to self-ignite when loaded with ketones). c. Thermal oxidation — See Section 6.1 — May not be applicable to the treatment of halogenated solvent wastes, in order to avoid generating and emitting PCBs and/or PCDD/F. d. Safe storage operation — See Section 6.1 — Generally applicable. e. Separate area for storage and handling of packaged hazardous waste — See Section 6.1 — Generally applicable.	Yes	a) The operations conducted onsite relate to solvent recovery from waste solvents. The emission from the distillation columns are low volumetric flow due to aspiration of the vessels. The emissions typically come from nitrogen blanketed operations. The distillation columns are connected to a scrubber but are not subject to forced extraction (i.e. no ID fan). Consequently, this technique is not applicable. b) All multi-purpose plants on the site (including new Plant 5.1) use wet scrubbing as the abatement technique. This offers flexibility in abatement as the scrubbing medium can be changed depending on the duty required. c) Whilst the Release Points from the reactors / distillation columns may have a reasonable concentration, the flowrates are quite low, i.e. 2 to 11.5m^3/hr. The flows are too low, along with the typical organic component concentration, to apply thermal oxidation. d) The storage of waste solvents is in accordance with industry safe standards. The site has undertaken appropriate DSEAR / ATEX assessments and equipment is appropriately rated for the defined ATEX Zones. e) See BAT 4 – d) earlier. With regards to BAT 8, the site monitor VOC every 3 months by BS EN 13649 – in accordance with the requirements of the Environmental Permit. BAT 14 relates to the collection and treatment of diffuse VOC emission sources. The operations at the site and on Plant 5.1 are for specific process plant with defined release points (i.e. release point A5 from the vent condenser scrubber). There is no diffuse collection system , e.g. hygiene system within a building from pollution sources. BAT 14 therefore does not apply.

BAT No.	BAT Justification	Operating to BAT	Operator Comments

The associated monitoring is given in BAT 8.

BAT 8 specifies for BAT 47:

- TVOC every 6 months by EN 12619

The BAT-AEL value for VOC for emissions is given in Section 4.5.

BAT 14.

In order to prevent or, where that is not practicable, to reduce diffuse emissions to air, in particular of dust, organic compounds and odour, BAT is to use an appropriate combination of the techniques given below. Depending on the risk posed by the waste in terms of diffuse emissions to air, BAT 14d is especially relevant.

	Technique	Description	Applicability
d.	Containment, collection and treatment of diffuse emissions	This includes techniques such as: • storing, treating and handling waste and material that may generate diffuse emissions in enclosed buildings and/or enclosed equipment (e.g. conveyor belts); • maintaining the enclosed equipment or buildings under an adequate pressure; • collecting and directing the emissions to an appropriate abatement system (see Section 6.1) via an air extraction system and/or air suction systems close to the emission sources.	The use of enclosed equipment or buildings may be restricted by safety considerations such as the risk of explosion or oxygen depletion. The use of enclosed equipment or buildings may also be constrained by the volume of waste.

4.5 BAT-AEL for Emissions or Organic Compounds to Air from the Re-refining of Waste Oil, Chemical Treatment of Waste with a Calorific Value and the Regeneration of Spent Solvents

Partial

The BAT-AEL for regenerating spent solvent is 5 – 30mg/m^3 as specified within Table 6.9 of section 4.5 of the BAT Conclusions.

The limit of TVOC does not apply to emissions of < 2kg/hr.

The current Environmental Permit has limits of 2kg/hr (as carbon) for Class B Volatile Organic Compounds and 100g/hr for Class A Volatile Organic Compounds (as species) for existing Release Points A1 to A4 and proposed emission point A5 – when recovering solvents.
In general therefore the concentration limit would not apply to the Class B emissions when processing waste solvents.

It is unclear if the concentration limit BAT-AEL would apply if CMR species comprise the Class A components when recovering waste solvents. The primary processes at the site are for the manufacture of organic chemical species and historically the regulation of the site, through the Environmental Permit conditions, has focused on the manufacture of organic chemicals as this is the bulk of the manufacturing undertaken at the site.

Table 6.9

BAT-associated emission level (BAT-AEL) for channelled emissions of TVOC to air from the re-refining of waste oil, the physico-chemical treatment of waste with calorific value and the regeneration of spent solvents

Parameter	Unit	BAT-AEL(1) (Average over the sampling period)
TVOC	mg/Nm^3	5 - 30

(1) The BAT-AEL does not apply when the emission load is below 2 kg/h at the emission point provided that no CMR substances are identified as relevant in the waste gas stream, based on the inventory mentioned in BAT 3.

Table 3: CIRIA guidance, C736, Containment systems for the prevention of pollution. Secondary, tertiary and other measures for industrial and commercial premises. 2014

BAT No.	BAT Justification	Operating to BAT	Operator Comments
	Demonstrate that any secondary / tertiary containment, vessel specification, pipework, surfacing, drainage is constructed to the standards in line with CIRIA guidance, CIRIA C736: "Containment systems for the prevention of pollution. Secondary, tertiary and other measures for industrial and commercial premises". Tanks, vessels and associated pipework provide the primary containment. The primary containment may also be located within a warehouse. Secondary containment can be provided by bunds constructed from reinforced concrete or earth, by lagoons or by tanks. Warehouse walls can also be designed to provide secondary containment. Tertiary containment can be provided by a number of means including lagoons, sacrificial areas such as car parks and providing storage on the surface of roadways using containment kerbs. Local containment is provided locally to the primary containment normally using a bund. Remote containment is provided away from the primary containment using, for example, a lagoon or tank. Transferring spilled inventory to the remote containment can be via a gravity drain or pumped. Combined containment uses both local containment and remote containment.	Yes	Plant 5.1 is a new facility where the primary, secondary and tertiary containment systems have been designed to fulfil the requirements of CIRIA C736. Plant 5.1 process area; containing the reactor, distillation column, wet scrubber etc. sits upon a bunded area of concrete with drainage and a local sump. Under normal operations the bund sump is isolated from the Plant 5.1 area drains. There is a tank farm consisting of three separate dedicated bunds – all conforming to the requirements of CIRIA C736. One bund is dedicated to the storage of hydrogen peroxide (61m^3 tank). The other two bunds house multi-purpose tanks for raw materials and products (tanks being 100m^3 to 200m^3 capacity). The three bunds will house 14 new tanks – not all of which will be installed initially. All bunds have discrete collection sumps that are isolated from the Plant 5.1 area drains. There was no existing surface water drainage in the area of construction of Plant 5.1. Consequently, the surface water areas associated with the Plant 5.1 roadways and road tanker loading / unloading are part of one drainage system for the plant area, together with the process areas. The bunds can all be drained into the single Plant 5.1 drainage system (once the contents have been shown not to be significantly contaminated by a spill), including the processing plant bund. The Plant 5.1 drains all route to a single sump, having passed through a fire trap. The sump then pumps the effluent over to the existing effluent tanks (TK001 and TK002) to be part of emission point S1. In the event of a significant spill on Plant 5.1, the materials can be kept locally within the plant drains. If required, the contaminated effluent can be pumped over to the effluent tanks (TK001 and TK002) for quarantine, before offsite disposal. In the event of a fire, the high volume of firewater can be routed to the 18inch storm drain to the east of the site. The firewater would then be kept back by the activation of the emergency "flapstopper" drain isolation valve, which is located within the 18inch drain. It is proposed to install a new bund / refurbished bund on the site of the old bulk storage methanol tanks (adjacent to the "flapstopper" location). Firewater held back by the "flapstopper" would be lifted from the "flapstopper" chamber by a fast fill pump into the newly installed bund, awaiting off site disposal. The newly installed bund will ultimately house two new effluent tanks – TK004 and TK005 (250m^3 each). These tanks are to replace the existing effluent tanks TK001 and TK002 and will be constructed after the installation of Plant 5.1. The new tanks will offer a greater quarantine capability and potentially offer a break / buffer between the current manufacturing facilities and any future effluent treatment plant – should one be required by the CWW BREF. It can be seen that the new drainage system for Plant 5.1 has accommodated the primary, secondary and tertiary containment requirements of CIRIA C736 – including the provision for total firewater containment and the containment of a large process spillage.

Table 4: Common Waste Water and Waste Gas Treatment / Management in the Chemical Sector – BAT Conclusions Published June 2016

BAT No.	BAT Justification	Operating to BAT	Operator Comments
Scope	These BAT conclusions concern the activities specified in Sections 4 of Directive 2010/75/EU, namely: — Section 4: Chemical industry.	-	The BREF document applies as the permitted activities is defined under 4.1 Part A(1)(a)(i)(ii)(iv)(viii) of Schedule 1 to the Environmental Permitting Regulations 2016 and therefore applies to the site.
BAT 1	In order to improve the overall environmental performance, BAT is to implement and adhere to an environmental management system (EMS). that incorporates all of the following features: (i) commitment of the management, including senior management; (ii) an environmental policy that includes the continuous improvement of 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 procedures paying particular attention to: (a) structure and responsibility; (b) recruitment, training, awareness and competence; (c) communication;	Yes	The site has an internal environmental management system (EMS), which is certified to ISO14001: 2015. The existing site EMS is compliant with aspects (i) to (v). The site has management commitment and review of the EMS and Environmental Policy. Environmental performance indicators have been established and these are communicated to all employees. Employees are also encouraged to contribute to the continuous improvement programmes on site. There is also a Resource Efficiency Team that meets quarterly to review progress against Key Performance Indicators and will establish improvement projects if deemed appropriate.

	(d) employee involvement; (e) documentation; (f) effective 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 Report on Monitoring of emissions to Air and Water from IED installations — ROM); (b) corrective and preventive action; (c) maintenance of records; (d) independent (where practicable) internal or external auditing in order to determine whether or not the EMS conforms to planned arrangements and has been properly implemented and maintained. (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 plant at the design stage of a new plant, and throughout its operating life; (ix) application of sectoral benchmarking on a regular basis; (x) Waste management plan (see BAT 13). Specifically for chemical sector activities, BAT is to incorporate the following features in the EMS: (xi) on multi-operator installations/sites, establishment of a convention that sets out the roles, responsibilities and coordination of operating procedures of each plant operator in order to enhance the cooperation between the various operators; (xii) Establishment of inventories of waste water and waste gas streams (see BAT 2). In some cases, the following features are part of the EMS: (xiii) Odour management plan (see BAT 20); (xiv) Noise management plan (see BAT 22). Applicability: The scope (e.g. level of detail) and nature of the EMS (e.g. standardised or non-standardised) will generally be related to the nature, scale and complexity of the installation, and the range of environmental impacts it may have.		The site has developed an Accident Management Plan in line with the requirements of the Environmental Permit. The site is a COMAH installation and has appropriate management systems and emergency preparedness procedures to cover environmental incidents, as part the standard operational procedures. (v) The site undertakes daily operational team meetings include a review of performance relating to environmental issues (such as loss of containment incidents), which are formally investigated, recorded and action tracked. (vi) Senior management undertakes an annual review of the EMS and associated targets. (vii) The site consists of a number of multi-purpose plants and new products introduced are assessed prior to implementation. Wherever possible the site will choose cleaner technologies if possible – under the multi-purpose nature of operations. (viii) The site has a site closure and decommissioning plan as part of the requirements of the Environmental Permit. (ix) The site consists of a number of multi-purpose plants and whilst Key Performance Indicators are tracked and monitors, sectoral benchmarking is difficult due to the variable nature of the products. The site has an established Resource Efficiency Team that meets quarterly with the aim of improving processes and minimising wastes. (x) A waste management plan is in place. (xi) The site has shared emergency services with Falck – including firefighting (the service provider on the Billingham Complex). (xii) All wastes are tracked through the tank stocks and drum/IBC stock sheets. A database of the measured releases to air and water for the consented species in the Environmental Permit is maintained. (xiii) An odour risk assessment is undertaken for each new product as part of the New Product Introduction procedures and the MPP. H1 assessments are undertaken for all new processes (as part of the MPP) and this will include an assessment of the odour threshold of new materials. Where appropriate, a management plan will be established. (xiv) An acoustics assessment was undertaken for Plant 5.1 and concluded that there was no significant risk at noise sensitive receptors.
BAT 2	In order to facilitate the reduction of emissions to water and air and the reduction of water usage, BAT is to establish and to maintain an inventory of waste water and waste gas streams, as part of the environmental management system (see BAT 1), that incorporates all of the following features: (i) information about the chemical production processes, including: (a) chemical reaction equations, also showing side products; (b) simplified process flow sheets that show the origin of the emissions; (c) descriptions of process-integrated techniques and waste water/waste gas treatment at source including their performances; (ii) information, as comprehensive as is reasonably possible, about the characteristics of the waste water streams, such as: (a) average values and variability of flow, pH, temperature, and conductivity; (b) average concentration and load values of relevant pollutants/parameters and their variability (e.g. COD/TOC, nitrogen species, phosphorus, metals, salts, specific organic compounds); (c) data on bio-eliminability (e.g. BOD, BOD/COD ratio, Zahn-Wellens test, biological inhibition potential (e.g. nitrification)); (iii) information, as comprehensive as is reasonably possible, about the characteristics of the waste gas streams, such as: (a) average values and variability of flow and temperature; (b) average concentration and load values of relevant pollutants/parameters and their variability (e.g. VOC, CO, NOX, SOX, chlorine, hydrogen chloride); (c) flammability, lower and higher explosive limits, reactivity; (d) Presence of other substances that may affect the waste gas treatment system or plant safety (e.g. oxygen, nitrogen, water vapour, dust).	Yes	The site is compliant with the requirements of BAT 2. i) Prior to any new products being introduced to the site the process reactions, mass balances and thermodynamics are all well understood. Products may be developed in the laboratory or on plant trials prior to full introduction to the multi-purpose plants. Products are assessed for environmental suitability using the MPP. ii) Waste water streams are assessed during the introduction of new products as i) above. Wastes are characterised and disposal routes are identified prior to the process going to full scale production. iii) Waste gas streams are also assessed prior to going to full production. The reaction chemistry is well understood and the best abatement techniques for the materials involved will be used. In general this will involve the choice of scrubber liquor to be used to minimise emissions of VOC's, or acid gases etc.
BAT 3	For relevant emissions to water as identified by the inventory of waste water streams (see BAT 2), BAT is to monitor key process parameters (including continuous monitoring of waste water flow, pH and temperature) at key locations (e.g. influent to pre-treatment and influent to final treatment).	Yes	The majority of the process waste waters generated onsite are disposed of through approved offsite waste disposal contractors. The effluent from Plant 5.1 will be contaminated rainwater from falling on process areas and also, occasionally, the last steamings, from cleaning out of vessels following water washing. The effluent from Plant 5.1 will also contain rainwater from non-process areas (i.e. road drains in the locality) as there are no separate storm drains. The combined Plant 5.1 effluent will be pumped from a common sump over to the existing effluent storage tanks (TK001 and TK002) where it will form part of effluent discharge point S1 (within the Environmental Permit). The effluent is quarantined and sampled, prior to discharge, to demonstrate compliance with emission consent conditions.
BAT 4	**Monitoring** BAT is to monitor emissions to water in accordance with EN standards with at least the minimum frequency given below. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.	Yes	Emission point S1 will receive the combined effluent from the whole of Plant 5.1 (through the existing effluent storage tank system). The addition of Plant 5.1 will not require a change in the consent conditions for emission point S1 – currently contained within the Environmental Permit. Emission point S1 is to the CF Fertilisers sewer drainage system and thence the River Tees – out of the RTO1 discharge point from

	Substance	Standard	Minimum Monitoring Frequency
	Total Organic Carbon (TOC)[3]	EN 1484	Daily
	Chemical Oxygen Demand (COD)[3]	No EN Standard	
	Total Suspended Solids (TSS)	EN 872	
	Total Nitrogen (TN)[4]	EN 12260	
	Total Inorganic Nitrogen[4] (N_{inorg})	Various EN Standards	
	Total Phosphorus	Various EN Standards	

[3] TOC monitoring and COD monitoring are alternatives. TOC monitoring is the preferred option because it does not rely on the use of very toxic compounds.
[4] TN and N_{inorg} monitoring are alternatives

There are monitoring requirements also for adsorbable organically bound halogens (AOX), metals and direct toxicity, which have not been reproduced herein.

the Billingham Complex.

Effluent is discharged from two effluent storage tanks (TK001 and TK002) on a batch wise basis, after sampling. Effluent is not released unless it is compliant with the discharge conditions of both the Environmental Permit and also the discharge agreement conditions in place with CF Fertilisers (so as to protect the RTO1 discharge consent).

The following monitoring is undertaken for the Environmental Permit:

- COD is analysed using an agreed method with the Environment Agency - C&FC 100201.
- pH is monitored via a pH probe calibrated against standard buffer solution using an agreed method with the Environment Agency - C&FC 100134.
- Copper and Vanadium are monitored by inductively coupled Plasma Spectroscopy using an agreed method with the Environment Agency.

BAT 5	**Diffuse VOC's** BAT is to periodically monitor diffuse VOC emissions to air from relevant sources by using an appropriate combination of the techniques I-III or, where large amounts of VOC are handled, all of the techniques I-III. I. Sniffing methods (e.g. with portable instruments according to EN 15446) associated with correlation curves for key equipment; II. Optical gas imaging methods; II. Calculation of emissions based on emissions factors, periodically validated (e.g. once every two years) by measurements. Where large amounts of VOCs are handled, the screening and quantification of emissions from the installation by periodic campaigns with optical absorption-based techniques, such as Differential absorption light detection and ranging (DIAL) or Solar occultation flux (SOF), is a useful complementary technique to the techniques I to III.	Yes	The site has a leak detection and repair programme. Monitoring campaigns for fugitive VOC's are undertaken periodically and where appropriate corrective actions are implemented.
BAT 6	**Odour** BAT is to periodically monitor odour emissions from relevant sources in accordance with EN standards.	Yes	Any new processing being implemented on site will be introduced under the MPP and New Product Introduction procedures. The odour profile of new materials will be assessed within the MPP using odour threshold data, and a management plan will be implemented if deemed appropriate.
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.	Yes	The majority of the process waste waters generated onsite are disposed of through approved offsite waste disposal contractors. Effluent is minimised by reusing process washes, where possible. The processes are conducted in production campaigns and these will be extended for as long as possible to minimise reactor clean outs and the generation of wastes through product changeovers.
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.	Partial	There are separate effluent / process drains and storm water drains on the main site. Plant 5.1, owing to its location and size, has one drainage system which is sent to the main site effluent tanks (TK001 and TK002).
BAT 9	In order to prevent uncontrolled emissions to water, BAT is to provide an appropriate buffer storage capacity for waste water incurred during other than normal operating conditions based on a risk assessment (taking into account e.g. the nature of the pollutant, the effects on further treatment, and the receiving environment), and to take appropriate further measures (e.g. control, treat, reuse).	Yes	The site storm water drains, feeding into the CF Fertiliser sewer drainage system, is fitted with an emergency "flapstopper" isolation valve that can isolate the drains in the event of a loss of containment spill on site or in the event of a fire (to contain firewater).. Contaminated stormwater / firewater may then be transferred to the effluent storage tanks or to other containers/road tanker prior to offsite disposal.
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 given below. a — Process integrated techniques - prevent or reduce pollutants — Techniques to prevent or reduce the generation of water pollutants. b — Recovery of pollutants at source — Techniques to recover pollutants prior to their discharge to the waste water collection system. c — Waste water pre-treatment — Techniques to abate pollutants before the final waste water treatment. Pre-treatment can be carried out at the source or in combined streams.	Potential Future Requirement	As mentioned earlier, the effluent arisings at the site (including Plant 5.1) is essentially contaminated rainwater from falling on process areas and also, occasionally, the last steamings, from cleaning out of vessels following water washing. The above is manifest in the low mass emission limit of COD for the effluent discharge (emission point S1) of 450kg/day. **The CWW BREF does not currently apply at the site and is unlikely to apply until the Waste Gas BREF applies.** The site will need to consider wastewater pre-treatment and final wastewater treatment techniques to process this unusual effluent at source, in order to meet the BAT- AEL values to controlled waters, as specified within BAT 12 (later). At this stage the definition of wastewater treatment plant is not possible. If the Waste Gas BREF is in force by 2021, then an effluent treatment plant may be required by 2025. As an alternative to the installation of a wastewater treatment plant, a valid derogation from the requirement to meet BAT 12

	d	Final waste water treatment	Final waste water treatment by, for example, preliminary and primary treatment, biological treatment, nitrogen removal, phosphorus removal and/or final solids removal techniques before discharge to a receiving water body.	emission limits will need to be obtained from the regulator.
BAT 11	In order to reduce emissions to water, BAT is to pre-treat waste water that contains pollutants that cannot be dealt with adequately during final waste water treatment by using appropriate techniques.		Potential Future Requirement	See BAT 10
BAT 12	In order to reduce emissions to water, BAT is to use an appropriate combination of final waste water treatment techniques. Final waste water treatment is carried out as part of an integrated waste water management and treatment strategy (see BAT 10). Appropriate final waste water treatment techniques, depending on the pollutant, include:		Potential Future Requirement	See BAT 10. Any future wastewater treatment plant at the site will need to be compliant with the BAT-AEL values in Tables 1, 2 and 3 of BAT 12.

	Technique [1]	Typical Pollutants Abated	Applicability
Preliminary and primary treatment			
(a)	Equalisation	All pollutants	Generally applicable.
(b)	Neutralisation	Acids, alkalis	
(c)	Physical separation, e.g. screens, sieves, grit separators, grease separators or primary settlement tanks	Suspended solids, oil/grease	
Biological treatment (secondary treatment), e.g.			
(d)	Activated sludge process	Biodegradable organic compounds	Generally applicable
(e)	Membrane bioreactor		
Nitrogen removal			
(f)	Nitrification/denitrification	Total nitrogen, ammonia	Nitrification may not be applicable in case of high chloride concentrations (i.e. around 10 g/l) and provided that the reduction of the chloride concentration prior to nitrification would not be justified by the environmental benefits. Not applicable when the final treatment does not include a biological treatment.
Phosphorus removal			
(g)	Chemical precipitation	Phosphorus	Generally applicable.
Final solids removal			
(h)	Coagulation and flocculation	Suspended solids	Generally applicable.
(i)	Sedimentation		
(j)	Filtration (e.g. sand filtration, microfiltration, ultrafiltration)		
(k)	Flotation		

(1) The descriptions of the techniques are given in Section 6.1

The BAT-associated emission levels (BAT-AELs), for emissions to water given in Table 1, Table 2 and Table 3 apply to direct emissions to a receiving water body from:

(i) the activities specified in Section 4 of Annex I to Directive 2010/75/EU;
(ii) independently operated waste water treatment plants specified in Section 6.11 of Annex I to Directive 2010/75/EU provided that the main pollutant load originates from activities specified in Section 4 of Annex I to Directive 2010/75/EU;
(iii) The combined treatment of waste water from different origins provided that the main pollutant load originates from activities specified in Section 4 of Annex I to Directive 2010/75/EU. The BAT-AELs apply at the point where the emission leaves the installation.

Table 1 BAT-AELs for Direct Emissions of TOC, COD and TSS to a Receiving Water Body

Parameter	BAT-AEL's (Yearly Average)	Conditions
Total Organic Carbon (TOC)[1][2]	10-33 mg/l [3][4][5][6]	The BAT-AEL applies if the emission exceeds 3.3 Te/yr
Chemical Oxygen Demand (COD)[1][2]	30-100 mg/l[3][4][5][6]	The BAT-AEL applies if the emission exceeds 10Te/yr
Total Suspended Solids (TSS)	5-35 mg/l[7][8]	The BAT-AEL applies if the emission exceeds 3.5 Te/yr

(1) No BAT-AEL applies for BOD
(2) Either BAT-AEL for TOC or COD applies. TOC monitoring is the preferred option because it does not rely on the use of very toxic compounds.
(**3**) The lower end of the range is typically achieved when few tributary waste water streams contain organic compounds and/or the waste water mostly contains easily biodegradable organic compounds.
(4) The upper end of the range may be up to 100 mg/l for TOC or up to 300 mg/l for COD, both as yearly averages, if both of the following conditions are fulfilled:

- Condition A: Abatement efficiency ≥ 90 % as a yearly average (including both pre-treatment and final treatment).
- Condition B: If a biological treatment is used, at least one of the following criteria is met:
  - A low-loaded biological treatment step is used (i.e. ≤ 0,25 kg COD/kg of organic dry matter of sludge). This implies that the BOD5 level in the effluent is ≤ 20 mg/l.
  - Nitrification is used.

(5) The upper end of the range may not apply if all of the following conditions are fulfilled:

- Condition A: Abatement efficiency ≥ 95 % as a yearly average (including both pre-treatment and final treatment).
- Condition B: same as Condition B in footnote (4).
- Condition C: The influent to the final waste water treatment shows the following characteristics: TOC > 2 g/l (or COD > 6 g/l) as a yearly average and a high proportion of refractory organic compounds

(6) The upper end of the range may not apply when the main pollutant load originates from the production of methylcellulose.
(7) The lower end of the range is typically achieved when using filtration (e.g. sand filtration, microfiltration, ultrafiltration, membrane bioreactor), while the upper end of the range is typically achieved when using sedimentation only.
(8) This BAT-AEL may not apply when the main pollutant load originates from the production of soda ash via the Solvay process or from the production of titanium dioxide.

Table 2. BAT-AELs for Direct Emissions of Nutrients to a Receiving Water Body

Parameter	BAT-AEL's (Yearly Average)	Conditions
Total Nitrogen [1]	5-25 mg/l [2] [3]	The BAT-AEL applies if the emission exceeds 2.5 Te/yr
Total Inorganic Nitrogen [1]	5-20 mg/l [2] [3]	The BAT-AEL applies if the emission exceeds 2.0 Te/yr
Total Phosphorus	0.5-3.0 mg/l [4]	The BAT-AEL applies if the emission exceeds 300 kg/yr

(1) Either the BAT-AEL for total nitrogen or the BAT-AEL for total inorganic nitrogen applies.
(2) The BAT-AELs for TN and N_{inorg} do not apply to installations without biological waste water treatment. The lower end of the range is typically achieved when the influent to the biological waste water treatment plant contains low levels of nitrogen and/or when nitrification/denitrification can be operated under optimum conditions.
(3) The upper end of the range may be higher and up to 40 mg/l for TN or 35 mg/l for N_{inorg}, both as yearly averages, if the abatement efficiency is ≥ 70 % as a yearly average (including both pre-treatment and final treatment).
(4) The lower end of the range is typically achieved when phosphorus is added for the proper operation of the biological waste water treatment plant or when phosphorus mainly originates from heating or cooling systems. The upper end of the range is typically achieved when phosphorus-containing compounds are produced by the installation.

Table 3. BAT-AELs for Direct Emission of AOX and Metals to a Receiving Water Body

Parameter	BAT-AEL's (Yearly Average)	Conditions
Adsorbable organically bound halogens (AOX)	0.2-1.0 mg/l (1) (2)	The BAT-AEL applies if the emission exceeds 100 kg/yr
Chromium (expressed as Cr)	5-25 µg/l (3) (4) (5) (6)	The BAT-AEL applies if the emission exceeds 2.5 kg/yr
Copper (expressed as Cu)	5-50 µg/l (3) (4) (5) (7)	The BAT-AEL applies if the emission exceeds 5 kg/yr
Nickel (expressed as Ni)	5-50 µg/l (3) (4) (5)	The BAT-AEL applies if the emission exceeds 5 kg/yr
Zinc (expressed as Zn)	20-300 µg/l (3) (4) (5) (8)	The BAT-AEL applies if the emission exceeds 30 kg/yr

(1)The lower end of the range is typically achieved when few halogenated organic compounds are used or produced by the installation.
(2) This BAT-AEL may not apply when the main pollutant load originates from the production of iodinated X-ray contrast agents due to the high refractory loads. This BAT-AEL may also not apply when the main pollutant load originates from the production of propylene oxide or epichlorohydrin via the chlorohydrin process due to the high loads.
(3)The lower end of the range is typically achieved when few of the corresponding metal (compounds) are used or produced by the installation.
(4) This BAT-AEL may not apply to inorganic effluents when the main pollutant load originates from the production of inorganic heavy metal compounds.
(5) This BAT-AEL may not apply when the main pollutant load originates from the processing of large volumes of solid inorganic raw materials that are contaminated with metals (e.g. soda ash from the Solvay process, titanium dioxide).
(6) This BAT-AEL may not apply when the main pollutant load originates from the production of chromium-organic compounds.
(7) This BAT-AEL may not apply when the main pollutant load originates from the production of copper-organic compounds or the production of vinyl chloride monomer/ethylene dichloride via the oxychlorination process.
(8) This BAT-AEL may not apply when the main pollutant load originates from the production of viscose fibres.

BAT 13	**Waste** In order to prevent or, where this is not practicable, to reduce the quantity of waste being sent for disposal, BAT is to set up and implement a waste management plan as part of the environmental management system (see BAT 1) that, in order of priority, ensures that waste is prevented, prepared for reuse, recycled or otherwise recovered.			Yes	The quantities of waste materials are tracked and monitored as a specific KPI. The site's Resource Efficiency Team specifically monitors the relative quantities of waste generated from the site taking into account the waste hierarchy. Waste generation levels are considered as part of the New Product Introduction Process and MPP, so as to minimise generation and also to define a secure and sustainable disposal route.
BAT 14	In order to reduce the volume of wastewater sludge requiring further treatment or disposal, and to reduce its potential environmental impact, BAT is to use one or a combination of the techniques given below.			Not Applicable	Not Applicable - no on site wastewater treatment plant.
	Technique	**Description**	**Applicability**		
(a)	Conditioning	Chemical conditioning (i.e. adding coagulants and/or flocculants) or thermal conditioning (i.e. heating) to improve the conditions during sludge thickening/dewatering.	Not applicable to inorganic sludges. The necessity for conditioning depends on the sludge properties and on the thickening/dewatering equipment used.		
(b)	Thickening / dewatering	Thickening can be carried out by sedimentation, centrifugation, flotation, gravity belts, or rotary drums. Dewatering can be carried out by belt filter presses or plate filter presses.	Generally applicable.		
(c)	Stabilisation	Sludge stabilisation includes chemical treatment, thermal treatment, aerobic digestion, or anaerobic digestion.	Not applicable to inorganic sludges. Not applicable for short-term handling before final treatment.		
(d)	Drying	Sludge is dried by direct or indirect contact with a heat source.	Not applicable to cases where waste heat is not available or cannot be used.		
BAT 15	**Emissions to Air - Waste Gas Collection** In order to facilitate the recovery of compounds and the reduction of emissions to air, BAT is to enclose the emission sources and to treat the emissions, where possible.			Yes	Emissions to air are minimised via the use of aspirated rather than forced ventilation reactor and distillation column systems. Vent condensers have wet scrubbers for abatement.

BAT 16	**Emissions to Air - Waste Gas Treatment** In order to reduce emissions to air, BAT is to use an integrated waste gas management and treatment strategy that includes process-integrated and waste gas treatment techniques. (The integrated waste gas management and treatment strategy is based on the inventory of waste gas streams (see BAT 2) giving priority to process-integrated techniques)	Not Applicable	The emissions to air at the site are discrete local release points (A1 to A5) from aspirated vessels and not forced extraction. Forced extraction would be a pre-cursor of an integrated abatement system and would create a significant pollutant load to abate.
BAT 17	**Flaring** In order to prevent emissions to air from flares, BAT is to use flaring only for safety reasons or non-routine operational conditions (e.g. start-ups, shutdowns) by using one or both of the techniques given below	Not Applicable	Not Applicable - no flaring is undertaken on site.

Technique	Description	Applicability
(a) Correct plant design	This includes the provision of a gas recovery system with sufficient capacity and the use of high-integrity relief valves.	Generally applicable to new plants. Gas recovery systems may be retrofitted in existing plants.
(b) Plant management	This includes balancing the fuel gas system and using advanced process control.	Generally applicable.

BAT 18	**Flaring** In order to reduce emissions to air from flares when flaring is unavoidable, BAT is to use one or both of the techniques given below.	Not Applicable	Not Applicable - no flaring is undertaken on site.

Technique	Description	Applicability
(a) Correct design of flaring devices	Optimisation of height, pressure, assistance by steam, air or gas, type of flare tips (either enclosed or shielded), etc., aimed to enable smokeless and reliable operation and to ensure the efficient combustion of excess gases.	Applicable to new flares. In existing plants, applicability may be restricted due to e.g. maintenance time availability during the turnaround of the plant.
(b) Monitoring and recording as part of flare management	Continuous monitoring of the gas sent to flaring, measurements of gas flow and estimations of other parameters (e.g. composition, heat content, ratio of assistance, velocity, purge gas flow rate, pollutant emissions (e.g. NOX, CO, hydrocarbons, noise)). The recording of flaring events usually includes the estimated/measured flare gas composition, the estimated/measured flare gas quantity and the duration of operation. The recording allows for the quantification of emissions and the potential prevention of future flaring events.	Generally applicable.

BAT 19	Diffuse VOC's to Air In order to prevent or, where that is not practicable, to reduce diffuse VOC emissions to air, BAT is to use a combination of the techniques given below. The associated monitoring is in BAT 5.	Yes	The site undertakes a leak detection and repair programme. Should significant fugitive emissions be identified then corrective actions would be implemented. The site has an extensive Planned Preventative Maintenance (PPM) programme that would identify and repair/replace faulty items that lead to fugitive emissions. Site operators report observations on plant integrity for feeding into the maintenance program. Storage vessels may be routed to a temporary scrubber system (if identified by the MPP), when using more volatile raw materials. Techniques relating to plant design: (a) The plant use is optimised such that the number of emission sources are limited. Materials are ordered and stored only as required to limit the potential for fugitive emissions from storage. (b) Emissions of VOC's from the process are minimised by the use of condensers with the use of a scrubber on the final release from the process. (c) Plant 5.1 is a newly constructed plant and has been designed with the latest technology. The plant has many instrumented safety systems included in the design to prevent conditions on the plant releasing material to the environment, due to operating outside of optimum operating conditions (e.g. high vent condenser temperatures). (d) The site has an electronic planned preventative maintenance system. The site has a risk-based approach to maintenance with items that offer protection to health, safety and the environment given the highest priority. Techniques related to construction and commissioning: (e) All new processes introduced to the site have comprehensive procedures and batch sheets. Training on a new process is provided to all of the operations team involved in operation of the new process. (f) New plant is commissioned using water prior to any process operations being introduced to the plant fully. This allows equipment to be leak checked and safety systems to be checked without any risk to the environment.

Technique		Applicability
Techniques related to plant design		
(a)	Limit the number of potential emission sources	Applicability may be restricted in the case of existing plants due to operability requirements.
(b)	Maximise process-inherent containment features	
(c)	Select high-integrity equipment	
(d)	Facilitate maintenance activities by ensuring access to potentially leaky equipment	
Techniques related to plant/equipment construction, assembly and commissioning		
(e)	Ensure well-defined and comprehensive procedures for plant/equipment construction and assembly. This includes	Generally applicable.

	using designed gasket stress for flanged joint assembly			
(f)	Ensure robust plant/equipment commissioning and handover procedures in line with the design requirements			The site operates to a robust Management of Change (MoC) system to ensure that operational change is managed. Health safety and environmental management are key to the MoC system. The MoC considered how the plant is commissioned and handed over to production to minimise any risks.
	Techniques related to plant operation			Techniques related to plant operation:
(g)	Ensure good maintenance and timely replacement of equipment			(g) The site operates to a planned preventative maintenance system. Equipment that is critical to the environment is identified and given high priority in the maintenance system. Where appropriate, critical spares are maintained so that malfunctioning equipment can be changed out quickly if required.
(h)	Use a risk based leak detection and repair (LDAR) programme		Generally applicable.	(h) The site has a Leak Detection and Repair programme in place and equipment is periodically checked for fugitive releases of VOC's. Where issues are identified then corrective actions are given high priority.
(i)	As far is as it is reasonable, prevent diffuse VOC emissions, collect them at source, and treat them			(i) Fugitive releases of VOC's are managed and minimised as far as possible. Where possible, material transfers are via hard piped systems to prevent losses from portable containers and flexible hoses. If materials are particularly volatile then the storage tank can be vented via the wet scrubber.

BAT 20 **Odour Emissions** In order to prevent or, where that is not practicable, to reduce odour emissions, BAT is to set up, implement and regularly review an odour management plan, as part of the environmental management system (see BAT 1), that includes all of the following elements: (i) a protocol containing appropriate actions and timelines; (ii) a protocol for conducting odour monitoring; (iii) a protocol for response to identified odour incidents; and (iv) an odour prevention and reduction programme designed to identify the source(s); to measure/estimate odour exposure; to characterise the contributions of the sources; and to implement prevention and/or reduction measures.		Yes	Potential odour issues are considered within the MPP and the New Product Introduction process for new product, through consideration of odour thresholds and the H1 impact assessment process. Should a material new to the plant be potentially odorous then a management plan will be implemented. Potential offsite impacts would be assessed for potentially odorous materials and corrective measures or mitigation implemented as required.
BAT 21 **Odour** In order to prevent or, where that is not practicable, to reduce odour emissions from wastewater collection and treatment and from sludge treatment, BAT is to use one or a combination of the techniques given below.		Not Applicable	No effluent treatment plant on site.

Technique		Description	Applicability
(a)	Minimise residence times	Minimise the residence time of waste water and sludge in collection and storage systems, in particular under anaerobic conditions.	Applicability may be restricted in the case of existing collection and storage systems.
(b)	Chemical treatment	Use chemicals to destroy or to reduce the formation of odorous compounds (e.g. oxidation or precipitation of hydrogen sulphide).	Generally applicable.
(c)	Optimise aerobic treatment	This can include: (i) controlling the oxygen content; (ii) frequent maintenance of the aeration system; (iii) use of pure oxygen; (iv) removal of scum in tanks.	Generally applicable.
(d)	Enclosure	Cover or enclose facilities for collecting and treating waste water and sludge to collect the odorous waste gas for further treatment.	Generally applicable.
(e)	End-of-pipe treatment	This can include: (i) biological treatment; (ii) thermal oxidation.	Biological treatment is only applicable to compounds that are easily soluble in water and readily bio eliminable.

BAT 22 **Noise Emissions** 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; and (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.		Yes	An acoustic survey was undertaken on the site and concluded that there were no significant effects at noise sensitive receptors due to addition of Plant 5.1 operations.

BAT 23 **Noise Emissions**

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.

	Technique	Description	Applicability
(a)	Appropriate location of equipment and buildings	Increasing the distance between the emitter and the receiver and using buildings as noise screens.	For existing plants, the relocation of equipment may be restricted by a lack of space or excessive costs.
(b)	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.	Generally applicable.
(c)	Low-noise equipment	This includes low-noise compressors, pumps and flares.	Applicable only when the equipment is new or replaced.
(d)	Noise-control equipment	This includes: (i) noise-reducers; (ii) equipment insulation; (iii) enclosure of noisy equipment; (iv) soundproofing of buildings.	Applicability may be restricted due to space requirements (for existing plants), health, and safety issues.
(e)	Noise abatement	Inserting obstacles between emitters and receivers (e.g. protection walls, embankments and buildings).	Applicable only to existing plants; since the design of new plants should make this technique unnecessary. For existing plants, the insertion of obstacles may be restricted by a lack of space.

Yes

An acoustic survey was undertaken on the site and concluded that there were no significant effects at noise sensitive receptors due to addition of Plant 5.1 operations.

(a) The site is located in an industrial setting with few residential receptors.
(b) The operational measures specified as BAT 23 are undertaken.
(c) Low noise equipment is chosen wherever possible.
(d) The acoustic assessment did not identify the need for noise attenuation, beyond that currently within the design intent of the new Plant 5.1 equipment.
(e) The acoustic assessment did not identify the need for noise abatement between the plant and receptor.

3. Conclusions

A review of the new Plant 5.1 has been undertaken against applicable technical guidance; SOC EPR 4.02, CIRIA C736, the Waste Treatment BREF (Solvent Recovery elements) and the Common Waste Water BREF (CWW).

It can be concluded that the new plant is compliant with the SOC EPR 4.02 and the CIRIA C736 guidance.

The Waste Treatment BREF contains a few BAT conclusions that are applicable to solvent regeneration and the new Plant 5.1 is broadly compliant.

The CWW BREF does not yet apply to the site. It is likely to be applied simultaneously with the Waste Gas BREF (under development) at a later date.

A key consideration of the CWW BREF will be the application of a wastewater treatment facility to meet the BAT-AEL values of BAT 12, for emissions to controlled waters, of the BREF BAT Conclusions.