Environment Agency

Review of an Environmental Permit for an Installation subject to Chapter II of the Industrial Emissions Directive under the Environmental Permitting (England & Wales) Regulations 2016 (as amended)

Draft Decision document recording our decision-making process following review of a permit

The Permit number is: EPR/BR6996IC
The Operator is: Esso Petroleum Company Limited
The Installation is: Esso Refinery
This Variation Notice number is: EPR/BR6996IC/V007

Consultation commences on: 13 August 2018
Consultation ends on: 11 September 2018

What this document is about

Article 21(3) of the Industrial Emissions Directive (IED) requires the Environment Agency to review conditions in permits that it has issued and to ensure that the permit delivers compliance with relevant standards, within four years of the publication of updated decisions on BAT conclusions.

We have reviewed the permit for this installation against the revised BAT Conclusions for the refining of mineral oil and gas industry sector published on 28th October 2014. This is our decision document, which explains the reasoning for the consolidated variation notice that we are issuing.

It explains how we have reviewed and considered the techniques used by the Operator in the operation and control of the plant and activities of the installation. This review has been undertaken with reference to the decision made by the European Commission establishing best available techniques (BAT) conclusions ('BAT Conclusions') for the refining of mineral oil and gas as detailed in document reference IEDC-7-1. It is our record of our decision-making process and shows how we have taken into account all relevant factors in reaching our position. It also provides a justification for the inclusion of any specific conditions in the permit that are in addition to those included in our generic permit template.

As well as considering the review of the operating techniques used by the Operator for the operation of the plant and activities of the installation, the consolidated variation notice takes into account and brings together in a single document all previous variations that relate to the original permit issued. It also modernises the entire permit to reflect the conditions contained in our current generic permit template.

The introduction of new template conditions makes the Permit consistent with our current general approach and philosophy and with other permits issued to installations in this sector. Although the wording of some conditions has changed, while others have been removed because of the new regulatory approach, it does not reduce the level of environmental protection achieved by the Permit in any way. In this document we therefore address only our determination of substantive issues relating to the new BAT Conclusions.

This is our record of our decision-making process and shows how we have taken into account all relevant factors in reaching our position.

Throughout this document we will use a number of expressions. These are as referred to in the glossary and have the same meaning as described in “Schedule 6 Interpretation” of the Permit.

We try to explain our decision as accurately, comprehensively and plainly as possible. We would welcome any feedback as to how we might improve our decision documents in future. A lot of technical terms and acronyms are inevitable in a document of this nature: we provide a glossary of acronyms near the front of the document, for ease of reference.

How this document is structured

Glossary of acronyms used in this document

(Please note that this glossary is standard for our decision documents and therefore not all these acronyms are necessarily used in this document.)

BAT	Best Available Technique(s)
BAT-AEL	BAT Associated Emission Level
BAT C	BAT conclusion
BREF	Best available techniques reference document
CEM	Continuous emissions monitor
CHP	Combined heat and power
CV	Calorific value
CWW	Common Waste Water
DAA	Directly associated activity – Additional activities necessary to be carried out to allow the principal activity to be carried out
DD	Decision document
Derogation	from BAT AELs stated in BAT Conclusions under specific circumstances as detailed under Article 15(4) of IED where an assessment shows that the achievement of emission levels associated with the best available techniques as described in BAT conclusions would lead to disproportionately higher costs
Diffuse VOC emission	Non-channelled VOC emissions that are not released via specific emission points such as stacks. They can result from 'area' sources (e.g. tanks) or 'point' sources (e.g. pipe flanges)
EAL	Environmental assessment level
ELV	Emission limit value derived under BAT or an emission limit value set out in IED
EMS	Environmental Management System
EPR	Environmental Permitting (England and Wales) Regulations 2010 (SI 2010 No. 675) as amended
EQS	Environmental quality standard
EWC	European waste catalogue
FCC	Fluidised Catalytic Cracking
FGD	Flue Gas Desulphurisation
HMT GB	Her Majesty's Treasury The Green Book - Appraisal and Evaluation in Central Government
IED	Industrial Emissions Directive (2010/75/EU)
IED Guidance	Industrial Emissions Directive EPR Guidance on Part A installations – (Defra February 2013)
IPPCD	Integrated Pollution Prevention and Control Directive (2008/1/EC) – now superseded by IED
IEMT Protocol	Integrated Emissions Management Technique Protocol developed by UK Bref Working Group
LCP	Large Combustion Plant subject to Chapter III of IED
LCPD	Large Combustion Plant Directive (2001/80/EC) – now superseded by IED
MFF Protocol	IED Chapter III Protocol for Multi-fuel Firing Refinery Combustion Plants granted a Permit prior to 7th January 2013, version 5
MSUL/MSDL	Minimum start up load/minimum shut-down load
NOx	Oxides of nitrogen (NO plus NO_2 expressed as NO_2)
NMVOC	VOC excluding methane

NPV	Net Present Value
PAH	Polycyclic Aromatic Hydrocarbons
PC	Process Contribution
PEC	Predicted Environmental Concentration
PPS	Public participation statement
PR	Public register
RGS	Regulatory Guidance Series
SGN	Sector guidance note
TGN	Technical guidance note
TOC	Total Organic Carbon
WFD	Waste Framework Directive (2008/98/EC)
VOC	Volatile organic compounds as defined in Article 3(45) of Directive 2010/75/EU - ‘volatile organic compound’ means any organic compounds well as the fraction of creosote, having at 293,15 K a vapour pressure of 0,01 kPa or more, or having a corresponding volatility under the particular conditions of use;

1 Our decision

We have decided to issue the Consolidated Variation Notice to the Operator. This will allow it to continue to operate the Installation, subject to the conditions in the Consolidated Variation Notice.

As part of our decision we have decided to grant the Operator's request for a derogation from the requirements of BAT Conclusion(s) 12, 25 and 52 as identified in the refining of mineral oil and gas BAT Conclusions document. The way we assessed the Operator's requests for derogation and how we subsequently arrived at our conclusion is recorded in section 6 of this document.

We consider that, in reaching that decision, we have taken into account all relevant considerations and legal requirements and that the varied permit will ensure that a high level of protection is provided for the environment and human health.

The Consolidated Variation Notice contains many conditions taken from our standard Environmental Permit template including the relevant Annexes. We developed these conditions in consultation with industry, having regard to the legal requirements of the Environmental Permitting Regulations and other relevant legislation. This document does not therefore include an explanation for these standard conditions. Where they are included in the Notice, we have considered the techniques identified by the operator for the operation of their installation, and have accepted that the details are sufficient and satisfactory to make those standard conditions appropriate. This document does, however, provide an explanation of our use of "tailor-made" or installation-specific conditions, or where our Permit template provides two or more options.

2 How we reached our decision

2.1 Requesting information to demonstrate compliance with BAT Conclusions for the refining of mineral oil and gas.

We issued a Notice under Regulation 60(1) of the Environmental Permitting (England and Wales) Regulations 2010 (a Regulation 60 Notice) on 05/08/15 requiring the Operator to provide information to demonstrate how the operation of their installation currently meets, or will subsequently meet, the revised standards described in the relevant BAT Conclusions document. The Notice also required that where the revised standards are not currently met, the operator should provide information that:

- Describes the techniques that will be implemented before 28/10/18, which will then ensure that operations meet the revised standard, or
- Justifies why standards will not be met by 28/10/18, and confirmation of the date when the operation of those processes will cease within the installation or an explanation of why the revised BAT standard is not applicable to those processes, or
- Justifies why an alternative technique will achieve the same level of environmental protection equivalent to the revised standard described in the BAT Conclusions.

Where the Operator proposed that they were not intending to meet a BAT standard that also included a BAT Associated Emission Level (BAT AEL) described in the BAT Conclusions Document, the Regulation 60 Notice requested that the Operator make a formal request for derogation from compliance with that AEL (as provisioned by Article 15(4) of IED). In this circumstance, the Notice identified that any such request for derogation must be supported and justified by sufficient technical and commercial information that would enable us to determine acceptability of the derogation request.

The Regulation 60 Notice response from the Operator was received on 05/02/16.

We considered it was in the correct form and contained sufficient information for us to begin our determination of the permit review but not that it necessarily contained all the information we would need to complete that review. Further information was received during determination as summarised in the Status Log table included in the introductory note of the permit.

The Operator claimed that certain information was commercially confidential and should be withheld from the public register. We considered this request and agreed the information meets the criteria in Regulation 51(c) (i), (ii) and (iii):

(i) The information is commercial
(ii) Its confidentiality is provided by law to protect a legitimate economic interest, and
(iii) In all the circumstances, the public interest in maintaining the confidentiality of the information outweighs the public interest in including it on the register.

We agreed to withhold the following information:

- Detailed financial information relating to compliance including CBA tool for all derogations
- Some operational information (for example proprietary processes, unit configuration, detailed project schedules etc.) to protect the operational details from being released to competitors
- Information obtained from third parties as private and confidential under contract.

This assessment was completed before the derogation applications were fully assessed. We are minded to grant the derogations and must go to public consultation. We have therefore re-assessed all confidentiality claims and have concluded that the information remains commercially confidential and will continue to be withheld from the public register.

Apart from the issues and information just described, we have not received any information in relation to the Regulation 60 Notice response that appears to be confidential in relation to any party.

2.2 Review of our own information in respect to the capability of the installation to meet revised standards included in the BAT Conclusions document

Based on our records and previous regulatory activities with the facility we have no reason to consider that the operator will not be able to comply with the conditions that we include in the permit.

In relation to a number of BAT Conclusions we agree with the operator in respect to their current stated capability as recorded in their Regulation 60 Notice response that improvements are required.

We have therefore included improvement conditions in the Consolidated Variation Notice, which requires them to upgrade their operational techniques so that the requirements of the BAT Conclusions are delivered. This is discussed in more detail in Section 6 and Annex 3 of this document.

2.3 Summary of how we considered the responses from public consultation.

We consulted on our draft decision from 13 August 2018 to 11 September 2018. A summary of the consultation responses and how we have taken into account all relevant representations is shown in Annex 3. The responses to the consultation did not lead to any amendments to the draft permit on which we consulted.

3 The legal framework

The Consolidated Variation Notice will be issued, under Regulation 20 of the EPR. The Environmental Permitting regime is a legal vehicle which delivers most of the relevant legal requirements for activities falling within its scope. In particular, the regulated facility is:

- an *installation* as described by the IED;
- subject to aspects of other relevant legislation which also have to be addressed.

We consider that, the Consolidated Variation Notice will ensure that the operation of the Installation complies with all relevant legal requirements and that a high level of protection will be delivered for the environment and human health.

We explain how we have addressed specific statutory requirements more fully in the rest of this document.

In line with Defra IED Guidance, where the BAT AELs are expressed as a range, the ELV has been set on the basis of the top of the relevant BAT-AEL range (the highest associated emission level) unless compliance with a lower ELV has been demonstrated and has been retained to ensure no deterioration. The emission limits and monitoring tables have been incorporated into Schedule 3.

4 Overview of site and installation

Esso Petroleum Company, Limited (EPCo) is a UK based company, which is part of the ExxonMobil group of companies. The Fawley Refinery installation boundary includes the EPCo oil refinery, and the ExxonMobil Chemical Limited (EMCL) petrochemical plant. The Fawley Refinery installation is located in Fawley, Hampshire, approximately 7.5km south-east of Southampton. The installation covers an area of 1,300 hectares and the entire site is centred at National Grid Reference SU 455043.

The installation is bounded to the east and north-east by mudflats, saltmarsh and Southampton Water. To the west and south the site is bounded by Fawley Road, the A326 and Long Lane. Beyond Fawley Road to the south is Fawley Village and undeveloped marshland. The village of Holbury is located to the west. To the north the site is bounded by Cadland Road, beyond which are a number of industrial properties.

The first oil refinery was constructed at the site in 1921 and was subsequently expanded in 1951, with commissioning of refining and early petrochemical plants, to the area it occupies today. The refining and associated combustion activities have been authorised under IPC since 1992.

The primary activity authorised by this permit is under Section 1.2 A(1) (d); the refining of mineral oil. The oil refining section of the installation regulated under this permit, receives crude oil and other petroleum feedstocks, primarily by sea transport, which is then stored in bulk tanks before it is refined to form products such as liquefied petroleum gas (LPG), automotive and aviation fuels, distillates, lubricant oils, fuel oils and feed streams for the EMCL petrochemicals plants.

The generic processes operated at the refinery include separation (fractional distillation), reforming (changing molecular structure to increase the value of products), treating (to remove impurities) and upgrading (catalytic cracking of heavy material to increase production of more valuable products). The Fluidised Catalytic Cracking Unit (FCCU) was built as part of the original site in the early 1950s. The unit has been heavily modified at various times.

There are also a number of support activities including:

- boilers, gas turbines for steam and electricity generation including two Combined Heat and Power (CHP) Plants and furnaces for heating hydrocarbons. Eight of these combustion plant have a net rated thermal input >50 MW and therefore the requirements of the Large Combustion Plant Directive apply;
- cooling water systems;
- transfer of waste sludges for treatment and reuse;
- raw water treatment for steam raising;
- waste water treatment prior to release; and
- flare system.

The main environmental impacts associated with releases to air are from sulphur dioxide from the incomplete recovery of sulphur from the Sulphur Recovery Plant, from the burning off of sulphur from the catalytic cracker catalyst and from the combustion of fuel oil. The air quality management area (AQMA) declared by New Forest District Council in 2005, was revoked in 2013 due to reductions in the release of sulphur dioxide emissions to air from the permitted activities. Other releases to air include nitrogen dioxide and dust from combustion and catalytic cracking activities and fugitive volatile organic compounds. None of these releases are significant in terms of the ambient air quality.

Process, cooling and surface waters are discharged, following treatment, via three outfalls onto intertidal mudflats close to high water within the Solent and Southampton Water SPA. Other European Habitats designated sites that could be affected by releases from the installation include Solent Maritime SAC, River Itchen SAC, Portsmouth Harbour SPA/Ramsar and Chichester and Langstone Harbours. Clean and dirty waters are treated separately using oil separators, dual media filtration and dissolved air flotation.

The site has an Environmental Management System that is regularly audited externally and has been shown to meet the requirements of ISO 14001, although not certified to this standard.

5 Key Issues

The key issues arising during this permit review are:

- The review and assessment of the derogation applications from meeting BATs 12, 25 and 52
- Fugitive VOC emissions - to monitor and minimise in line with BATs 6, 18 and 49
- Flaring - to minimise in line with BATs 55 and 56
- BAT Conclusions 57 and 58 to use an integrated emissions management technique for oxides of nitrogen (NO_X) and sulphur dioxide (SO_2) emissions.

We therefore describe how we determined these issues in most detail in the relevant sections of this document.

6 Decision checklist regarding relevant BAT Conclusions

BAT Conclusions for the refining of mineral oil and gas, were published by the European Commission on 28th October 2014. There are 58 BAT Conclusions.

This annex provides a record of decisions made in relation to each relevant BAT Conclusion applicable to the installation. This annex should be read in conjunction with the Consolidated Variation Notice.

The overall status of compliance with the BAT conclusion is indicated in the table as:

NA	Not Applicable
CC	Currently Compliant
FC	Compliant in the future (within 4 years of publication of BAT conclusions)
NC	Not Compliant
PC	Partially Compliant

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
General				
1	**In order to improve the overall environmental performance of the plants for the refining of mineral oil and gas, BAT is to implement and adhere to an environmental management system (EMS) that incorporates all of the following features:** i. commitment of the management, including senior management; ii. definition of 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 (a) Structure and responsibility (b) Training (c) Communication (d) Employee involvement (e) Documentation (f) Efficient process control (g) Maintenance programmes (h) Emergency preparedness and response (i) Safeguarding compliance with environmental legislation v. checking performance and taking corrective action, paying particular attention to: (a) monitoring and measurement (see also the Reference Document on the General Principles of Monitoring) (b) corrective and preventive action (c) maintenance of records (d) independent (where practicable) internal and external auditing in order to determine whether or not the EMS conforms to planned arrangements and has been properly implemented and maintained; vi. review of the EMS and its continuing suitability, adequacy and effectiveness by senior management; vii. following the development of cleaner technologies; viii. consideration for the environmental impacts from the eventual decommissioning of the installation at the stage of designing a new plant, and throughout its operating life;	CC	The operator has confirmed that the features specified by the BAT Conclusion are incorporated into the site Operations Integrity Management System (OIMS). OIMS is an ExxonMobil global system and whilst not externally certified, it is structured to meet the intent of ISO 14001. The system is subject to an internal audit programme and externally audited periodically. We agree with the Operator's stated compliance status of CC.	1.1.1

<table>
<tr><th>BAT Conclusion Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th><th>Relevant permit condition(s)</th></tr>
<tr><td></td><td>viii. consideration for the environmental impacts from the eventual decommissioning of the installation at the stage of designing a new plant, and throughout its operating life;
ix. application of sectoral benchmarking on a regular basis.

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.</td><td></td><td></td><td></td></tr>
<tr><td>2</td><td>In order to use energy efficiently, BAT is to use an appropriate combination of the techniques given below.

<table>
<tr><th colspan="2">Technique</th><th>Description</th></tr>
<tr><td>i.</td><td colspan="2">Design techniques</td></tr>
<tr><td>a.</td><td>Pinch analysis</td><td>Methodology based on a systematic calculation of thermodynamic targets for minimising energy consumption of processes. Used as a tool for the evaluation of total systems designs</td></tr>
<tr><td>b.</td><td>Heat integration</td><td>Heat integration of process systems ensures that a substantial proportion of the heat required in various processes is provided by exchanging heat between streams to be heated and streams to be cooled</td></tr>
<tr><td>c.</td><td>Heat and power recovery</td><td>Use of energy recovery devices e.g.
• waste heat boilers
• expanders/power recovery in the FCC unit
• use of waste heat in district heating</td></tr>
<tr><td>ii.</td><td colspan="2">Process control and maintenance techniques</td></tr>
<tr><td>a.</td><td>Process optimisation</td><td>Process optimisation. Automated controlled combustion in order to lower the fuel consumption per tonne of feed processed, often combined with heat integration for improving furnace efficiency</td></tr>
<tr><td>b.</td><td>Management and reduction of steam consumption</td><td>Management and reduction of steam consumption. Systematic mapping of drain valve systems in order to reduce steam consumption and optimise its use</td></tr>
</table></td><td>CC</td><td>The operator has confirmed that a range of energy efficiency techniques are applied.

Pinch analysis is applied to regular process data reviews and to specific areas identified from benchmarking.

Several examples of heat integration are in place, including the use of recovered heat from distillation units to preheat crude and to minimises losses to atmosphere.

Waste heat boilers are installed and a number of buildings are heated with steam produced on site. Air/fuel set points are used and monitored on a daily basis to ensure process optimisation, as well as a programme of testing for minimum excess air.

A dedicated database allows operators to report steam leaks. The database is reviewed regularly by The Steam Team who have responsibility for repairing leaks across the site. Focussed studies are carried out to identify opportunities to reduce steam usage. The steam system is optimised daily.

Global benchmarking analysis is carried out every 2 years. Results are used to identify energy saving opportunities. Internal benchmarking is carried out</td><td>1.2.1</td></tr>
</table>

<table>
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<tr><td></td><td><table>
<tr><td>c. Use of energy benchmarking</td><td>Use of energy benchmark. Participation in ranking and benchmarking activities in order to achieve continuous improvement by learning from best practice</td></tr>
<tr><td colspan="2">iii. Energy efficient production techniques and description</td></tr>
<tr><td>a. Use of combined heat and power.</td><td>System designed for the co-production (or the cogeneration) of heat (e.g. steam) and electric power from the same fuel</td></tr>
<tr><td>b. Integrated gasification combined cycle (IGCC).</td><td>Technique whose purpose is to produce steam, hydrogen (optional) and electric power from a variety of fuel types (e.g. heavy fuel oil or coke) with a high conversion efficiency</td></tr>
</table></td><td></td><td>monthly at business unit level and stewarded by the management team. This forms part of the Global Energy Management System designed to drive continuous improvement.

We agree with the Operator’s stated compliance status of CC.</td><td></td></tr>
<tr><td>3</td><td>In order to prevent or, where that is not practicable, to reduce dust emissions from the storage and handling of dusty materials, BAT is to use one or a combination of the techniques given below:
i. store bulk powder materials in enclosed silos equipped with a dust abatement system (e.g. fabric filter);
ii. store fine materials in enclosed containers or sealed bags;
iii. keep stockpiles of coarse dusty material wetted, stabilise the surface with crusting agents, or store under cover in stockpiles;
iv. use road cleaning vehicles</td><td>CC</td><td>The operator has confirmed that all techniques are employed.
Powders are stored in bulk silos and fine materials in sealed containers. FCCU cyclone fines are loaded into tanker for removal off site; there is no venting to atmosphere during tanker loading. Spent catalyst is kept wetted pending removal from site.

We agree with the Operator’s stated compliance status of CC.</td><td>3.2.1</td></tr>
<tr><td>4</td><td>BAT is to monitor emissions to air by using the monitoring techniques with at least the minimum frequency given below and in accordance with EN standards. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.

<table>
<tr><th>Description</th><th>Unit</th><th>Minimum frequency</th><th>Monitoring technique</th></tr>
<tr><td rowspan="2">SO_X, NO_X and dust emissions</td><td>Catalytic cracking</td><td>continuous</td><td>Direct measurement</td></tr>
<tr><td>Combustion units ≥ 100MW ([3])</td><td>continuous</td><td>Direct measurement ([4])</td></tr>
</table></td><td>CC/FC</td><td><u>FCCU and combustion units > 100MW</u>
Emissions of SO_X, NO_X, dust and CO are measured directly by continuous emissions monitors at the FCCU (emission point A22) and combustion units <u>></u> 100MW: emissions points A1 (SP4 Units 1 and 2), A2 (PS/V3), A5 (PH2), A16 (Unit 3 GTG) and A29 (Unit 5 Cogen).

In accordance with the MFF Protocol, where it can be demonstrated that emissions from gas fired plant are consistently less than 5mg/Nm^3, we consider periodic monitoring for dust on combustion plant >100MW is satisfactory. We have reviewed monitoring data and</td><td>3.5.1 and Table 3.1a</td></tr>
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<tr><td></td><td>
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<tr><td></td><td>and calcining units</td><td></td><td></td></tr>
<tr><td></td><td>Combustion units of 50 to 100 MW (3)</td><td>continuous</td><td>Direct measurement or indirect monitoring</td></tr>
<tr><td></td><td>Combustion units < 50 MW (3)</td><td>once a year and after significant fuel changes</td><td>Direct measurement or indirect monitoring</td></tr>
<tr><td></td><td>Sulphur recovery units (SRU)</td><td>continuous for SO2 only</td><td>Direct measurement or indirect monitoring (6)</td></tr>
<tr><td>NH_3 emissions</td><td>All units equipped with SCR or SNCR</td><td>continuous</td><td>Direct measurement</td></tr>
<tr><td>CO emissions</td><td>Catalytic Cracking and combustion units >= 100MW (3)</td><td>continuous</td><td>Direct measurement</td></tr>
<tr><td></td><td>Other combustion units</td><td>once every 6 months (5)</td><td>Direct measurement</td></tr>
<tr><td>Metal emissions: Nickel (Ni) Antimony (Sb) Vanadium (V)</td><td>Catalytic cracking
Combustion units (8)</td><td>once every 6 months and after significant changes to the unit (5)</td><td>Direct measurement or analysis based on metals content in the catalyst fines and in the fuel</td></tr>
<tr><td>Polychlorinated dibenzodioxins / furans</td><td>Catalytic reformer</td><td>once a year or once a regeneration,</td><td>Direct measurement</td></tr>
</table>
</td><td></td><td>are satisfied that this is met for dust emissions from points: A2, and A5. Exceedences are required to be notified to us in accordance with permit requirements.

Combustion units 50 – 100MW
It has been demonstrated that there is no correlation between NO_X emissions and fuel use. We have therefore reviewed periodic monitoring data for emission points A3 (LCP 147 - PH1), A7 (LCP 145 - ENSR) and A8 (LCP 150 - PS/V1) and have concluded the results show little variation across the period 2012 to 2017. We have agreed therefore that 6 monthly periodic monitoring for NO_X is adequate.

With regard to SO_2 the operator has shown that the results from indirect monitoring methods (calculated from continuous flow rate data and monthly fuel composition sample results) show little variation when compared with the latest measured periodic sampling result. We have therefore agreed that for emission points A3 (LCP 147 - PH1), A7 (LCP 145 - ENSR) and A8 (LCP 150 - PS/V1) 6 monthly periodic monitoring for SO_X is adequate.

CO and dust are measured twice per year; all relevant furnaces fire gaseous fuel only.

Combustion units > 20 < 50MW
NO_X, CO and SO_X are measured twice per year for all combustion units < 50MW - emission points A4 (PH1-F4), A9 (PV2), A10 (HD5/6/7), A11 (ISOM), A12 (LESR), A13 (HD3), A14 (HD4), A15 (RESID), A20 (WISR), A21 (SCAN) and A28 (HD8).
It is not possible to measure dust on these units due to platform restrictions. There is no BAT-AEL for dust for gas-only fired plant, therefore for these units, in line with our position of only requiring monitoring where there is an AEL, we do not require dust</td><td></td></tr>
</table>

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
	(PCDD/F) emissions | | whichever is longer | (1) Continuous measurement of SO2 emissions may be replaced by calculations based on measurements of the sulphur content of the fuel or the feed; where it can be demonstrated that this leads to an equivalent level of accuracy (2) Regarding SO_X, only SO_2 is continuously measured while SO_3 is only periodically measured (e.g. during calibration of the SO_2 monitoring system) (3) Refers to the total rated thermal input of all combustion units connected to the stack where emissions occur. (4) Or indirect monitoring of SO_X (5) Monitoring frequencies may be adapted if, after a period of one year, the data series clearly demonstrate a sufficient stability. (6) SO_2 emissions measurements from SRU may be replaced by continuous material balance or other relevant process parameter monitoring, provided appropriate measurements of SRU efficiency are based on periodic (e.g. once every 2 years) plant performance tests. (7) Antimony (Sb) is monitored only in catalytic cracking units when Sb injection is used in the process (e.g. for metals passivation) (8) With the exception of combustion units firing only gaseous fuel		monitoring to be carried out. If this changes in the future and an AEL is introduced, the appropriate monitoring would also be required. <u>Sulphur recovery units</u> SO_2 emissions from the Sulphur Units are measured directly by continuous emissions monitors. <u>Metal emissions</u> Metals content in catalyst fines (Ni, Sb and V) and liquid fuel (Ni, V) from the FCCU (emission point A22) and emission point A1 (SP4 fired on a mixture of gaseous and liquid fuels) respectively is not currently monitored. These parameters will be added to the existing monitoring programme to meet the requirements of the BAT Conclusion and this has been included in Table 3.1a. <u>Polychlorinated dibenzodioxins/ furans</u> PCDD/F are not currently measured but will be included within test regimes on PH1 and PH2 to meet the requirements of the BAT Conclusion. Monitoring requirements have been added to emission points A3 and A5 in Table S3.1a to ensure this requirement is met. We agree with the Operator's stated compliance status of CC and FC in respect of metals and PCDD/F monitoring.	
5	**BAT is to monitor the relevant process parameters linked to pollutant emissions, at catalytic cracking and combustion units by using appropriate techniques and with at least the frequency given below.** **Description | Minimum frequency**	PC	Testing of fuel into all furnaces for N and S is carried out at least monthly. In addition, emissions from the FCCU and combustion units >100 MW are measured continuously. All furnaces measure oxygen continuously with the exception of the WISR unit (emission point A20). This unit is <5 MW and represents around 0.2% of total site emissions of SO_2	3.5.1 and Tables 3.1a and 3.1b

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
	Monitoring of parameters linked to pollution emissions, e.g. O_2 content in flue-gas, N and S content in fuel or feed (1) — Continuous for O_2 content. For N and S content, periodic at a frequency based on significant fuel/feed changes. (1) N and S monitoring in fuel or feed may not be necessary when continuous emission measurement of NO_X and SO_2 are carried out at the stack.		and NO_X. Given the size of this unit, we are not requiring continuous oxygen monitoring to be installed. We agree with the Operator's stated compliance status of PC.	
6	**BAT is to monitor diffuse VOC emissions to air from the entire site by using all of the following techniques:** i. sniffing methods associated with correlation curves for key equipment; ii. optical gas imaging techniques; iii. calculations of chronic emissions based on emissions factors periodically (e.g. once every two years) validated by measurements. The screening and quantification of site emissions by periodic campaigns with optical absorption-based-techniques, such as differential absorption light detection and ranging (DIAL) or solar occultation flux (SOF) is a useful complementary technique. **Description**. See section 1.20.6, Annex 1.	PC	Site-wide Leak Detection and Repair (LDAR) surveys are completed periodically using optical gas imaging. Where possible, leaks are repaired at the time of identification. Where this is not possible, repairs are incorporated within the planned maintenance programme. Sniffing methods are not currently used. Emissions are calculated annually, using Energy Industry factors. In order to ensure that BAT is applied, Improvement Condition 39 has been included. This requires the Operator to develop a VOC monitoring plan, taking into account the appropriate techniques for monitoring set out in the BAT conclusions and provide justification for the techniques selected. See also comments under BAT 18 and 49. We agree with the Operator's stated compliance status of PC.	3.2.1, 4.2.2 and IC39
7	**In order to prevent or reduce emissions to air, BAT is to operate the acid gas removal units, sulphur recovery units and all other waste gas treatment systems with a high availability and at optimal capacity.** Special procedures can be defined for other than normal operating conditions, in particular: i. During start-up and shutdown operations.	CC	Acid gas removal (MEA scrubbers) and sulphur recovery units are operated at high availability. Capacity will vary according to operational conditions. Some redundancy is built into the sulphur recovery units to provide contingency in the case of individual unit upset or trip. In normal operation, the two units are running within the safe operating window, with the load shared across both units. Procedures are in place:	2.3.1 and 2.3.7

<table>
<tr><th>BAT Conclusion Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th><th>Relevant permit condition(s)</th></tr>
<tr><td></td><td>ii. during other circumstances that could affect the proper functioning of the systems (e.g. regular and extraordinary maintenance work and cleaning operations of the units and/or of the waste gas treatment system);
iii. in case of insufficient waste gas flow or temperature which prevents the use of the waste gas treatment system at full capacity.</td><td></td><td>• For start-up and shutdown of the units
• To cover transient operations that impact sulphur balance
• For special operations such as wash procedures

For unusual operations, specific procedures are developed via the Management of Change process.

We agree with the Operator’s stated compliance status of CC.</td><td></td></tr>
<tr><td>8</td><td>In order to prevent and reduce ammonia (NH_3) emissions to air when applying selective catalytic reduction (SCR) or selective non-catalytic reduction (SNCR) techniques, BAT is to maintain suitable operating conditions of the SCR or SNCR waste gas treatment systems, with the aim of limiting emissions of unreacted NH_3.

Table 2 BAT- associated emission levels for ammonia (NH_3) emissions to air for a combustion process unit where SCR or SNCR techniques are used.

<table>
<tr><th>Parameter</th><th>BAT-AEL (monthly average mg/m^3)</th></tr>
<tr><td>Ammonia expressed as NH_3</td><td><5 - 15mg/Nm^3 (1) (2)</td></tr>
<tr><td colspan="2">(1) the higher end of the range is associated with higher inlet NO_X concentrations, higher NO_X reduction rates and the ageing of the catalyst
(2) The lower end of the range is associated with the use of the SCR technique.</td></tr>
</table></td><td>N/A</td><td>The operator has confirmed that SCR and SNCR is not operated on the installation.

We agree this BAT Conclusion is not applicable to the installation.</td><td>N/A</td></tr>
<tr><td>9</td><td>In order to prevent and reduce emissions to air when using a sour water steam stripping unit, BAT is to route the acid off-gases from this unit to an SRU or any equivalent gas treatment system.

It is not BAT to directly incinerate the untreated sour water stripping gases.</td><td>CC</td><td>During normal operation sour water stripper gas is routed to the Sulphur Recovery units.

We agree with the Operator’s stated compliance status of CC.</td><td>2.3.1 and 2.3.8</td></tr>
</table>

<table>
<tr><th>BAT Conclusion Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th><th>Relevant permit condition(s)</th></tr>
<tr><td>10</td><td>BAT is to monitor emissions to water by using the monitoring techniques with at least the frequency given in Table 3 (as below) and in accordance with EN standards. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.

Table 3 BAT – associated emission levels for direct waste water discharges from the refining of mineral oil and gas monitoring frequencies associated with BAT ([1])

<table>
<tr><th>Parameter</th><th>Unit</th><th>BAT – AEL (yearly average)</th><th>Monitoring ([2]) frequency and analytical method (standard)</th></tr>
<tr><td>Hydrocarbon oil index (HOI)</td><td>mg/l</td><td>0.1 – 2.5</td><td>Daily
EN 9377-2</td></tr>
<tr><td>Total suspended solids (TSS)</td><td>mg/l</td><td>5 - 25</td><td>Daily</td></tr>
<tr><td>Chemical oxygen demand (COD) (4)</td><td>mg/l</td><td>30 - 125</td><td>Daily</td></tr>
<tr><td>BOD 5</td><td>mg/l</td><td>No BAT - AEL</td><td>Weekly</td></tr>
<tr><td>Total nitrogen (5) expressed as N</td><td>mg/l</td><td>1 – 25 (6)</td><td>Daily</td></tr>
<tr><td>Lead, expressed as Pb</td><td>mg/l</td><td>0.005 – 0.030</td><td>Quarterly</td></tr>
<tr><td>Cadmium expressed as Cd</td><td>mg/l</td><td>0.002 – 0.008</td><td>Quarterly</td></tr>
<tr><td>Nickel, expressed as Ni</td><td>mg/l</td><td>0.005 – 0.100</td><td>Quarterly</td></tr>
<tr><td>Mercury, expressed as Hg</td><td>mg/l</td><td>0.0001 – 0.001</td><td>Quarterly</td></tr>
<tr><td>Vanadium</td><td>mg/l</td><td>No BAT - AEL</td><td>Quarterly</td></tr>
<tr><td>Phenol index</td><td>mg/l</td><td>No BAT - AEL</td><td>Monthly
EN 14402</td></tr>
</table>
</td><td>FC</td><td>In order to meet the requirements of the BAT Conclusion, existing sampling and laboratory monitoring equipment will be replaced where required prior to October 2018.

The Bref requires some changes to the parameters sampled (and associated sampling methods) as summarised below.

<table>
<tr><th>Current parameter</th><th>Bref parameter</th></tr>
<tr><td>Oil in Water</td><td>Hydrocarbon Oil Index</td></tr>
<tr><td>Ammoniacal Nitrogen</td><td>Total Nitrogen</td></tr>
<tr><td>VOC (24 hour composite)</td><td>Benzene (spot)</td></tr>
</table>

Due to these changes, limited data using the new methods are available. Therefore, an accurate assessment of compliance with the BAT-AEL cannot currently be made. In order to obtain sufficient quality assurance of the level of compliance under the new test methods, we have agreed that a period of parallel monitoring, using both the current and Bref test methods, can be undertaken for these parameters (see Regulatory Position Statement BR6996IC/30/07/2018). During this period, compliance will be assessed against the Bref BAT-AEL using the current method. Upon completion of this period of monitoring, the Bref test method will be adopted and sufficient data will be available to determine the level of compliance with the BAT-AEL. The results will be used to determine a corresponding daily limit for hydrocarbon oil index and total nitrogen in line with paragraph 3b of the RPS. Details are included in the footnotes to Table S3.2.

There is currently no requirement to monitor benzene however, samples are collected for Pollution Inventory reporting. The Bref requires 24-hour composite</td><td>3.5.1
IC46</td></tr>
</table>

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
	<table><tr><td>Benzene, toluene, ethyl benzene, xylene (BTEX)</td><td>mg/l</td><td>Benzene 0.001 – 0.050 No BAT – AEL for T, E, X</td><td>Monthly</td></tr><tr><td colspan="4">(1) Not all parameters and sampling frequencies are applicable to effluent from gas refining sites (2) Refers to a flow-proportional composite sample taken over period of 24 hours, or provided that sufficient flow stability is demonstrated, a time-proportional sample (3) Moving from the current method to EN 9377-2 may require an adaptation period (4) Where on-site correlation is available, COD may be replaced by TOC. The correlation between COD and Total Organic Compounds (TOC) should be elaborated on a case-by-case basis. TOC monitoring would be the preferred option because it does not rely on the use of very toxic compounds (5) Where total-nitrogen is the sum of the total Kjedahl nitrogen (TKN), nitrates and nitrites (6) When nitrification/denitrification is used, levels below 15 mg/l can be achieved</td></tr></table>		sampling for benzene on a monthly basis. We have reviewed the sampling methodology and because it is not technically feasible to analyse this parameter from a composite sample as VOCs will degas whilst sitting in the sample vessel over time, we have agreed spot sampling is appropriate and the relevant method included in Table S4.2. The Bref requires phenol index monitoring which is not currently tested. A BAT-AEL is not set for this parameter and therefore does not require the parallel monitoring provision set out in the RPS although the test method differs from the current one. Sulphide is currently monitored at all outfalls and assessed against the relevant emission limit value. This requirement was included in the permit to determine whether this substance was an issue in terms of concentration levels. The results have consistently shown compliance with the ELVs at all outfalls since permit issue. In view of this, we have concluded that monitoring of sulphide is no longer required. Monitoring of this parameter is not required by the BAT Conclusion. Arsenic and cyanides are currently monitored at all Outfalls, but no ELV is set. Having reviewed monitoring returns, we have concluded that monitoring of these parameters is no longer required because measured levels have been consistently low since permit issue. Monitoring of these parameters is not required by the BAT Conclusion. Chromium is currently monitored at all outfalls and assessed against the relevant emission limit value. There have been four apparent non-compliances reported to us in the last 5 years but the results were contributed to spurious results or due to elevated	

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
			levels in the incoming salt water cooling water and therefore not treated as non-compliances. In view of this we have concluded that monitoring of chromium is no longer required at outfalls 1 and 3. Monitoring of this parameter is not required by the BAT Conclusions. However, the requirement to monitor at outfall 2 will be retained because this is required under the CWW Bref. The ELV has been retained to ensure no deterioration. Although not included in Table 3 of the Bref BAT Conclusions, monitoring of copper and zinc is currently carried out at all outfalls. There have been occasional exceedences of permit limits for these parameters. In order to ensure no backsliding the ELVs and monitoring requirements for these parameters will be retained in the permit. We have agreed the monitoring frequency for these parameters can be amended from monthly to quarterly in line with the Bref requirements. Vanadium is not currently monitored; this parameter will be included for testing at outfall 1 from October 2018. It is only required at outfall 1 because it is related to the operation of the FCCU and effluent associated with this activity is discharged via outfall 1. Table S3.2 has been amended to clarify that the temperature limit applies on an hourly basis. Footnote (4) to table 3 of the BAT Conclusion makes provision to replace COD with TOC, where a correlation can be demonstrated. A programme of COD/TOC testing has been carried out and the results provided. The results show an average measured COD of 10.4 ppm and TOC of 3.96 ppm. This gives a ratio of COD:TOC of 2.7. We have reviewed this against information in the Common Waste Water Bref	

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
			which makes reference to a factor of 3 when applying the COD/TOC range. The results from the site monitoring are broadly consistent with this. We have therefore agreed that TOC may be used as a surrogate for COD using a ratio of 3:1. This is noted in the footnotes to Table S3.2. A large proportion of cooling water is provided by once through sea water. Incoming seawater is sampled monthly to determine the incoming levels for Oil In Water, Total Suspended Solids (TSS) and TOC as well as some metals. We have reviewed measured incoming data for the period January 2013 to August 2015. The results show that incoming levels can be highly variable, with the most significant seen in TSS. We have agreed that monthly monitoring should continue because there is no benefit in increasing the frequency given the variability of the data. The annual average value, calculated across the data set, will be taken to apply a net figure to the monitored results at the outfalls. This is included in the footnotes to Table S3.2. In the cases of metals we concluded that there is no benefit in applying the factor given the very low levels monitored in the incoming sea water. We have determined that monitoring of BOD is not required. Monitoring of COD is required and this is considered to provide sufficient control on effluent quality. In addition to implementing the annual average BAT-AELs for all parameters except BOD, existing daily, monthly and quarterly limits will be retained in the permit to ensure there is no deterioration, unless justification for their removal has been demonstrated (see comments above).	

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
			On site, process and clean waste water streams are combined following treatment and discharged together at the outfalls. Because the BAT-AEL applies only to the process waste water, the operator has provided a breakdown of clean and process flow rates for each outfall so that this can be applied to the values measured at the outfall so BAT-AEL applies only to the proportion of process water in the overall discharge. A factor will be applied to each BAT-AEL to take this into account and this is included in the footnotes to Table S3.2. Given the low measured levels, issues encountered with applying factors to low values, and that sources may also be from clean effluent streams (through heat exchangers for example) we have agreed this should not be applied to metal parameters. Where appropriate, the requirements of the CWW Bref have been considered for Outfall 2. We have included IC46 which requires the operator to monitor Adsorbable organically bound halogens (AOX) at outfall2. Although this is not a requirement of the Bref, the CWW Bref sets a BAT-AEL if the emission exceeds 100 kg/yr. This parameter is not currently monitored so emission levels are unknown. The IC requires the operator to submit a monitoring plan for approval so the emission levels can be assessed and the BAT-AEL be applied in future if required. This is only relevant to outfall 2 as it relates to emissions from activities carried out on the integrated chemicals plant. Outfall 3 comprises clean surface water runoff from the refinery as well as segregated process effluent from a third party operator (Nalco) that operates under Environmental Permit PP3432HA within the refinery installation boundary. Permit PP3432HA includes a requirement to monitor effluent quality from a hold-up tank before it is transferred into the refinery effluent	

<table>
<tr><th>BAT Conclusion Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th><th>Relevant permit condition(s)</th></tr>
<tr><td></td><td></td><td></td><td>system. As the refinery proportion of the discharge consists only of surface water runoff, the BAT-AELs do not apply. The existing ELVs have been retained to ensure no deterioration. In line with Outfalls 1 and 2, we no longer require the monitoring of sulphides, arsenic and cyanides and Table S3.2 has been updated accordingly.

We agree with the Operator’s stated compliance status of FC.</td><td></td></tr>
<tr><td>11</td><td>In order to reduce water consumption and the volume of contaminated water, BAT is to use all of the techniques given below.

<table>
<tr><th>Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>i. water stream integration</td><td>Reduction of process water produced at the unit level prior to discharge by the internal reuse of water streams from e.g. cooling, condensates, especially for use in crude desalting</td><td>Generally applicable for new units. For existing units, applicability may require a complete rebuilding of the unit or the installation</td></tr>
<tr><td>ii. water and drainage system for segregation of contaminated water streams</td><td>Design of an industrial site to optimise water management, where each stream is treated as appropriate, by e.g. routing generated sour water (from distillation, cracking, coking units, etc.) to appropriate pre-treatment, such as a stripping unit</td><td>Generally applicable for new units. For existing units, applicability may require a complete rebuilding of the unit or the installation</td></tr>
<tr><td>iii. segregation of non-contaminated water streams (e.g. once-through</td><td>Design of a site in order to avoid sending non-contaminated water to general waste water treatment and to have a separate release after</td><td>Generally applicable for new units. For existing units, applicability may require a complete</td></tr>
</table></td><td>CC</td><td>The operator has confirmed all techniques are used. Process and cooling water is segregated for treatment before discharge.

Whilst the majority of cooling water is provided from a once through system, a number of newer units have closed cooling water systems and water is recycled for re-use in some cases.

Crude desalter water is sourced from sour water streams/effluent to minimise freshwater usage. Crude desalter effluent is treated for oil removal prior discharge into the site sewer.

Clean and process streams remain segregated until after treatment in the separators/effluent treatment system where they combine into a single discharge pipe. Clean water streams pass through a series of separator bays. Process water streams also pass through a series of separator bays followed by secondary effluent treatment (removal of oil through filtration and dissolved air flotation).
Specific maintenance and emergency procedures are documented in OIMS.

We agree with the Operator’s stated compliance status of CC.</td><td>1.3.1</td></tr>
</table>

<table>
<tr><th>BAT Conclusion Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th><th>Relevant permit condition(s)</th></tr>
<tr><td></td><td><table>
<tr><td>cooling, rain water)</td><td>possible reuse for this type of stream</td><td>rebuilding of the unit or the installation</td></tr>
<tr><td>iv. prevention of spillages and leaks</td><td>Practices that include the utilisation of special procedures and/or temporary equipment to maintain performances when necessary to manage special circumstances such as spills, loss of containment, etc</td><td>Generally applicable</td></tr>
</table></td><td></td><td></td><td></td></tr>
<tr><td>12</td><td>In order to reduce the emission load of pollutants in the waste water discharge to the receiving water body, BAT is to remove insoluble and soluble polluting substances by using all of the techniques given below.

<table>
<tr><th>Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>i. Removal of insoluble substances by recovering oil</td><td>See Section 1.21.2, Annex 1.</td><td>Generally applicable</td></tr>
<tr><td>ii. Removal of insoluble substances by recovering suspended solids and dispersed oil</td><td>See Section 1.21.2, Annex 1.</td><td>Generally applicable</td></tr>
<tr><td>iii. Removal of insoluble substances including biological treatment and clarification.</td><td>See Section 1.21.2, Annex 1.</td><td>Generally applicable</td></tr>
</table>
BAT – associated emission levels – see Table 3</td><td>NC</td><td>The operator submitted a derogation application for this BAT Conclusion in relation to COD at Outfall 2. We have assessed the application and are minded to grant the derogation. Details are provided in section 7.1 of this document.

Treatment facilities are included prior to discharge at the outfalls as follows:

<u>Outfall 1</u>. Waste water is processed through a series of separators designed to remove insoluble substances by recovering oil. The Secondary Effluent Treatment plant provide a further treatment process to remove suspended solids and dispersed oil through dual-media filtration.

<u>Outfall 2</u>. Waste water is processed through a series of separators designed to remove insoluble substances by recovering oil. Process effluent from the integrated chemicals plant is the main effluent discharged through outfall 2. Due to the nature of the effluent, further processing, such as by biological treatment, is not viable due to the cohesive nature of components in specific effluent streams.</td><td>2.3.1
IC40</td></tr>
</table>

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
			Outfall 3. Waste water is processed through a series of separators designed to remove insoluble substances by recovering oil. We agree with the Operator's stated compliance status of NC.	
13	**When further removal of organic substances or nitrogen is needed, BAT is to use an additional treatment step as described in Section 1.21.2 (see Annex 1).**	N/A	This BAT Conclusion is only required in cases where there are issues with water quality in association with these parameters. We agree this BAT Conclusion is not applicable to the installation.	N/A
14	**In order to prevent or, where that is not practicable, to reduce waste generation, BAT is to adopt and implement a waste management plan that, in order of priority, ensures that waste is prepared for reuse, recycling, recovery or disposal.**	CC	There are documented procedures for waste handling (Site Waste Manual). Management is assigned to a third party contractor (based on site), overseen by the Waste Management Co-ordinator. Opportunities to reduce the quantities of waste produced and increase recycling and recovery are taken where possible. Performance is stewarded through the monthly scorecard. The operator provided data that shows overall waste production has steadily reduced since 2011. We agree with the Operator's stated compliance status of CC.	1.4.1

<table>
<tr><th>BAT Conclusion Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th><th>Relevant permit condition(s)</th></tr>
<tr><td>15</td><td>In order to reduce the amount of sludge to be treated or disposed of, BAT is to use one or a combination of the techniques given below.
<table>
<tr><th>Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>i Sludge pretreatment</td><td>Prior to final treatment (e.g. in a fluidised bed incinerator), the sludges are dewatered and/or de-oiled (by e.g. centrifugal decanters of steam dryers) to reduce their volume and to recover oil from slop equipment.</td><td>Generally applicable</td></tr>
<tr><td>ii Reuse of sludge in process units</td><td>Certain types of sludge (e.g. oily sludge) can be processed in units (e.g. coking) as part of the feed due to their oil content.</td><td>Applicability is restricted to sludges that can fulfil the requirements to be processed in units with appropriate treatment</td></tr>
</table></td><td>CC</td><td>Oily sludge, for example from the secondary effluent treatment plant, separator bays and tank cleaning operations, is processed through a centrifugal skid to dewater and reduce volume prior to transfer to the biopile where the wastes are treated prior to recovery for re-use on site under permit ZP3133RH. Recovered oily material is routed to the crude slop for reprocessing when possible.

We agree with the Operator’s stated compliance status of CC.</td><td>2.3.1</td></tr>
</table>

<table>
<tr><th>BAT Conclusion Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th><th>Relevant permit condition(s)</th></tr>
<tr><td>16</td><td>In order to reduce the generation of spent solid catalyst waste, BAT is to use one or a combination of the techniques given below.
<table>
<tr><th>Technique</th><th>Description</th></tr>
<tr><td>i. Spent solid catalyst management</td><td>Scheduled and safe handling of the materials used as catalyst (e.g. by contractors) in order to recover or reuse them in off-site facilities. These operations depend on the type of catalyst and process</td></tr>
<tr><td>ii. Removal of catalyst from slurry decant oil</td><td>Decanted oil sludge from process units (e.g. FCC unit) can contain significant concentrations of catalyst fines. These fines can be separated prior to the reuse of decant oil as a feedstock.</td></tr>
</table></td><td>CC</td><td>The operator has confirmed that both techniques are used.

Catalysts are regenerated and precious metals reclaimed where possible. Where this is not possible, the catalyst is sent for re-use preferentially or disposal.
Recovery of catalyst fines from the FCC is maximised by removal through the two-stage cyclone system. A settling aid chemical is added to the bottoms residue stream which, together with residence time in tankage prior to export, allows fines to settle out. The tank is subject to periodic emptying and cleaning.

We agree with the Operator's stated compliance status of CC.</td><td>1.4.1</td></tr>
<tr><td>17</td><td>In order to prevent or reduce noise, BAT is to use one or a combination of the techniques given below:

i. Make an environmental noise assessment and formulate a noise management plan as appropriate to the local environment;
ii. Enclose noisy equipment/operation in a separate structure/unit;
iii. Use embankments to screen the source of noise;
iv. Use noise protection walls;</td><td>CC</td><td>The operator confirmed that a Noise Management Plan is in place. The Plan includes a regular monitoring programme and is updated at least annually. A site acoustic model is maintained. A number of other measures are used to minimise noise including:
• silencers on vents and stacks;
• acoustic barriers and enclosures; and
• perimeter tree belt to provide screening.

We agree with the Operator's stated compliance status of CC.</td><td>3.4.1</td></tr>
<tr><td>18</td><td>In order to prevent or reduce diffuse VOC emissions, BAT is to apply the techniques given below.
<table>
<tr><th>Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>I. Techniques related to plant design.</td><td>i. Limiting the number of potential emission sources</td><td>Applicability may be</td></tr>
</table></td><td>CC</td><td>The operator has confirmed that all techniques used. Emission sources are minimised through process design which requires that high integrity equipment is selected and appropriate access is allowed for maintenance. This is stewarded through the project process.</td><td>2.3.1, 3.2.1 and IC39</td></tr>
</table>

<table>
<tr><th>BAT Conclusion Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th><th>Relevant permit condition(s)</th></tr>
<tr><td></td><td><table>
<tr><td></td><td>ii. Maximising inherent process containment features
iii. Selecting high integrity equipment
iv. Facilitating monitoring and maintenance activities by ensuring access to potentially leaking components</td><td>limited for existing units</td></tr>
<tr><td>II. Techniques related to plant installation and commissioning</td><td>i. Well defined procedures for construction and assembly
ii. Robust commissioning and hand-over procedures to ensure that the plant is installed in line with the design requirements.</td><td>Applicability may be limited for existing units</td></tr>
<tr><td>III. Techniques related to plant operation</td><td>Use of a risk based leak detection and repair (LDAR) programme in order to identify leaking components, and to repair these leaks.
See table 1.20.6 under BAT 6</td><td>Generally applicable</td></tr>
</table></td><td></td><td>Project procedures require leak testing in the field to ensure integrity prior to commissioning. Actions are documented and prioritised. A formal handover is completed.

Procedures for construction activities are documented through OIMS. A pre start-up safety review is required ahead of commissioning.

Site-wide Leak Detection and Repair (LDAR) surveys are completed periodically using optical gas imaging. Where possible, leaks are repaired at the time of identification. Where this is not possible, repairs are incorporated within the planned maintenance programme.

We agree with the Operator’s stated compliance status of CC.

See also comments under BAT 6 and 49.</td><td></td></tr>
<tr><td>19</td><td>In order to prevent hydrofluoric acid (HF) emissions to air from the hydrofluoric acid alkylation process, BAT is to use wet scrubbing with alkaline solution to treat incondensable gas streams prior to venting to flare.

Description: See section 1.20.3, Annex 1.
Applicability: Generally applicable. Safety requirements, due to the hazardous nature of hydrofluoric acid, are to be considered.</td><td>N/A</td><td>The operator has confirmed that hydrofluoric acid alkylation processes are not carried out on the installation.

We agree this BAT Conclusion is not applicable to the installation.</td><td>N/A</td></tr>
</table>

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
20	**In order to reduce emissions to water from the hydrofluoric acid alkylation process, BAT is to use a combination of the techniques given below.** <table><tr><th>Technique</th><th>Description</th><th>Applicability</th></tr><tr><td>i. Precipitation / Neutralisation step</td><td>Precipitation (with e.g. calcium or aluminium-based additives) or neutralisation (where the effluent is indirectly neutralised with potassium hydroxide (KOH))</td><td>Generally applicable. Safety requirements due to the hazardous nature of hydrofluoric acid (HF) are to be considered.</td></tr><tr><td>ii Separation step</td><td>The insoluble compounds produced at the first step (e.g. CaF_2 or AlF_3) are separated in e.g. settlement basin.</td><td>Generally applicable</td></tr></table>	N/A	The operator has confirmed that hydrofluoric acid alkylation processes are not carried out on the installation. We agree this BAT Conclusion is not applicable to the installation.	N/A
21	**In order to reduce the emissions to water from the sulphuric acid alkylation process, BAT is to reduce the use of sulphuric acid by regenerating the spent acid and to neutralise the waste water generated by this process before routing to waste water treatment.**	N/A	The operator has confirmed that hydrofluoric acid alkylation processes are not carried out on the installation. We agree this BAT Conclusion is not applicable to the installation.	N/A
22	**In order to prevent and reduce the emissions of hazardous substances to air and water from base oil production processes, BAT is to use one or a combination of the techniques given below.** <table><tr><th>Technique</th><th>Description</th><th>Applicability</th></tr><tr><td>i. Closed process with a solvent recovery</td><td>Process where the solvent, after being used during base oil manufacturing (e.g. in extraction, dewaxing units), is</td><td>Generally applicable</td></tr></table>	CC	The extraction and dewaxing units are closed processes with solvent recovery. The extraction unit uses nitrogen stripping to recover the NMP solvent. Contaminated water from the solvent recovery on the dewaxing unit is routed to the dirty water sewer and effluent treatment plant prior to final discharge. Solvent recovery is maximised through the use of high	2.3.1

<table>
<tr><th>BAT Conclusion Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th><th>Relevant permit condition(s)</th></tr>
<tr><td></td><td>
<table>
<tr><td></td><td>recovered through distillation and stripping steps.
See Section 1.20.7, Annex 1.</td><td></td></tr>
<tr><td>ii. Multi-effect extraction solvent-based process</td><td>Solvent extraction process including several stages of evaporation (e.g. double or triple effect) for a lower loss of containment</td><td>Generally applicable to new units. The use of a triple effect process may be restricted to non-fouling feed stocks</td></tr>
<tr><td>iii. Extraction unit processes using less hazardous substances</td><td>Design (new plants) or implement changes (into existing) so that the plant operates a solvent extraction process with the use of a less hazardous solvent: e.g. converting furfural or phenol extraction into the n-methylpyrrolidone (NMP) process</td><td>Generally applicable to new units. Converting existing units to another solvent-based process with different physico-chemical properties may require substantial modifications</td></tr>
<tr><td>iv. Catalytic processes based on hydrogenation</td><td>Processes based on conversion of undesired compounds via catalytic hydrogenation similar to hydrotreatment.</td><td>Generally applicable to new units</td></tr>
</table>
</td><td></td><td>and low pressure flash drums; this involves a three stage process and solvent losses are monitored by measuring content in the product.

Hydrogenation processes are used in the final treatment stages in the Wax Isomerisation Unit.

We agree with the Operator’s stated compliance status of CC.</td><td></td></tr>
</table>

<table>
<tr><th>BAT Conclusion Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th><th>Relevant permit condition(s)</th></tr>
<tr><td>23</td><td>In order to prevent and reduce emissions to air from the bitumen production process, BAT is to treat the gaseous overhead by using one of the techniques given below
<table>
<tr><th>Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>i. Thermal oxidation of gaseous overhead over 800 °C</td><td>See Section 1.20.6, Annex 1.</td><td>Generally applicable for the bitumen blowing unit</td></tr>
<tr><td>ii. Wet scrubbing of gaseous overhead</td><td>See Section 1.20.3, Annex 1.</td><td>Generally applicable for the bitumen blowing unit</td></tr>
</table></td><td>N/A</td><td>The operator has confirmed that bitumen processes are not carried out on the installation.

We agree this BAT Conclusion is not applicable to the installation.

Emission points A17 (BIT 1) and A18 (BIT 2) which relate to historical bitumen plant activities which ceased 2011 and the plant has subsequently been decommissioned. Table S3.1a has been updated to note this and the requirement to report annual production quantities removed from table S4.2</td><td>N/A</td></tr>
<tr><td colspan="2">BAT conclusions for the fluid catalytic cracking process</td><td></td><td></td><td></td></tr>
<tr><td>24</td><td>In order to prevent or reduce NO_X emissions to air from the catalytic cracking process (regenerator), BAT is to use one or a combination of the techniques given below.

I. Primary or process-related techniques, such as:
<table>
<tr><th>Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td colspan="3">Process optimisation and use of promoters or additives</td></tr>
<tr><td>i. Process optimisation</td><td>Combination of operating conditions or practices aimed at reducing NO_X formation, e.g. lowering the excess oxygen in the flue-gas in full combustion mode, air staging of the CO boiler in partial combustion mode, provided that the CO boiler is appropriately designed.</td><td>Generally applicable</td></tr>
</table></td><td>CC</td><td>The operator has confirmed that emissions are minimised through the application of process optimisation measures and the use of low NO_X CO oxidation promoters.

The FCCU operates in full combustion mode. Excess oxygen in flue gas is minimised to limit CO production and NO_X formation.

Non-platinum CO oxidation promoter is used to reduce NO_X emissions.

The operator has demonstrated that antimony injection is used and the footnote to Table 4 of the BAT conclusion applies. Guidance on interpretation of footnotes from the European Commission clarifies that the use of this footnote is not understood as extending the BAT-AEL range but merely complementary information to be taken into consideration during determination. Monitoring results show that NO_X is consistently below 300 mg/m^3. A higher level cannot therefore be justified based on operational performance. Therefore the AEL has been set at the top of the range at 300 mg/m^3.</td><td>2.3.1</td></tr>
</table>

<table>
<tr><th>BAT Conclusion Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th><th>Relevant permit condition(s)</th></tr>
<tr><td></td><td>
<table>
<tr><td>ii. Low-NO_X CO oxidation promoters</td><td>Use of a substance that selectively promotes the combustion of CO only and prevents the oxidation of the nitrogen that contain intermediates to NO_X e.g. non-platinum promoters.</td><td>Applicable only in full combustion mode for the substitution of platinum-based CO promoters. Appropriate distribution of air in the regenerator may be required to obtain the maximum benefits</td></tr>
<tr><td>iii. Specific additive for NO_X reduction</td><td>Use of specific catalyst additives for enhancing the reduction of NO by CO</td><td>Applicable only in full combustion mode for the substitution of platinum-based CO promoters. Appropriate distribution of air in the regenerator may be required to obtain the maximum benefits.</td></tr>
</table>
II Secondary or end-of-pipe techniques such as:
<table>
<tr><th>Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>i. Selective catalytic reduction (SCR)</td><td>See section 1.20.2, Annex 1.</td><td>To avoid potential fouling downstream, additional firing might be required upstream of the SCR. For existing units, the applicability may be limited by space availability.</td></tr>
</table>
</td><td></td><td>An hourly ELV is currently included. We have concluded that individual hourly stack ELVs are no longer required for emissions that will be controlled through the Integrated Emissions Monitoring Technique as this provides sufficient protection to the environment.

The operator has elected to manage emissions from the FCCU in accordance with provisions for an Integrated Emissions Management Technique made in BAT Conclusion 57. Further details are provided in this section.

We agree with the Operator’s stated compliance status of CC.</td><td></td></tr>
</table>

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)

ii. Selective non-catalytic reduction (SNCR)	See section 1.20.2, Annex 1.	For partial combustion FCCs with CO boilers, a sufficient residence time at the appropriate temperature is required. For full combustion FCCs without auxiliary boilers, additional fuel injection (e.g. hydrogen) may be required to match a lower temperature window.
	See section 1.20.2, Annex 1.	Need for additional scrubbing capacity. Ozone generation and the associated risk management need to be properly addressed. The applicability may be limited by the need for additional waste water treatment and related cross-media effects (e.g. nitrate emissions) and by an insufficient supply of liquid oxygen (for ozone generation). The applicability of the technique may be limited by space availability.

Table 4 BAT- associated emission levels for NO_X emissions to air from the regenerators in the catalytic cracking process

Parameter	**Type of unit/combustion mode**	**BAT-AEL (monthly average) Mg/Nm^3**
NO_X expressed as NO_2	New unit/all combustion mode	<30 – 100
	Existing unit/full combustion mode	<100 – 300 (1)

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
	| | Existing unit/partial combustion mode | 100 - 400 (1) | When antimony (Sb) injection is used for metal passivation, NO_X levels up to 700 mg/Nm^3 may occur. The lower end of the range can be achieved by using the SCR technique.			
25	**In order to reduce dust and metals emissions to air from the catalytic cracking process (regenerator), BAT is to use one or a combination of the techniques given below.** I. Primary or process-related techniques, such as: **Technique** / **Description** / **Applicability** i. Use of an attrition-resistant catalyst / Selection of catalyst substance that is able to resist abrasion and fragmentation in order to reduce dust emissions. / Generally applicable provided the activity and selectivity of the catalyst are sufficient ii. Use of low sulphur feedstock (e.g. by feedstock selection or hydrotreatment of feed) / Feedstock selection favours low sulphur feedstocks among the possible sources. Hydrotreatment aims at reducing the sulphur, nitrogen and metal contents of the feed. / Requires sufficient availability of low sulphur feedstocks, hydrogen production and hydrogen sulphide (H2S) treatment capacity (e.g. amine and Claus units) II. secondary or end-of-pipe techniques, such as: **Technique** / **Description** / **Applicability** i. Electrostatic precipitator (ESP) / See section 1.20.1, Annex1. / For existing units, the applicability may be limited by space availability	NC	We agree with the Operator's stated compliance status of NC. The operator submitted a derogation application for this BAT Conclusion. We have assessed the application and are minded to grant the derogation. Details are provided in section 7.2 of this document.	2.3.1 and IC41

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)

ii. Multistage cyclone separators	See section 1.20.1, Annex1.	Generally applicable
iii. Third stage blowback filter	See section 1.20.1, Annex1.	Applicability may be restricted
iv. Wet scrubbing	See section 1.20.3, Annex1.	The applicability may be limited in arid areas and in the case where the by-products from treatment (including e.g. waste water with high level of salts) cannot be reused or appropriately disposed of. For existing units, the applicability may be limited by space availability.

Table 5 BAT – associated emission levels for dust emissions to air form the regenerator in the catalytic cracking process.

Parameter	Type of unit	BAT-AEL (monthly average) (1) Mg/Nm3
Dust	New unit	10 – 25
	Existing unit	10 – 50 (2)

(1) Soot blowing in CO boiler and through the gas cooler is excluded
(2) The lower end of the range can be achieved with a 4-field ESP

The associated monitoring is in BAT 4.

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
26	**In order to prevent or reduce SO_X emissions to air from the catalytic cracking process (regenerator), BAT is to use one or a combination of the techniques given below**.	FC	The operator has confirmed that a combination of primary and process related techniques are used. SO_X reduction catalyst additives are currently used.	2.3.1 and 4.2.2

<table>
<tr><th>BAT Conclusion Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th><th>Relevant permit condition(s)</th></tr>
<tr><td></td><td>
I. Primary or process-related techniques such as:
<table>
<tr><th>Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>i. Use of SO_x reducing catalyst additives</td><td>Use of a substance that transfers the sulphur associated with coke from the regenerator back to the reactor.</td><td>Applicability may be restricted by regenerator conditions design. Requires appropriate hydrogen sulphide abatement capacity (e.g. SRU)</td></tr>
<tr><td>ii. Use of low sulphur feedstock (e.g. by feedstock selection of by hydrotreatment of the feed)</td><td>Feedstock slelction favours low sulphur feedstocks among the possible sources to be processed at the unit.
Hydrotreatment aims at reducing the sulphur, nitrogen and metal contents of the feed.
Section 1.20.3, Annex1</td><td>Requires sufficient availability of low sulphur feedstocks, hydrogen production anf hydrogen sulphide (H_2S) treatment capacity (e.g. amine and Claus units)</td></tr>
</table>
II. Secondary or end-of pipe techniques, such as:
<table>
<tr><th>Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>i. Non-regenerative scrubbing</td><td>Wet scrubbing or seawater scrubbing</td><td>The applicability may be limited in arid areas and in the case where the by-products form the treatment (including e.g. waste water with high levels of salts) cannot be reused or appropriately disposed of.</td></tr>
</table>
</td><td></td><td>
Approximately 30% of FCCU feed is hydrotreated to remove sulphur, nitrogen and metals. Off gases are processed in the Sulphur Recovery units.

The FCCU is an existing unit that operates in full combustion mode. Future compliance and further sulphur dioxide reductions will be achieved through the implementation of improvement projects including:
Increase in the addition rate of deSO_x catalyst additive (resulting in an estimated reduction of approximately 900 SO_2 t/yr)
The operator has provided data that demonstrates whilst 30% of the FCCU feed is hydrotreated, the overall average sulphur content of the feed is 0.5% w. This has consistently been the case from 2010. Therefore, it is appropriate to apply footnote 1 to Table 6 of the BAT Conclusion in this case, which clearly affects the AEL range. A reporting requirement has been included requiring the operator to report the sulphur content of the FCCU feed annually as specified in Table S4.1.

The operator has elected to manage emissions from the FCCU in accordance with provisions for an Integrated Emissions Management Technique made in BAT Conclusion 58. Further details are provided in this section.

We agree with the Operator’s stated compliance status of FC.
</td><td></td></tr>
</table>

<table>
<tr><th>BAT Conclusion Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th><th>Relevant permit condition(s)</th></tr>
<tr><td></td><td>
<table>
<tr><td>ii. Regenerative scrubbing</td><td>Use of a specific SO_X absorbing reagent (e.g. absorbing solution) which generally enables the recovery of sulphur as a by-product during a regenerating cycle where the reagent is reused
Section 1.20.3, Annex1</td><td>The applicability is limited to the case where regenerated by-products can be sold. For existing units, the applicability may be limited by the existing sulphur recovery capacity as well as by space availability</td></tr>
</table>

Table 6 BAT-associated emission levels for SO_2 emissions to air from the regenerator in the catalytic cracking process

<table>
<tr><th>Parameter</th><th>Type of units/mode</th><th>BAT-AEL (monthly average) mg/Nm^3</th></tr>
<tr><td>SO_2</td><td>New units</td><td>< 300</td></tr>
<tr><td></td><td>Existing units/full combustion</td><td><100 – 800(1)</td></tr>
<tr><td></td><td>Existing units/partial combustion</td><td>100 – 1 200 (1)</td></tr>
<tr><td colspan="3">(1) Where selection of low sulphur (e.g. < 0.5% w/w) feed (or hydrotreatment) and/or scrubbing is applicable, for all combustion modes, the upper end of the BAT-AEL range is <600 mg/Nm^3</td></tr>
</table>

The associated monitoring is in BAT 4.
</td><td></td><td></td><td></td></tr>
<tr><td>27</td><td>
In order to reduce carbon monoxide (CO) emissions to air from the catalytic cracking process (regenerator), BAT is to use one or a combination of the techniques given below.

<table>
<tr><th>Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>i. Combustion operation control</td><td>See section 1.20.5, Annex 1.</td><td>Generally applicable</td></tr>
</table>
</td><td>CC</td><td>The operator has confirmed that emissions are minimised through the application of combustion control measures and use of catalyst with CO oxidation promoters.</td><td>2.3.1</td></tr>
</table>

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
	<table><tr><td>ii. Catalysts with carbon monoxide (CO) oxidation promoters</td><td>See section 1.20.5, Annex 1.</td><td>Generally applicable only for full combustion mode</td></tr><tr><td>iii. Carbon monoxide (CO) boiler</td><td>See section 1.20.5, Annex 1.</td><td>Generally applicable only for partial combustion mode</td></tr></table> **Table 7 BAT- associated emission levels for carbon monoxide emissions to air from the regenerator in the catalytic cracking process for partial combustion mode.** <table><tr><th>Parameter</th><th>Combustion mode</th><th>BAT-AEL (monthly average) mg/Nm3</th></tr><tr><td>Carbon monoxide expressed as CO</td><td>Partial combustion mode</td><td>≤ 100 (1)</td></tr><tr><td colspan="3">(1) May not be achievable when not operating the CO boiler at full load.</td></tr></table> The associated monitoring is in BAT 4		The FCCU operates in full combustion mode. Full burn is confirmed by minimum after burn and CO measured levels in the regenerator flue gas. Regenerator bed temperature is controlled by reactor stripping steam rate. This is generally at maximum with maximum heavy feed into the unit. The rate of supplementary oxygen routed into the regenerator is controlled to ensure complete combustion whilst minimising excess oxygen. CO levels are checked through monitoring the temperature difference in the regeneration bed and regeneration cyclones. A small difference is indicative of good combustion and not excessive CO. The BAT-AEL is not applicable to full combustion mode units. We agree with the Operator's stated compliance status of CC.	
28	**In order to reduce emissions of polychlorinated dibenzodioxins/furans (PCDD/F) to air from the catalytic reforming unit, BAT is to use one or a combination of the techniques given below** <table><tr><th>Technique</th><th>Description</th><th>Applicability</th></tr><tr><td>i. Choice of the catalyst promoter</td><td>Use of catalyst promoter in order to minimise polychlorinated dibenzodioxins/furans (PCDD/F) formation during regeneration. See section 1.20.7, Annex 1.</td><td>Generally applicable</td></tr><tr><td colspan="3">ii Treatment of the regeneration flue-gas</td></tr></table>	CC	The operator has confirmed that catalyst promoter to reduce the PCDD/F emissions is used together with some treatment. Both reforming units (PH1 and PH2) use perchloroethylene as catalyst promoter. During normal operation propylene dichloride is added continuously to PH2 (which is semi regenerative) to maintain catalyst activity. Waste gases from regeneration are treated to remove chlorinated compounds. PH1 gases are routed to an absorbent drum acting as a chloride trap. PH2 has 2 parallel driers, with one online at any one time, to remove water, HCl and H_2S during normal operation and regeneration cycles.	2.3.1

<table>
<tr><th>BAT Conclusion Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th><th>Relevant permit condition(s)</th></tr>
<tr><td></td><td>
<table>
<tr><td>a) Regeneration gas recycling loop with adsorption bed</td><td>Waste gas from the regeneration step is treated to remove chlorinated compounds (e.g. dioxins)</td><td>Generally applicable to new units. For existing units the applicability may depend of the current regeneration unit design</td></tr>
<tr><td>b) Wet scrubbing</td><td>See section 1.20.3, Annex 1.</td><td>Not applicable to semi-regenerative reformers</td></tr>
<tr><td>c) Electrostatic precipitator (ESP)</td><td>See section 1.20.1, Annex 1.</td><td>Not applicable to semi-regenerative reformers</td></tr>
</table>
</td><td></td><td>We agree with the Operator’s stated compliance status of CC.</td><td></td></tr>
<tr><td>29</td><td>In order to reduce emissions to air from the coking production processes, BAT is to use one or a combination of the techniques given below:
<table>
<tr><th>Applicability</th><th>Description</th><th>Applicability</th></tr>
<tr><td>i. Collection and recycling of coke fines</td><td>Systematic collection and recycling of coke fines generated during the whole coking process (drilling, handling, crushing, cooling etc)</td><td>Generally applicable</td></tr>
<tr><td>ii. Handling and storage of coke according to BAT 3</td><td>See BAT 3</td><td>Generally applicable</td></tr>
<tr><td>iii. Use of a closed blowdown system</td><td>Arrestment system for pressure relief from the coke drum</td><td>Generally applicable</td></tr>
<tr><td>iv. Recovery of gas (including the venting prior to the drum being opened</td><td>Carrying venting from the coke drum to the gas compressor to</td><td>For existing units, the applicability of the techniques may be</td></tr>
</table>
</td><td>N/A</td><td>The operator has confirmed that coking production processes are not carried out on the installation.

We agree this BAT conclusion is not applicable to the installation.</td><td>N/A</td></tr>
</table>

<table>
<tr><th>BAT Conclusion Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th><th>Relevant permit condition(s)</th></tr>
<tr><td></td><td><table><tr><td>to atmosphere) as a component of refiner fuel gas (RFG)</td><td>recover as RFG rather than flaring. For the flexicoking process, a conversion step (to convert the carbonyl sulphide (COS) into S_2S) is needed prior to treating the gas from the coking unit.</td><td>limited by space availability</td></tr></table></td><td></td><td></td><td></td></tr>
<tr><td>30</td><td>In order to reduce NO_X emissions to air from the calcining of green coke process, BAT is to use selective non-catalytic reduction (SNCR).

Description: See section 1.20.2, Annex 1.
Applicability: The applicability of the SNCR technique (especially with respect to residence time and temperature window) may be restricted due to the specificity of the calcining process.</td><td>N/A</td><td>The operator has confirmed that calcining processes are not carried out on the installation.

We agree this BAT conclusion is not applicable to the installation.</td><td>N/A</td></tr>
<tr><td>31</td><td>In order to reduce SO_X emissions to air from the calcining of green coke process, BAT is to use one or a combination of the techniques given below.

<table><tr><th>Technique</th><th>Description</th><th>Applicability</th></tr><tr><td>i. Non-regenerative scrubbing</td><td>Wet scrubbing or seawater scrubbing.

See Section 5.20.3</td><td>The applicability may be limited in arid areas and in the case where the by-products from treatment (including e.g. waste water with high level of salts) cannot be reused or appropriately disposed of. For existing units, the applicability may be limited by space availability</td></tr></table></td><td>N/A</td><td>The operator has confirmed that calcining processes are not carried out on the installation.

We agree this BAT conclusion is not applicable to the installation.</td><td>N/A</td></tr>
</table>

<table>
<tr><th>BAT Conclusion Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th><th>Relevant permit condition(s)</th></tr>
<tr><td></td><td><table><tr><td>ii. Regenerative scrubbing</td><td>Use of a specific SO_X absorbing reagent (e.g. absorbing solution) which generally enables the recovery of sulphur as a by-product during a regenerating cycle where the reagent is reused. See Section 5.20.3, Annex 1.</td><td>The applicability is limited to the case where regenerated by-products can be sold.
For existing units, the applicability may be limited by the existing sulphur recovery capacity as well as by space availability</td></tr></table></td><td></td><td></td><td></td></tr>
<tr><td>32</td><td>In order to reduce dust emissions to air from the calcining of green coke process, BAT is to use a combination of the techniques given below.
<table><tr><th>Technique</th><th>Description</th><th>Applicability</th></tr><tr><td>i. Electrostatic precipitator (ESP)</td><td>See section 1.20.1, Annex 1.</td><td>For existing units, the applicability may be limited by space availability.
For graphite and anode coke calcining production, the applicability may be restricted due to the high resistivity of the coke particles</td></tr><tr><td>ii. Multistage cyclone separators</td><td>See section 1.20.1, Annex 1.</td><td>Generally applicable</td></tr></table>
Table 8 BAT- associated emission levels of dust emissions to air from a unit for the calcining of green coke
<table><tr><th>Parameter</th><th>BAT-AEL (monthly average) mg/Nm^3</th></tr><tr><td>Dust</td><td>10 - 50 ([1, 2])</td></tr></table></td><td>N/A</td><td>The operator has confirmed that calcining processes are not carried out on the installation.

We agree this BAT conclusion is not applicable to the installation.</td><td>N/A</td></tr>
</table>

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
	(1) The lower end of the range can be achieved with a 4-field ESP (2) When an ESP is not applicable, values of up to 150 mg/Nm^3 may occur. The associated monitoring is in BAT 4.			
33	**In order to reduce water consumption and emissions to water from the desalting process, BAT is to use one or a combination of the techniques given below.**	CC	The operator has confirmed that all techniques are used. A significant proportion of desalter wash water is provided by sour water stripper effluent with the remainder recycled from distillation units. Freshwater make-up is minimised. A specialist contractor monitors key parameters, including approximation of mixing, pH, volts/amps of the desalter grids, dehydration and desalination efficiency and solid/wash water rates, three times per week. This information is used to ensure the process is optimised. A regular review process is in place to capture longer term issues and identify improvement opportunities. There is a two-stage desalting process on the larger units (which represent 70% of crude throughput). Desalter effluent is routed to a storage tank providing around 40 hours residence time, prior to discharge to process water sewer. The oil that accumulates during this is recycled into crude tankage for processing. We agree with the Operator's stated compliance status of CC.	1.3.1 and 2.3.1

Technique	Description	Applicability
i. Recycling water and optimisation of the desalting process	An ensemble of good desalting practices aiming at increasing the efficiency of the desalter and reducing wash water usage e.g. using low shear mixing devices, low water pressure. It includes the management of key parameters for washing (e.g. good mixing) and separation (e.g. pH, density, viscosity, electric field potential for coalescence) steps	Generally applicable
ii. Multistage desalter	Multistage desalters operate with water addition and dehydration, repeated through two stages or more for achieving a better efficiency in the separation and therefore less corrosion in further processes	Applicable for new units
iii. Additional separation step	An additional enhanced oil/water and solid/water separation designed for reducing the charge of oil to the waste water treatment plant and recycling it to the process. This includes, e.g. settling drum, the use of	Generally applicable

<table>
<tr><th>BAT Conclusion Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th><th>Relevant permit condition(s)</th></tr>
<tr><td></td><td><table><tr><td></td><td>optimum interface level controllers</td><td></td></tr></table></td><td></td><td></td><td></td></tr>
<tr><td>34</td><td>BAT 34. In order to prevent or reduce NO_X emissions to air from the combustion units, BAT is to use one or a combination of the techniques given below.

I. Primary or process-related techniques, such as:
<table><tr><th>Technique</th><th>Description</th><th>Applicability</th></tr><tr><td colspan="3">i. Selection or treatment of fuel</td></tr><tr><td>(a) Use of gas to replace liquid fuel</td><td>Gas generally contains less nitrogen than liquid and its combustion leads to a lower level of NO_X emissions. See section 1.20.3, Annex 1.</td><td>The applicability may be limited by the constraints associated with the availability of low sulphur gas fuels, which may be impacted by the energy policy of the Member State</td></tr><tr><td>(b) Use of low nitrogen refinery fuel oil (RFO) e.g. by RFO selection or by hydrotreatment of RFO</td><td>Refinery fuel oil selection favours low nitrogen liquid fuels among the possible sources to be used at the unit. Hydrotreatment aims at reducing the sulphur, nitrogen and metal contents of the fuel. See section 1.20.3, Annex 1.</td><td>Applicability is limited by the availability of low nitrogen liquid fuels, hydrogen production and hydrogen sulphide (H_2S) treatment capacity (e.g. amine and Claus units)</td></tr><tr><td colspan="3">ii. Combustion modifications</td></tr></table></td><td>FC</td><td>The operator has confirmed that a combination of primary and process related techniques are used.

Use of liquid fuel has been reduced over recent years. The use of RFG is maximised followed by natural gas.

Only one combustion plant remains with liquid-firing during normal operation. The liquid fuel used has been hydrotreated which reduces nitrogen. There is additional storage in place to ensure the continued use of treated liquid fuel during planned outages.

A number of combustion units employ fuel and air staged combustion techniques. In addition, a number of units employ flue-gas recirculation burners. Combustion is optimised through the minimisation of excess oxygen and monitoring of CO to measure to optimise efficiency.

Low NO_X burners are employed on a number of units following upgrades completed as part of IC28. Steam injection for NO_X control in Gas Turbines is already in use on Unit 5 Cogen (emission point A29) and scheduled for installation on SP4 Unit 3 in 2018 (and subject to Regulatory Position Statement BR6996IC/16/02/2017).

The operator has provided data that demonstrate that units PS/V3 (emission point A2), PH1 (emission point A3) and ENSR (emission point A7) either have air pre heat to > 200ºC or gaseous H_2 content of >50%. It is appropriate to apply foot note 1 to Table 10 of the</td><td>2.3.1</td></tr>
</table>

<table>
<tr><th>BAT Conclusion Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th><th>Relevant permit condition(s)</th></tr>
<tr><td></td><td>
<table>
<tr><td>(a) Staged combustion:
• air staging
• fuel staging</td><td>See section 1.20.2, Annex 1.</td><td>Fuel staging for mixed or liquid firing may require a specific burner design</td></tr>
<tr><td>(b) Optimisation of combustion</td><td>See section 1.20.2, Annex 1.</td><td>Generally applicable</td></tr>
<tr><td>(c) Flue-gas recirculation</td><td>See section 1.20.2, Annex 1.</td><td>Applicable through the use of specific burners with internal recirculation of the flue-gas.
The applicability may be restricted to retrofitting external flue-gas recirculation to units with a forced/induced draught mode of operation</td></tr>
<tr><td>(d) Diluent injection</td><td>See section 1.20.2, Annex 1.</td><td>Applicable for gas turbines where appropriate inert diluents are available</td></tr>
<tr><td>(e) Use of low-NO_X burners (LNB)</td><td>See section 1.20.2, Annex 1.</td><td>Generally applicable for new units taking into account, the fuel-specific limitation (e.g. for heavy oil).
For existing units, applicability may be restricted by the complexity caused by site-specific conditions e.g. furnaces design, surrounding devices.
In very specific cases, substantial modifications may be required.</td></tr>
</table>
</td><td></td><td>BAT Conclusion in these cases. The applicable BAT-AEL will be 200 mg/Nm^3 for these units.

For Large Combustion Plant, Chapter III emission limits have been retained as a backstop for the individual emission points. These are shown in brackets where applicable and a foot note to the table included.

Unless an existing limit has been retained to ensure no deterioration, or a relevant footnote applies, Table S3.1a specifies the following emission limits:
• For gas fired only plant: 150mg/m^3
• For multi fuel fired plant: 300 mg/m^3 (maximum range applied due to lack of correlation between fuel fired and NO_X emissions)

The operator has elected to manage emissions from the combustion units in accordance with provisions for an Integrated Emissions Management Technique made in BAT Conclusion 57. Further details are provided in this section.

We agree with the Operator’s stated compliance status of FC.</td><td></td></tr>
</table>

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
	(continued) | | The applicability may be restricted for furnaces in the delayed coking process, due to possible coke generation in the furnaces. In gas turbines, the applicability is restricted to low hydrogen content fuels (generally < 10 %) | II. Secondary or end-of-pipe techniques, such as:			

Technique	Description	Applicability
i. Selective catalytic reduction (SCR)	See section 1.20.2, Annex 1.	Generally applicable for new units. For existing units, the applicability may be constrained due to the requirements for significant space and optimal reactant injection
ii. Selective non-catalytic reduction (SNCR)	See section 1.20.2, Annex 1.	Generally applicable for new units. For existing units, the applicability may be constrained by the requirement for the temperature window and the residence time to be reached by reactant injection
iii. Low temperature oxidation	See section 1.20.2, Annex 1.	The applicability may be limited by the need for additional scrubbing capacity and by the fact

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
	(see nested content below)			

		that ozone generation and the associated risk management need to be properly addressed. The applicability may be limited by the need for additional waste water treatment and related cross-media effects (e.g. nitrate emissions) and by an insufficient supply of liquid oxygen (for ozone generation). For existing units, the applicability of the technique may be limited by space availability
iv. SNO_X combined technique	See section 1.20.4, Annex 1.	Applicable only for high flue-gas (e.g. > 800 000 Nm3/h) flow and when combined NO_X and SO_X abatement is needed

BAT- associated emission levels: See Table 9, Table 10 and Table 11

Table 9 BAT-associated emission levels for NO_X emissions to air from a gas turbine

Parameter	Type of equipment	BAT-AEL [(1)] (monthly average) mg/Nm^3 at 15% O_2
NOx, expressed as NO_2	Gas turbine (including combined cycle gas turbine – CCGT) and	40 - 120 (existing gas turbine)

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
	(see below)			

	integrated gasification combined cycle turbine (IGCC))	20 - 50 (new turbine) (2)

(1) BAT-AEL refers to combined emissions from the gas turbine and the supplementary firing recovery boiler, where present
(2) For fuel with high H_2 content (i.e. above 10%), the upper end of the range is 75 mg/Nm^3

Table 10 BAT- associated emission levels for NOX emissions to air from a gas-fired combustion unit, with the exception of gas turbines

Parameter:	**Type of combustion**	**BAT-AEL (monthly average) mg/Nm^3**
NOx, expressed as NO_2	Gas firing	30 - 150 for existing unit (1)
		30 - 100 for new unit

(1) For an existing unit using high air pre-heat (i.e. > 200 C) or with H2 content in the fuel gas higher that 50% the upper end of the BAT-AEL range is 200 mg/Nm^3

Table 11 BAT –associated emission levels for NO_X emissions to air from a multi-fuel fired combustion unit with the exception of gas turbines

Parameter:	**Type of combustion**	**BAT-AEL (monthly average) mg/Nm^3**
NO_X expressed as NO_2	Multi-fuel fired combustion unit	30 -300 for existing unit (1) (2)

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
	(1) For existing units < 100 MW firing fuel oil with a nitrogen content higher that 0.5% (w/w) or with liquid firing > 50% or using air preheating values up to 450 mg/Nm^3 may occur (2) The lower end of the range can be achieved by using the SCR technique The associated monitoring is in BAT 4			
35	**In order to prevent or reduce dust and metal emissions to air from the combustion units, BAT is to use one or a combination of the techniques given below.** I. Primary or process-related techniques, such as:	CC	The operator has confirmed that a combination of primary and process related techniques are used. Use of liquid fuel has been reduced over recent years. The use of RFG is maximised followed by natural gas. Only one combustion plant remains with liquid-firing during normal operation. The liquid fuel used has been hydrotreated which reduces metals. Combustion is optimised through the minimisation of excess oxygen and ensure complete combustion takes place. Steam atomisation is employed on the one liquid-firing unit. The BAT-AEL applies only to multi-fuel fired units (with the exception of gas turbines). SP4 (emission point A1) is the only remaining unit that regularly uses liquid fuels. The emission limit specified in Table S3.1a is calculated in accordance with agreed MFF Protocol. We agree with the Operator's stated compliance status of CC.	2.3.1

Technique	Description	Applicability
Selection or treatment of fuel		
(a) Use of gas to replace liquid fuel	Gas instead of liquid combustion leads to lower level of dust emissions See section 1.20.3, Annex 1.	The applicability may be limited by the constraints associated with the availability of low sulphur fuels such as natural gas which may be impacted by the energy policy of the Member State
(b) Use of low sulphur refinery fuel oil (RFO) e.g. by RFO selection or by hydro-treatment of RFO	Refinery fuel oil selection favours low sulphur liquid fuels among the possible sources to be used at the unit. Hydrotreatment aims at reducing the sulphur, nitrogen and metal contents of the fuel	The applicability may be limited by the availability of low sulphur liquid fuels, hydrogen production and the hydrogen sulphide (H_2S) treatment capacity (e.g. amine and Claus units)

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
	(continued table below)			

	See section 1.20.3, Annex 1.	
Combustion modifications		
(a) Optimisation of combustion	See section 1.20.2, Annex 1.	Generally applicable to all types of combustion
(b) Atomisation of liquid fuel	Use of high pressure to reduce the droplet size of liquid fuel. Recent optimal burner designs generally include steam atomisation	Generally applicable to liquid fuel firing

II Secondary or end-of-pipe techniques, such as:

Technique	Description	Applicability
i. Electrostatic precipitator (ESP)	See section 1.20.1, Annex 1.	For existing units, the applicability may be limited by space availability
ii. Third stage blowback filter	See section 1.20.1, Annex 1.	Generally applicable

<table>
<tr><th>BAT Conclusion Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th><th>Relevant permit condition(s)</th></tr>
<tr><td></td><td>

iii.	Wet scrubbing	See section 1.20.1, Annex 1.	The applicability may be limited in arid areas and in the case where by-products from treatment (including e.g. waste water with a high level of salt) cannot be reused or appropriately disposed of. For existing units, the applicability of the technique may be limited by space availability
iv.	Centrifugal washers	See section 1.20.1, Annex 1.	Generally applicable

Table 12 BAT – associated emission levels of dust emissions to air from a multi-fuel fired combustion unit with the exception of gas turbines

Parameter	Type of combustion	BAT-AEL (monthly average) mg/Nm^3
Dust	Multi-fuel firing	5 – 50 for existing unit (1) (2)
		5 – 25 for new unit < 50 MW

(1) The lower end of the range is achievable for units with the use of end-of-pipe techniques
(2) The upper end of the range refers to the use of a high percentage of oil burning and where only primary techniques are applicable

The associated monitoring is in BAT 4

</td><td></td><td></td><td></td></tr>
</table>

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
36	**In order to prevent or reduce SO_X emissions to air from the combustion units, BAT is to use one or a combination of the techniques given below.** I. Primary or process-related techniques <table><tr><th>Technique</th><th>Description</th><th>Applicability</th></tr><tr><td>i. Use of gas to replace liquid fuel</td><td>See section 1.20.3, Annex 1.</td><td>The applicability may be limited by the constraints associated with the availability of low sulphur fuels such as natural gas, which may be impacted by the energy policy of the Member State</td></tr><tr><td>ii. Treatment of refinery fuel gas (RFG)</td><td>Residual H2S concentration in RFG depends on the treatment process parameter, e.g. the amine-scrubbing pressure. See Section 1.20.3, Annex 1.</td><td>For low calorific gas containing carbonyl sulphide (COS) e.g. from coking units, a converter may be required prior to H_2S removal</td></tr><tr><td>iii. Use of low sulphur refinery fuel oil (RFO) e.g. by RFO selection or by hydrotreatment of RFO</td><td>Refinery fuel oil selection favours low sulphur liquid fuels among the possible sources to be used at the unit. Hydrotreatment aims at reducing the sulphur, nitrogen and metal contents of the fuel.</td><td>The applicability is limited by the availability of low sulphur liquid fuels, hydrogen production and the hydrogen sulphide (H_2S) treatment capacity (e.g. amine and Claus units</td></tr></table>	FC	The operator has confirmed that a combination of primary and process related techniques are used. Use of liquid fuel has been reduced over recent years (IC23). The use of RFG is maximised followed by natural gas with any marginal shortfall fulfilled by firing low sulphur liquid fuel (generally during winter or planned outages). Only one combustion plant remains with liquid-firing during normal operation. The liquid fuel used has been hydrotreated which reduces nitrogen. There is additional storage in place to ensure the continued use of treated liquid fuel during planned outages. Amine scrubbing is employed to reduce the H_2S content of RFG on a number of streams. See comments under BAT 54. Future compliance and further sulphur dioxide reductions will be achieved through the implementation of improvement projects including: • Debottlenecking amine tower to increase treatment capacity (estimated reduction of 700 t/yr); • Isolation of sour overheads stream and provision of natural gas for additional fuel requirements (estimated reduction of approximately 400 t/yr). For Large Combustion Plant, Chapter III emission limits have been retained as a backstop for the individual emission points. These are shown in brackets where applicable and a foot note to the table included. Hourly ELVs are currently included for individual stacks. We have concluded that individual hourly stack ELVs are no longer required for emissions that	2.3.1

<table>
<tr><th>BAT Conclusion Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th><th>Relevant permit condition(s)</th></tr>
<tr><td></td><td>
<table>
<tr><td></td><td>See Section 1.20.3, Annex 1.</td><td></td></tr>
</table>
II. Secondary or end-of-pipe techniques
<table>
<tr><th>Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>i. Non-regenerative scrubbing</td><td>Wet scrubbing or seawater scrubbing. See Section 1.20.3, Annex 1.</td><td>The applicability may be limited in arid areas and in the case where the by-products from treatment (including e.g. waste water with high level of salts) cannot be reused or appropriately disposed of.
For existing units, the applicability of the technique may be limited by space availability</td></tr>
</table>
Table 13 BAT – associated emission levels for SO_2 emissions to air from combustion unit firing refinery fuel gas (RFG), with the exception of gas turbines
<table>
<tr><th>Parameter</th><th>BAT-AEL (monthly average) mg/Nm^3</th></tr>
<tr><td>SO2</td><td>5 – 35 ([1])</td></tr>
<tr><td colspan="2">(1) In the specific configuration of RFG treatment with a low scrubber operative pressure and with refinery fuel gas with an H/C molar ratio above 5, the upper end of the BAT-AEL range can be as high as 45 mg/Nm3</td></tr>
</table>
The associated monitoring is in BAT 4
</td><td></td><td>
will be controlled through the Integrated Emissions Monitoring Technique as this provides sufficient protection to the environment. The operator has not elected to manage emissions from the sulphur recovery units (emission point A23 – Table 3.1a) through the Integrated Emissions Monitoring Technique and therefore the hourly stack limit will be retained to ensure no deterioration. The hourly bubble limit has also been retained (Table 3.1b) to protect air quality.
Unless an existing limit has been retained to ensure no deterioration, or a relevant footnote applies, Table S3.1a specifies the following emission limits:

For gas fired only plant: 35mg/m^3
For multi fuel fired plant: limit calculated adopting the principles agreed MFF protocol

The operator has elected to manage emissions from combustion units (excluding gas turbines where no AEL for sulphur dioxide applies) in accordance with provisions for an Integrated Emissions Management Technique made in BAT Conclusion 58. Further details are provided in this section.
We agree with the Operator’s stated compliance status of FC.
</td><td></td></tr>
</table>

<table>
<tr><th>BAT Conclusion Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th><th>Relevant permit condition(s)</th></tr>
<tr><td></td><td>Table 14 BAT- associated emission levels for SO_2 emissions to air from multi-fuel fired combustion units, with the exception of gas turbines and stationary engines

<table><tr><th>Parameter</th><th>BAT-AEL (monthly average) mg/Nm^3</th></tr><tr><td>SO_2</td><td>35 - 600</td></tr></table>The associated monitoring is in BAT 4</td><td></td><td></td><td></td></tr>
<tr><td>37</td><td>In order to reduce carbon monoxide (CO) emissions to air from the combustion units, BAT is to use a combustion operation control.

Description: See section 1.20.5, Annex 1.

Table 15 BAT – associated emission levels for carbon monoxide emissions to air from combustion unit

<table><tr><th>Parameter</th><th>BAT- AEL (monthly average) mg/Nm^3</th></tr><tr><td>Carbon monoxide expressed as CO</td><td>$\leq$ 100</td></tr></table>
Associated monitoring is in BAT 4.</td><td>CC</td><td>The operator has confirmed that combustion control measures are in place on all units. This includes the minimisation of excess oxygen and ensuring full combustion takes place. This also brings energy efficiency savings. See comments under BAT 2. CO monitoring is carried out (either continuously for LCP or periodic for smaller units) to ensure combustion efficiency is optimised.

We agree with the Operator’s stated compliance status of CC.</td><td>2.3.1</td></tr>
<tr><td>38</td><td>In order to reduce emissions to air from the etherification process, BAT is to ensure the appropriate treatment of process off-gases by routing them to the refinery fuel gas system.</td><td>N/A</td><td>The operator has confirmed that etherification processes are not carried out on the installation.

We agree this BAT conclusion is not applicable to the installation.</td><td>N/A</td></tr>
<tr><td>39</td><td>In order to prevent upset of the biotreatment, BAT is to use a storage tank and an appropriate unit production plan management to control the toxic components dissolved content (e.g. methanol, formic acid, ethers) of the waste water stream prior to final treatment.</td><td>N/A</td><td>The operator has confirmed that etherification processes are not carried out on the installation.

We agree this BAT conclusion is not applicable to the installation.</td><td>N/A</td></tr>
</table>

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
40	**In order to reduce emissions to air of chlorinated compounds, BAT is to optimise the use of chlorinated organic compounds used to maintain catalyst activity when such a process is in place or to use non-chlorinated catalytic systems.**	CC	The operator has confirmed that non-chlorinated catalyst is used. We agree with the Operator's stated compliance status of CC.	2.3.1
41	**In order to reduce sulphur dioxide emissions to air from the natural gas plant, BAT is to apply BAT 54.**	N/A	The operator has confirmed that natural gas refining processes are not carried out on the installation. We agree this BAT conclusion is not applicable to the installation.	N/A
42	**In order to reduce nitrogen oxides (NO_X) emissions to air from the natural gas plant, BAT is to apply BAT 34**	N/A	The operator has confirmed that natural gas refining processes are not carried out on the installation. We agree this BAT conclusion is not applicable to the installation.	N/A
43	**In order to prevent emissions of mercury when present in raw natural gas, BAT is to remove the mercury and recover the mercury-containing sludge for waste disposal.**	N/A	The operator has confirmed that natural gas refining processes are not carried out on the installation. We agree this BAT conclusion is not applicable to the installation.	N/A
44	**In order to prevent or reduce waste water flow generation from the distillation process, BAT is to use liquid ring vacuum pumps or surface condensers.** **Applicability**. May not be applicable in some retrofit cases. For new units, vacuum pumps, either in or not in combination with the steam ejectors, may be needed to achieve a high volume (10 mm Hg). Also, a spare should be available in case the vacuum pump fails.	CC	Both vacuum distillation units use a combination of steam ejectors (to desalter wash water) and surface condensers to achieve the required vacuum. Steam requirements are low level and generally provided from waste process heat which delivers energy efficiency gains, reductions in raw material usage and eliminates venting. We agree with the Operator's stated compliance status of CC.	2.3.1

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
45	In order to prevent or reduce water pollution from the distillation process, BAT is to route sour water to the stripping unit.	CC	Sour water from the distillation units has a high oil content that can lead to foaming. Therefore, distillation sour water is routed to a large drum and combined with other sour water streams. This combined stream is used as desalter wash water. The direct benefits of this are reduction in water consumption and reabsorption of pollutants. We consider this to be an equivalent technique. See also comments under BAT 33. We agree with the Operator's stated compliance status of CC.	2.3.1
46	In order to prevent or reduce emissions to air from distillation units, BAT is to ensure the appropriate treatment of process off-gases, especially incondensable off-gases, by acid gas removal prior to further use. **Applicability**. Generally applicable for crude and vacuum distillation units. May not be applicable for standalone lubricant and bitumen refineries, with emissions of less than 1 t/d of sulphur compounds. In specific refinery configurations, applicability may be restricted, due to the need for e.g. large piping, compressors or additional amine treating capacity.	FC	Currently distillation off gases are routed to the furnaces without prior treatment. We have agreed that compliance with this BAT conclusion can be met through the application of the Integrated Emissions Management Technique set out in BAT 58. Details of estimated future SO_X reductions are included under the relevant BAT conclusion in this section (see BAT 26 and BAT 36). See also comments under BAT 26 and 36. We agree with the Operator's stated compliance status of FC.	2.3.1
47	In order to reduce emissions to air from the products treatment process, BAT is to ensure the appropriate disposal of off-gases, especially odorous spent air from sweetening units, by routing them to destruction, e.g. by incineration. **Applicability**. Generally applicable to products treatment processes where the gas streams can be safely processed to the destruction units. May not be applicable to sweetening units, due to safety reasons.	N/A	The operator has confirmed that products treatment processes are not carried out on the installation. We agree this BAT conclusion is not applicable to the installation.	2.3.1

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
48	In order to reduce waste and waste water generation when a products treatment process using caustic is in place, BAT is to use cascading caustic solution and a global management of spent caustic, including recycling after appropriate treatment, e.g. by stripping.	CC	A circulating caustic system is in use which has a top up frequency based on monitoring and performance. Spent caustic is segregated into 2 systems: • The Sulphidic caustic is routed to a single tank via a hold up drum prior to neutralisation and reuse. • The Cresylic caustic is routed to a single tank and periodically removed by tanker for offsite disposal. We agree with the Operator's stated compliance status of CC.	2.3.1
49	In order to reduce VOC emissions to air from the storage of volatile liquid hydrocarbon compounds, BAT is to use floating roof storage tanks equipped with high efficiency seals or a fixed roof tank connected to a vapour recovery system. **Description**. High efficiency seals are specific devices for limiting losses of vapour e.g. improved primary seals, additional multiple (secondary or tertiary) seals (according to quantity emitted). **Applicability**. The applicability of high efficiency seals may be restricted for retrofitting tertiary seals in existing tanks.	CC	The operator has confirmed that floating roof tanks with secondary seals are in use where filling operations are in place. We agree with the Operator's stated compliance status of CC. In order to ensure that these sources are captured by the emissions monitoring plan, Improvement Condition IC39 has been including which requires the operator to monitor emissions and identify any areas for improvement. See also comments under BAT 6 and 18.	2.3.1 IC39

<table>
<tr><th>BAT Conclusion Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th><th>Relevant permit condition(s)</th></tr>
<tr><td>50</td><td>In order to reduce VOC emissions to air from the storage of volatile liquid hydrocarbon compounds, BAT is to use one or a combination of the techniques given below.

<table>
<tr><th>Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>i. Manual crude oil tank cleaning</td><td>Oil tank cleaning is performed by workers entering the tank and removing sludge manually</td><td>Generally applicable</td></tr>
<tr><td>ii. Use of a closed-loop system</td><td>For internal inspections, tanks are periodically emptied, cleaned and rendered gas-free. This cleaning includes dissolving the tank bottom. Closed-loop systems that can be combined with end-of-pipe mobile abatement techniques prevent or reduce VOC emissions</td><td>The applicability may be limited by e.g. the type of residues, tank roof construction or tank materials</td></tr>
</table></td><td>CC</td><td>The operator has confirmed that manual tank cleaning is carried out. Third party contractors enter tanks manually and remove sludge for recovery/disposal.

Tanks are periodically emptied for internal inspection and cleaning. The removal of hydrocarbon product in the tank is maximised before opening to minimise venting to atmosphere by pumping out bottoms, breaking down heavier products with diluent, using mixers and heaters and displacement of lighter products with water.

We agree with the Operator’s stated compliance status of CC.</td><td>2.3.1</td></tr>
<tr><td>51</td><td>In order to prevent or reduce emissions to soil and groundwater from the storage of liquid hydrocarbon compounds, BAT is to use one or a combination of the techniques given below.

<table>
<tr><th>Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>i. Maintenance programme including corrosion monitoring, prevention and control</td><td>A management system including leak detection and operational controls to prevent overfilling, inventory control and risk-based inspection</td><td>Generally applicable</td></tr>
</table></td><td>PC</td><td>The operator has a management system in place that covers the requirements specified.

Secondary containment is provided by tanks bunds. There is tertiary containment in place along South Avenue.

For tanks covered by UK Competent Authority (CA) COMAH Containment Policy, compliance with this BAT conclusion is addressed through the CA inspection and assessment work. In order to ensure that measures have been applied to all relevant</td><td>1.1.1
2.3.1
3.2.3
IC42</td></tr>
</table>

<table>
<tr><th>BAT Conclusion Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th><th>Relevant permit condition(s)</th></tr>
<tr><td></td><td><table>
<tr><td></td><td>procedures on tanks at intervals to prove their integrity, and maintenance to improve tank containment. It also includes a system response to spill consequences to act before spills can reach the groundwater. To be especially reinforced during maintenance periods</td><td></td></tr>
<tr><td>ii. Double bottomed tanks</td><td>A second impervious bottom that provides a measure of protection against releases from the first material</td><td>Generally applicable for new tanks and after an overhaul of existing tanks (1)</td></tr>
<tr><td>iii. Impervious membrane liners</td><td>A continuous leak barrier under the entire bottom surface of the tank</td><td>Generally applicable for new tanks and after an overhaul of existing tanks ([1])</td></tr>
<tr><td>iv. Sufficient tank farm bund containment</td><td>A tank farm bund is designed to contain large spills potentially caused by a shell rupture or overfilling (for both environmental and safety reasons). Size and associated building rules are generally defined by local regulations</td><td>Generally applicable</td></tr>
</table></td><td></td><td>storage areas, Improvement Condition IC42 has been included which requires the operator to review secondary containment measures excluding those bunds in scope of the COMAH Containment Policy, to verify whether the requirements of CIRIA C736 guidance are met.</td><td></td></tr>
</table>

<table>
<tr><th>BAT Conclusion Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th><th>Relevant permit condition(s)</th></tr>
<tr><td></td><td>(1) Techniques ii and iii may be generally applicable where tanks are dedicated to products that require heat for liquid handling (e.g. bitumen) and where no leak is likely because of solidification</td><td></td><td></td><td></td></tr>
<tr><td>52</td><td>
In order to prevent or reduce VOC emissions to air from loading and unloading operations of volatile liquid hydrocarbon compounds, BAT is to use one or a combination of the techniques given below to achieve a recovery rate of at least 95 %.
<table>
<tr><th>Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>Vapour recovery by:
i. Condensation
ii. Absorption
iii. Adsorption
iv. Membrane separation
v. Hybrid systems</td><td>See section 1.20.6, Annex 1.</td><td>Generally applicable to loading/unloading operations where annual throughput is > 5 000 m^3/yr. Not applicable to loading/unloading operations for sea-going vessels with an annual throughput < 1 million m^3/yr (1)</td></tr>
<tr><td colspan="3">(1) A vapour destruction unit (e.g. by incineration) may be substituted for a vapour recovery unit, if vapour recovery is unsafe or technically impossible because of the volume of return vapour</td></tr>
</table>
Table 16 BAT- associated emission levels for non-methane VOC and benzene emissions to air from loading and unloading operations of volatile liquid hydrocarbon compounds
<table>
<tr><th>Parameter</th><th>BAT-AEL (hourly average) (1)</th></tr>
<tr><td>NMVOC</td><td>0.15 - 10g/Nm^3 (2) (3)</td></tr>
<tr><td>Benzene (3)</td><td><1 mg/Nm^3</td></tr>
<tr><td colspan="2">(1) Hourly values in continuous operation expressed and measured according to Directive 94/63/EA
(2) Lower value achievable with two-stage hybrid systems. Upper value achievable with single-stage adsorption or membrane system</td></tr>
</table>
</td><td>NC/CC</td><td>We agree with the Operator’s stated compliance status of NC. The operator submitted a derogation application for this BAT Conclusion in relation to the loading/unloading of sea-going vessels. We have assessed the application and are minded to grant the derogation. Details are provided in section 7.3 of this document.

The existing emission limits and monitoring requirements for the Vapour Destruction Unit (emission point A19, MVEC) have been retained except for:
• Benzene which has been set at the BAT-AEL which is lower; and
• Calculation of hourly average value for SO$_2$ has been removed, periodic monitoring is still required in line with all other parameters.

With regard to road loading, the operator has provided details of the existing recovery system and demonstrated that the recovery rate is > 95%.</td><td>2.3.1</td></tr>
</table>

<table>
<tr><th>BAT Conclusion Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th><th>Relevant permit condition(s)</th></tr>
<tr><td></td><td>(3) Benzene monitoring may not be necessary where emissions of NMVOC are at the lower end of the range.</td><td></td><td></td><td></td></tr>
<tr><td>53</td><td>In order to reduce emissions to water from visbreaking and other thermal processes, BAT is to ensure the appropriate treatment of waste water streams by applying the techniques of BAT 11.</td><td>N/A</td><td>The operator has confirmed that visbreaking is not carried out on the installation.

We agree this BAT conclusion is not applicable to the installation.</td><td>N/A</td></tr>
<tr><td>54</td><td>In order to reduce sulphur emissions to air from off-gases containing hydrogen sulphides (H_2S), BAT is to use all of the techniques given below.
<table>
<tr><th>Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>i. Acid gas removal e.g. by amine treating</td><td>See section 1.20.3, Annex 1.</td><td>Generally applicable</td></tr>
<tr><td>ii. Sulphur recovery unit (SRU), e.g. by Claus process</td><td>See section 1.20.3, Annex 1.</td><td>Generally applicable</td></tr>
<tr><td>iii. Tail gas treatment unit (TGTU)</td><td>See section 1.20.3, Annex 1.</td><td>For retrofitting existing SRU, the applicability may be limited by the SRU size and configuration of the units and the type of sulphur recovery process already in place</td></tr>
<tr><td colspan="3">(1) My not be applicable for stand-alone lubricant or bitumen refineries with a release of sulphur compounds of less than 1 t/d</td></tr>
</table>
Table 17 BAT-associated environmental performance levels for a waste gas sulphur (H_2S) recovery system
<table>
<tr><th></th><th>BAT-associated environmental performance level (monthly average)</th></tr>
<tr><td>Acid gas removal</td><td>Achieve hydrogen sulphides (H2S) removal in the treated RFG in order</td></tr>
</table></td><td>CC</td><td>The operator has confirmed that all techniques are in place to some degree.

The majority of sour gas/LPG streams are treated to remove H_2S by MEA scrubbing and subsequent recovery in the Sulphur Units. Acid gas from the process is routed to the sulphur recovery units. There are 2 Sulphur Recovery Units (SRUs) which include a Super Claus 3rd stage exothermic catalytic treatment stage to provide further tail gas treatment and improve recovery rates. As existing units, the up-graded SRUs are capable of meeting the efficiency recovery rate.

It is not viable to treat all, in particular small streams. The operator has elected to manage emissions from combustion units (but excluding gas turbines) and the FCCU in accordance with provisions for an Integrated Emissions Management Technique made in BAT Conclusion 58 to ensure that environmental equivalence to BAT 36 is achieved.

We agree with the Operator’s stated compliance status of CC.</td><td>2.3.1
2.3.8</td></tr>
</table>

<table>
<tr><th>BAT Conclusion Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th><th>Relevant permit condition(s)</th></tr>
<tr><td></td><td>
<table>
<tr><td></td><td>to meet gas firing BAT-AEL for BAT 36</td></tr>
<tr><td>Sulphur recovery efficiency ([1])</td><td>New unit: 99.5 – > 99.9 %
Existing unit: ≥ 98.5 %</td></tr>
<tr><td colspan="2">(1) Sulphur recovery efficiency is calculated over the whole treatment chain (including SRU and TGTU) as the fraction of sulphur in the feed that is recovered in the sulphur stream routed to the collection pots. When the applied technique does not include a recovery of sulphur (e.g. seawater scrubber) it refers to the sulphur removal efficiency, as the % of sulphur removed by the whole treatment chain</td></tr>
</table>
The associated monitoring is described in BAT 4.</td><td></td><td></td><td></td></tr>
</table>

<table>
<tr><th>BAT Conclusion Number</th><th>Summary of BAT Conclusion requirement</th><th>Status NA/ CC / FC / NC</th><th>Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement</th><th>Relevant permit condition(s)</th></tr>
<tr><td>55</td><td>In order to prevent emissions to air from flares, BAT is to use flaring only for safety reasons or for non-routine operational conditions (e.g. start-ups, shutdown).</td><td>CC</td><td>The operator has confirmed that refinery streams are not routinely routed to flare. Flaring is utilised to manage events, non-routine and unplanned unit shutdowns and reformer regens.

The flare gas recovery compressor minimises flaring by recovering gas into the refinery fuel gas main. When planning events, potential flaring sources are considered so that staged flaring can be adopted, taking into account compressor capability, to maximise flare gas recovery and minimise flaring.

Flare gas recovery rates and flaring is monitored and reviewed every shift. The flare check list for each operational area enables a systematic check on all potential routings and helps minimise flaring.

We agree with the Operator’s stated compliance status of CC. In order to ensure flaring is minimised, Improvement Condition IC43 has been included which requires the operator to review the flare system operation and identify any opportunities for flare minimisation.

See also comments under BAT 56.</td><td>2.3.1, 3.5.5, 4.3.8 and IC43</td></tr>
<tr><td>56</td><td>In order to reduce emissions to air from flares when flaring is unavoidable, BAT is to use the techniques given below.

<table><tr><th>Technique</th><th>Description</th><th>Applicability</th></tr><tr><td>i. Correct plant design</td><td>See section 1.20.7, Annex 1.</td><td>Applicable to new units.
Flare gas recovery system may be retrofitted in existing units</td></tr><tr><td>ii. Plant management</td><td>See section 1.20.7, Annex 1.</td><td>Generally applicable</td></tr></table></td><td>CC</td><td>The operator has confirmed that all techniques are applied to some degree.

The flare main has 4 stacks; all refinery units are connected.

Gas to each flare is routed to through a system of surge and/or seal drums. Flare 4 is used preferentially because it is the most remotely located to neighbouring residential areas.
There is sufficient spare capacity; site requirements can be met by 3 flares.</td><td>2.3.1, 3.5.5, 4.3.8 and IC43</td></tr>
</table>

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
	iii. Correct flaring devices design — See section 1.20.7, Annex 1. — Applicable to new units iv. Monitoring and reporting — See section 1.20.7, Annex 1. — Generally applicable		The systems is designed to provide sufficient capacity for unplanned and emergency events. Flare gas recovery and tip flaring is monitored and assessed to ensure flaring is minimised. All flares are located at elevation and are fitted with a pilot. Pilot detection is not currently installed on all flares although tip design modification to allow this is in progress. Each flare is equipped with manually adjustable steam feed to ensure efficient combustion and reduce smokiness. Flare gas recovery is measured on the main flare gas recovery compressor (GGC3). There is continuous gas flow measurement on flare 4. Other flaring is not directly measured but steam flow is measured to each flare stack – this is used to calculate flare gas flow for reporting purposes. Flare gas quality is sampled once a week. Emissions are estimated from measured data together with log book entries and known flaring events. Remote real time monitoring of flares is available via cctv in the control room. We agree with the Operator's stated compliance status of CC. In order to ensure flaring is minimised, Improvement Condition IC43 has been included which requires the operator to review the flare system operation. In addition, the operator is required to notify acid/sour gas flaring events over a specified threshold and is now required to report on flaring events that exceed 1.6 tonnes/hour as a daily mean.	

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
			See also comments under BAT 55.	
57	**In order to achieve an overall reduction of NO_X emissions to air from combustion units and fluid catalytic cracking (FCC) units, BAT is to use an integrated emission management technique as an alternative to applying BAT 24 and BAT 34.** **Description:** The technique consists of managing NO_X emissions from several or all combustion units and FCC units on a refinery site in an integrated manner, by implementing and operating the most appropriate combination of BAT across the different units concerned and monitoring the effectiveness thereof, in such a way that the resulting total emissions are equal to or lower than the emissions that would be achieved through a unit-by-unit application of the BAT-AELs referred to in BAT 24 and BAT 34. This technique is especially suitable to oil refining sites: • with a recognised site complexity, multiplicity of combustion and process units interlinked in terms of their feedstock and energy supply; • with frequent process adjustments required in function of the quality of the crude received; • with a technical necessity to use a part of process residues as internal fuels, causing frequent adjustments of the fuel mix according to process requirements. **BAT-associated emission levels: See Table 18.** In addition, for each new combustion unit or new FCC unit included in the integrated emission management system, the BAT-AELs set out under BAT 24 and BAT 34 remain applicable. **Table 18 BAT associated emission levels for NOX emissions to air when applying BAT 58** The BAT-AEL for NO_x emissions from the units concerned by BAT 57, expressed in mg/Nm^3 as a monthly average value, is equal to or less than the weighted average of the NO_x concentrations	FC	The operator has submitted a document setting out units deemed suitable to be managed through an Integrated Emissions Management Technique (IEMT). This sets out: • The units to be included in the IEMT; • Typical flue gas flow rates for each unit and how these have been determined; • The associated BAT AEL for NO_X; and • The calculated fixed IEMT limit. This is based on the following principles in line with the IEMT Protocol: • Mean unit flue gas flow rates based on actual unit flow rate data between 2014 – 2017, which is representative of typical operation. • AEL set at the top of the range for non-multi-fuel fired plant in line with our position. • Maximum range applied for multi fuel fired plant due to lack of correlation between fuel fired and NO_X emissions. As specified in the IEMT Protocol, furnaces firing RFG permitted under permit ZP3839MG, and part of the installation, may be included in the IEMT. The refinery Bref BAT-AELs have been applied. The operator is required to submit further information setting out details of the monitoring programme for the fixed bubble to demonstration compliance with the IEMT fixed bubble limit. Improvement Condition 44 has been included to this effect.	2.3.1, 3.7.1, 3.7.2, 4.3.9 and IC44.

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
	(expressed in mg/Nm^3 as a monthly average) that would be achieved by applying in practice at each of those units techniques that would enable the units concerned to meet the following: (a) for catalytic cracking process (regenerator) units: the BAT-AEL range set out in Table 4 (BAT 24); (b) for combustion units burning refinery fuels alone or simultaneously with other fuels: the BAT-AEL ranges set out in Tables 9, 10 and 11 (BAT 34). This BAT-AEL is expressed by the following formula: $\frac{\Sigma\,[(\text{flue gas flow rate of the unit concerned}) \times (NO_x \text{ concentration that would be achieved for that unit})]}{\Sigma(\text{flue gas flow rate of all units concerned})}$ Notes 1. The applicable reference conditions for oxygen are those specified in Table 1. 2. The weighing of the emission levels of the individual units is done on the basis of the flue-gas flow rate of the unit concerned, expressed as a monthly average value (Nm^3/hour), which is representative for the normal operation of that unit within the refinery installation (applying the reference conditions under Note 1). 3. In case of substantial and structural fuel changes which are affecting the applicable BAT-AEL for a unit or other substantial and structural changes in the nature or functioning of the units concerned, or in case of their replacement or extension or the addition of combustion units or FCC units, the BAT-AEL defined in Table 18 needs to be adjusted accordingly. Monitoring associated with BAT 57			

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
	BAT for monitoring emissions of NO_x under an integrated emission management technique is as in BAT 4, complemented with the following: • a monitoring plan including a description of the processes monitored, a list of the emission sources and source streams (products, waste gases) monitored for each process and a description of the methodology (calculations, measurements) used and the underlying assumptions and associated level of confidence; • continuous monitoring of the flue-gas flow rates of the units concerned, either through direct measurement or by an equivalent method; • a data management system for collecting, processing and reporting all monitoring data needed to determine the emissions from the sources covered by the integrated emission management technique.			
58	**In order to achieve an overall reduction of SO_2 emissions to air from combustion units, fluid catalytic cracking (FCC) units and waste gas sulphur recovery units, BAT is to use an integrated emission management technique as an alternative to applying BAT 26, BAT 36 and BAT 54.** **Description:** The technique consists of managing SO_2 emissions from several or all combustion units, FCC units and waste gas sulphur recovery units on a refinery site in an integrated manner, by implementing and operating the most appropriate combination of BAT across the different units concerned and monitoring the effectiveness thereof, in such a way that the resulting total emissions are equal to or lower than the emissions that would be achieved through a unit-by-unit application of the BAT-AELs referred to in BAT 26 and BAT 36 as well as the BAT-AEPL set out under BAT 54. This technique is especially suitable to oil refining sites:	FC	The operator has submitted a document setting out units deemed suitable to be managed through an Integrated Emissions Management Technique (IEMT). This sets out: • The units to be included in the IEMT; • Typical flue gas flow rates for each unit and how these have been determined; • The associated BAT AEL for SO_2; and • The calculated fixed IEMT limit. This is based on the following principles in line with the IEMT Protocol: • Mean unit flue gas flow rates based on actual unit flow rate data between 2014 – 2017, which is representative of typical operation. • AEL set at the top of the range for non-multi-fuel fired plant in line with our position • AEL for multi-fuel fired plant calculated adopting the principles agreed in the MFF Protocol.	2.3.1, 3.7.1, 3.7.2, 4.3.9 and IC44

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
	- with a recognised site complexity, multiplicity of combustion and process units interlinked in terms of their feedstock and energy supply; - with frequent process adjustments required in function of the quality of the crude received; - with a technical necessity to use a part of process residues as internal fuels, causing frequent adjustments of the fuel mix according to process requirements. **BAT associated emission level**: See Table 19. In addition, for each new combustion unit, new FCC unit or new waste gas sulphur recovery unit included in the integrated emission management system, the BAT-AELs set out under BAT 26 and BAT 36 and the BAT- AEPL set out under BAT 54 remain applicable. **Table 19 BAT associated emission level for SO_2 when applying BAT 58** The BAT-AEL for SO_2 emissions from the units concerned by BAT 58, expressed in mg/Nm3 as a monthly average value, is equal to or less than the weighted average of the SO_2 concentrations (expressed in mg/Nm3 as a monthly average) that would be achieved by applying in practice at each of those units techniques that would enable the units concerned to meet the following: (a) for catalytic cracking process (regenerator) units: the BAT-AEL ranges set out in Table 6 (BAT 26); (b) for combustion units burning refinery fuels alone or simultaneously with other fuels: the BAT-AEL ranges set out in Table 13 and in Table 14 (BAT 36); and (c) for waste gas sulphur recovery units: the BAT-AEPL ranges set out in Table 17 (BAT 54). This BAT-AEL is expressed by the following formula:		As specified in the IEMT Protocol, furnaces firing RFG permitted under permit ZP3839MG, and part of the installation, may be included in the IEMT. The refinery Bref BAT-AELs have been applied. The operator is required to submit further information setting out details of the monitoring programme for the fixed bubble to demonstration compliance with the IEMT fixed bubble limit. Improvement Condition 44 has been included to this effect.	

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
	Σ [(flue gas flow rate of the unit concerned) x (SO_2 concentration that would be achieved for that unit)] --- Σ(flue gas flow rate of all units concerned) Notes: 1. The applicable reference conditions for oxygen are those specified in Table 1. 2. The weighing of the emission levels of the individual units is done on the basis of the flue-gas flow rate of the unit concerned, expressed as the monthly average value (Nm^3/hour), which is representative for the normal operation of that unit within the refinery installation (applying the reference conditions under Note 1). 3. In case of substantial and structural fuel changes which are affecting the applicable BAT-AEL for a unit or other substantial and structural changes in the nature or functioning of the units concerned, or in case of their replacement, extension or the addition of combustion, FCC, or waste gas sulphur recovery units, the BAT-AEL defined in Table 19 needs to be adjusted accordingly. Monitoring associated with BAT 58 BAT for monitoring emissions of SO_2 under an integrated emission management approach is as in BAT 4, complemented with the following: • a monitoring plan including a description of the processes monitored, a list of the emission sources and source streams (products, waste gases) monitored for each process and a description of the methodology (calculations, measurements) used and the underlying assumptions and associated level of confidence;			

BAT Conclusion Number	Summary of BAT Conclusion requirement	Status NA/ CC / FC / NC	Assessment of the installation capability and any alternative techniques proposed by the operator to demonstrate compliance with the BAT Conclusion requirement	Relevant permit condition(s)
	• continuous monitoring of the flue-gas flow rates of the units concerned, either through direct measurement or by an equivalent method; • a data management system for collecting, processing and reporting all monitoring data needed to determine the emissions from the sources covered by the integrated emission management technique			

7 Review and assessment of derogation requests made by the operator in relation to BAT Conclusions which include an associated emission level (AEL) value

Article 15(4)

The IED enables a competent authority to allow derogations from BAT AELs stated in BAT Conclusions under specific circumstances as detailed under Article 15(4):

By way of derogation from paragraph 3, and without prejudice to Article 18, the competent authority may, in specific cases, set less strict emission limit values. Such a derogation may apply only where an assessment shows that the achievement of emission levels associated with the best available techniques as described in BAT conclusions would lead to disproportionately higher costs compared to the environmental benefits due to:

> *(a) the geographical location or the local environmental conditions of the installation concerned; or*
>
> *(b) the technical characteristics of the installation concerned.*

Cost Benefit Analysis

If a derogation is applicable then Cost Benefit Analysis (CBA) is undertaken. The CBA allows calculation to indicate whether the costs of compliance are greater or less than the environmental benefits.

It essentially groups all the costs on one side, with all the benefits, as far as possible, on the other side. It then includes the effect of time on the value of those costs and benefits in order to produce a Net Present Value (NPV).

This gives an indication of whether those costs are disproportionate of not, but there are many sensitivities in the analysis and many aspects of the environment that cannot yet be monetised so the actual decision on disproportionality rests with the National Derogation Panel (NDP).

Where the NPV is positive, this indicates that the cost of compliance with the BAT-AEL(s) does not outweigh the environmental benefits. Where the NPV is negative, this indicates that the costs of compliance with the BAT-AEL(s) outweigh the environmental benefits.

Derogation Requests

As part of their Regulation 60 Notice response, the operator has requested derogations from compliance with the AEL values included in BAT Conclusions 12, 25 and 52 for the refining of Mineral Oil and Gas. All requests are non-time limited until review of the permit is triggered by an event stipulated in article 21 of the IED.

Sufficient information was provided in their response, and as additional information, to allow us to commence assessment of the derogation requests.

We have decided to grant the derogation requested by the operator in respect to the AEL values described in BAT Conclusion 12, 25 and 52. We have set ELVs that are higher than the BAT-AELs in the Consolidated Variation Notice that will ensure suitable protection of the environment.

The justification for our decision to allow derogations in respect of the AEL values associated with BATs 12, 25 and 52 is set out below.

7.1 Derogation from BAT 12:

The operator requested a derogation from BAT 12, in relation the BAT-AEL for COD at Outfall 2, as described in BAT Conclusions for Refining of Mineral Oil and Gas (2014/7/738/EU), until a review of the permit is triggered by an event stipulated in article 21 of the Industrial Emissions Directive 2010 (2010/75/EU).

BAT 12 requires operators to reduce the emission load of pollutants in the waste water discharge to the receiving body by the removal of insoluble substances by recovering oil, suspended solids and dispersed oil and the removal of soluble substances by all treatment techniques listed including biological treatment and clarification and additional treatment steps to further remove organic substances if required. An Associated Emission Limit (AEL) range of 30-125 mg/l is set for Chemical Oxygen Demand (COD).

7.1.1 The Derogation justification criteria from BAT 12:

Fawley refinery is an integrated refinery and chemicals complex. Whilst the chemicals site is permitted separately, it forms part of the installation and there are a number of common services including utilities and sewer systems, which is typical of a large integrated site. The majority of process units use a once-through salt-water cooling system, which was common at the time of construction. More recently constructed units have closed systems using cooling towers.

There are 3 separate outfall lines at different geographical locations that serve different ‘zones’ of the site. This is a reflection of the size and age of the site which has expanded over time. Treated waste water and cooling water is discharged into Southampton Water via the 3 outfalls. Outfall 3 was originally constructed in the 1920s, with outfalls 1 and 2 constructed in the 1950’s.

The existing facilities were designed and built to treat effluent from refining activities. A summary of the contribution of flows at the two main outfalls is presented below which shows the majority of effluent processed comes from the refining operations.

Outfall	Refinery contribution m^3/hr	Chemicals contribution m^3/hr	Total flow m^3/hr
1	9,400	0	9400
2	2780	3120	5900

There are separate clean and process water sewer systems. Typically, cooling water is discharged to the clean sewer and process effluent to the process water sewer. However, particular effluent streams from the chemicals plant are discharged into the clean water sewer because they are soluble and have solvent properties which would result in re-solubilising oils. This would be detrimental to the existing process sewer treatment system which relies on physical separation of contaminants. Clean and process sewers are combined before discharge. Mass balance calculations have determined the contributions from the process and clean water streams at each outfall; these factors have been applied to the BAT-AELs.

Techniques currently employed to reduce the volume of contaminated water include the segregation of clean and process water streams. Both the clean and process water sewer systems have separators for the removal of free oil.

There is provision in the BAT Conclusion to monitor Total Organic Carbon (TOC) as a surrogate for COD. Data were submitted with the initial Regulation 60 response which showed a ratio of 3:1 COD: TOC. This was verified with our Water Quality Technical Experts. Therefore, it has been agreed that the BREF COD AEL range of 30 – 125 mg/l corresponds to a TOC AEL range of 10 – 42 mg/l.

Due to the composition of the effluent stream, we have also reviewed the Common Waste Water (CWW) Bref. The BAT-AEL for TOC is 33 mg/l (for direct emissions to a receiving water body). There is provision to set the AEL at 100 mg/l where the abatement efficiency $\geq$ 95% (annual average). Whilst the existing methyl ether ketone (MEK) steam stripper achieves this, it cannot be demonstrated for the smaller streams.

The derogation application concerns only Outfall 2. The BAT AEL for TOC (as a surrogate of COD) of 42 mg/l is not met at this outfall. This Outfall serves predominantly the effluent from the integrated chemicals plant as well as part of the refinery clean water effluent stream. The clean water sewer passes through a 3-bay separator system. The process water sewer system passes through either a 2 or 5 bay separator system. During periods of heavy rainfall, this outfall provides storm overflow discharge. Waste water streams from the Butyl Polymers and MEK chemical plants contribute significantly to elevate the TOC at the outfall. Contrary to the usual configuration, effluent from the MEK plant discharges into the clean water sewer because of its solvent properties which increase the solubility of oil in the effluent and is therefore separated from the dirty water system.

The derogation criteria is based on technical characteristics. The configuration of the sewer systems on site is such that clean and dirty water streams are separated prior to treatment, however, due to the integrated nature of the refinery and chemical plant, effluent streams from all processes are discharged through a single sewer system. The composition of effluent streams from certain chemicals processes requires particular handling. MEK process effluent is discharged to the clean water sewer because of its solvent properties. Due to the high flow rate, it is not technically feasible to treat the entire clean water discharge. Equally, given the enclosed nature of the existing system, it would not be practical to divert streams away from the sewer to return following treatment, so this is not a viable option. The MEK and Butyl Polymers process effluent streams present difficulties for biological treatment due to foaming tendencies and the presence of adhesive rubber fines respectively. As there is no single treatment process that can treat all the effluent streams from the different chemical processes, this makes it more technically difficult and costly to comply, making it a special case which would result in costs over and above typical plant costs.

We agreed that the justification for derogation met the requirements of Article 15(4).

7.1.2 Costs and Benefits consideration for BAT 12

Set out below is a summary of the options considered and an assessment of the costs of compliance with the BAT-AEL against the costs associated with the harm avoided (Cost Benefit Analysis – CBA).

The operator described six relevant options for achieving the BAT-AEL. The operator already employs a number of these to some degree on various effluent streams (equalisation, neutralisation and separation/solids, gas stripping and process control) and justified the screening out of Dissolved Gas Flotation. We believe that all possible options have been considered. Additional Gas Stripping and BiOx were taken forward to conduct CBA.

The operator provided details of the investment costs for the expansion and reconfiguration of the existing gas striping systems and a BiOx unit. The stripper reconfiguration cost (£0.7M) is based on retrofitting alternative routing for high-TOC process effluent streams. The costs for a BiOx (£6.8M) were compared against data in the Bref, scaled to treat the effluent streams from the MEK plant and found to be comparable based on size and scale. The total costs include additional costs above those normally expected such as retrofitting pipework design and installation due to the integrated nature of the site with the downstream chemicals plant, configuration of the existing sewer system and composition of the different effluent streams.

As part of our review, we carried out a number sensitivity checks around the data inputs. The results of these checks did not change the overall outcome of the assessments.

The capital expenditure costs and Net Present Value (NPV) for each BAT option are summarised in the table below.

Option	Total capital investment £M	Net Present Value £M
Stripper reconfiguration	0.7	-1.1
BiOx	6.8	-8.6

Compliance with the BAT-AEL can therefore be demonstrated as disproportionately costly compared to the environmental benefits in relation to the BiOx which shows the costs of meeting the BAT-AEL outweigh the benefits by -£8.6M. The cost of compliance in relation to the stripper reconfiguration is close to zero (-£1.1M). The operator has initiated a project to evaluate the technical feasibility of the permanent use of this routing which, subject to successful development, is scheduled for completion by end 2020.

7.1.3 Environmental consequences of allowing a derogation for BAT 12 and other considerations

There will be no increase in emissions and impacts on sensitive receptors. Releases at current levels have already been assessed as part of the permitting process. Emissions will start to reduce, as will the subsequent impact, from 2021 when the on-site improvements are completed.

In addition to the proposed derogation, a number of other improvements are either planned for completion or being trialled. These include improved process control measures on the butyl polymers plant (additional flow meters, additional control systems to reduce the use of reaction chemicals and additional mixing facilities) and installation of sieves on the butyl polymers plant to increase recovery of rubber at source.

The estimated reductions in TOC from the planned improvements have been quantified at source. Because it is not possible to quantify the corresponding reductions at the outfall until the improvements are completed, we have included an Improvement Condition that requires the operator to submit a plan to regularly review the monitored release data at the outfall, taking into account the key milestones for the various improvement projects. This also requires the operator to identify whether compliance at a lower ELV can be achieved following data review.

7.1.4 Conclusion for BAT 12 derogation assessment

All suitable abatement options have been considered and taken forward for CBA where appropriate. Robust CBAs have been completed to support the derogation application. There will be no increase in emissions and therefore impact on sensitive receptors. In conclusion, the operator has demonstrated that the costs of achieving the BAT-AEL through the installation of a BiOx plant are higher than the environmental benefits. However, in the case of the stripper reconfiguration, this is marginal and the operator has committed to pursue a permanent routing change as the proposed derogation.

The National Derogation Panel agreed with our conclusions 14 May 2018.

7.2 Derogation from BAT 25

The operator requested a derogation from BAT 25 as described in BAT Conclusions for Refining of Mineral Oil and Gas (2014/7/738/EU), until a review of the permit is triggered by an event stipulated in article 21 of the Industrial Emissions Directive 2010 (2010/75/EU).

BAT 25 which requires operators to reduce dust and metals emissions to air from the catalytic cracking process (regenerator), and sets a BAT-AEL for dust emissions to air of 10 – 50 mg/Nm^3 (monthly average).

7.2.1 The derogation justification criteria from BAT 25

The Fluidised Catalytic Cracking Unit (FCCU) was built as part of the original site in the early 1950s. The unit has been heavily modified at various times. It is fitted with a Multistage Cyclone Separator (two sets of internal cyclones followed by a third set of cyclones in a Tertiary Cyclone Vessel (TCV)). Efficient capture of dust depends on particle size distribution. Cyclones are the most effective abatement technique for coarser dust (> 10 - 40 microns) and Electrostatic Precipitators (ESP) are most effective for finer dust. Cyclone technology is often used in combination with other techniques such as ESP. BAT Conclusion 25 is based on achievable dust emissions from catalytic cracking operations fitted with cyclone and ESP abatement. Whilst some plant have ESP fitted, Fawley and a number of others in the UK and Europe, were designed without ESP.

Fawley already apply both BATs for primary and process related control: use of attrition resistant catalyst and feed pre-treatment. Retrofitting standard design ESP, or any other abatement equipment, is not practicable because of the lack of available space.

The area on and around the FCCU is heavily congested; as well as the FCCU, it also contains downstream processing units, sulphur plants, distillation units and residfiner. Existing space near the TCV cannot be built on because it is required for regular access (catalyst removal by tanker and crane for maintenance). The installation of any new BAT on Block 8 would require a unique design. The units would need to be designed with a smaller footprint due to the space constraints. In addition, the units would need to be elevated to 6m to lift them clear of existing live equipment and maintain maintenance access for existing equipment. This would present a number of atypical construction challenges and result in increased investment costs. Siting the abatement plant elsewhere on site has been considered but this would result in additional material and engineering costs required to connect the abatement plant to the FCCU across a considerable distance.

The derogation criteria is based on technical characteristics. The configuration of the plant on site will make it more technically difficult and costly to comply because the FCCU is located within the centre of the site on an already congested block. Due to the existing space constraints, bespoke abatement equipment would need to be designed and installed. The space constraints present a number of technical difficulties making it a special case which would result in costs over and above typical plant costs.

We agreed that the justification for derogation met the requirements of Article 15(4).

7.2.2 Costs and Benefits consideration for BAT 25

Set out below is a summary of the options considered and an assessment of the costs of compliance with the BAT-AEL against the costs associated with the harm avoided (Cost Benefit Analysis – CBA).

The operator already employs the two primary/process related abatement techniques set out in the BAT conclusions. Of the four secondary abatement techniques specified, the operator already applies one (multistage cyclone separators) and have considered the other three (electrostatic precipitator (ESP), third stage blowback filter and wet gas scrubber (WGS)). We believe that all possible options have been considered. The operator provided satisfactory justification to discount the option of a third stage blowback filter. Therefore ESP and WGS options were taken forward to conduct CBA.

The operator provided details of the investment costs for an ESP unit at Fawley. These were compared against data in the Bref, scaled to meet the existing throughput at Fawley and not found to be significantly different. The total cost of £58M (in 2017) includes additional costs above those normally expected for an ESP, such as engineering drawings for the bespoke design and additional support steel, due to the congested location which are unique to the site. The investment cost for a WGS at Fawley was provided as £106M in 2017.

As part of our review, we carried out a number sensitivity checks around the data inputs. The results of these checks did not change the overall outcome of the assessments.
The capital expenditure costs and Net Present Value (NPV) for each BAT option are summarised in the table below.

Option	**Total capital investment £M**	**Net Present Value £M**
ESP	58	-36.3
WGS	106	-68.5

In conclusion the CBA shows that the costs of meeting BAT-AEL outweigh the benefits by -£36.3M. Compliance with the BAT-AEL can therefore be demonstrated as disproportionately costly compared to the environmental benefits.

7.2.3 Environmental consequences of allowing a derogation for BAT 25 and other considerations

Maximum monthly average dust emissions are reported quarterly to us. In addition, the operator has provided information in relation to dispersion modelling completed in support of the derogation application. The model outputs predict the emissions from the FCCU to account for 0.6% of the AQO for PM10, or 1.5% of the existing background levels, and therefore not considered to be significant. This is supported by the conclusions drawn when determining the original permit application that the process contribution (for all sources of dust emissions from the refinery) is low compared to the EAL and is not therefore likely to threaten air quality standards. A number of improvements have subsequently been implemented which further reduce dust emissions, for example all but one furnace has now removed all oil firing, operating solely on gaseous fuels.

The impact of releases to air on designated habitats sites within 10km of the site was considered as part of the permit review in 2007. We concluded there was no adverse effect or potential damage from aerial emissions from the site. As discussed above, a number of improvements have subsequently been implemented that reduce dust emissions. Therefore, allowing the derogation will not increase the emissions loading from site and therefore presents no additional risk.

Information from the local authority (New Forest District Council) shows there have been no exceedances of the National Air Quality Objective for PM10 at the local Holbury monitoring location. There is no Air Quality Management Plan for dust in the locality.

There is no scope to reduce the current dust ELV. Continued compliance with this is expected and therefore there will be no deterioration.

However, in order to meet the Bref BAT-AEL for SO_X, and continue to reduce SO_X emissions, it will be necessary for the $DeSO_X$ catalyst addition rate to be increased. There is the potential for increased dust emissions as a result of this although trials shows this is not considered to be significant and continued compliance with the current ELV is expected. To ensure current performance is maintained or improved we have included an Improvement Condition that requires the operator to review compliance data at a suitable period following stabilisation of the new $DeSO_X$ dosing regime upstream of the TCV.

7.2.4 Conclusion for BAT 25 derogation assessment

All suitable abatement options have been considered and taken forward for CBA where appropriate. Robust CBAs have been completed to support the derogation application. There is not scope to reduce the current dust ELV but continued compliance with this is expected and therefore there will be no deterioration. In conclusion, the operator has demonstrated that the costs of achieving the BAT-AEL are higher than the environmental benefits.

The National Derogation Panel agreed with our conclusions 6 December 2017.

7.3 Derogation from BAT 52

The operator requested a derogation from BAT 52, for marine loading operations, as described in BAT Conclusions for Refining of Mineral Oil and Gas (2014/7/738/EU), until a review of the permit is triggered by an event stipulated in article 21 of the Industrial Emissions Directive 2010 (2010/75/EU).

BAT 52 requires operators to prevent or reduce VOC (Volatile Organic Compound) emissions to air from loading and unloading operations of volatile liquid compounds which sets BAT-AELs for emissions to air of Non-Methane VOCs of 0.15 – 10mg/Nm^3 and Benzene of <1mg/Nm^3.

7.3.1 The derogation justification criteria from BAT 52

The Fawley Marine Terminal (FMT) dates from the late 1950s and has been adapted to accommodate increasing demand for fuels and vessel size. The structure is 1400 m long and handles around 2,000 ship movements (22 million tonnes of crude and product movements) each year. It is constructed 500m from the shoreline. There are nine berths in total; five ocean (high loading rates around 2000 m^3/hour for petrol and 750 m^3/hour for benzene) and four coastal (petrol loading rates of 500 m^3/hour).

It is not possible to reduce jetty movements by scaling back petrol manufacturing rates without having a significant impact of diesel production and UK fuel balances.

Berth 4 is already fitted with a benzene vapour destruction facility (incinerator). Although this plant can treat a vapour rate of 1560 m^3/hour, it is not sufficiently sized to treat ocean going cargoes.

The FMT is heavily utilised and congested. It is configured to load applicable products from seven of the berths spread across 1000m. It is always operational and is never shutdown.

The derogation criteria is based on technical characteristics. The configuration of the plant on site will make it more technically difficult and costly to comply because the jetty area is highly congested and operates continuously, at capacity, from multiple berths. Due to existing space constraints, abatement equipment would need to be sited away from the jetty which presents practical constraints and results in additional costs. The berths do not have space to accommodate additional vapour collection lines to connect the jetty with a vapour recovery unit; new structural platforms would be required. The space constraints present a number of technical difficulties, making it a special case which would result in costs over and above typical plant costs.

We agreed that the justification for derogation met the requirements of Article 15(4).

7.3.2 Costs and Benefits consideration for BAT 52

Set out below is a summary of the options considered and an assessment of the costs of compliance with the BAT-AEL against the costs associated with the harm avoided (Cost Benefit Analysis – CBA).

BAT 52 includes five secondary abatement techniques (condensation, absorption, adsorption, membrane separation and hybrid systems), all of which have been considered by the Operator. There is an existing Vapour Destruction Unit (VDU) which destroys recovered vapour by incineration from benzene ships loading on berth 4. The operator has considered absorption/adsorption (Large ADAB VRU) and a hybrid system (Small ADAB VRU and existing VDU). We believe that all possible options have been considered. The operator provided satisfactory justification to discount the options of condensation and membrane separation. Therefore both Large and Small ADAB options were taken forward to conduct CBA.

The operator provided details of the investment costs for the installation of both a large and small VRU at Fawley. These were compared against data in the Bref for typical costs of VRUs and appear reasonable although not directly comparable. The total cost of £24.6M (in 2017) and £18.5M (in 2017) for a large and small VRU respectively includes additional costs above those normally expected for the VRU, such as foundations, piping, instrumentation and steel supports for berth extensions due to the congested location which are unique to the site design.

As part of our review, we carried out a number of sensitivity checks around the data inputs. The results of these checks did not change the overall outcome of the assessments. The capital expenditure costs and NPV for each option are summarised in the table below.

Option	**Total capital investment £M**	**Net Present Value £M**
BAT-LARGE VRU ADAB	24.6	-33.2
SMALL VRU + existing VDU hybrid	18.5	-26.6

In conclusion the CBA shows that the costs of meeting BAT-AEL outweigh the benefits by -£33.2M. Compliance with the BAT-AEL can therefore be demonstrated as disproportionately costly compared to the environmental benefits.

7.3.3 Environmental consequences of allowing a derogation for BAT 52 and other considerations

Allowing the proposed derogation would not cause any significant pollution or prevent a high level of protection of the environment as a whole to be achieved.

Approximately 230 tonnes of VOCs to atmosphere are emitted through vessel loadings per year. The Marine Terminal operates at capacity, therefore it can be assumed that the emissions are currently at their maximum.

Results of periodic emissions monitoring of the existing VDU are reported quarterly. In addition, the operator has provided information in relation to dispersion modelling completed in support of the derogation application. The model outputs predict worst case process contributions from loading operations are less than 0.5% of the AQO/EAL and therefore considered to be not significant. Furthermore, the location of the marine terminal within the Southampton Water channel means that sensitive receptors are not located in close proximity. The modelling report has been subject to our own screening tool and we have found that the results concur with the statements made by the operator in support of the derogation application – impacts from all VOCs are not considered significant.

The impact of releases to air on designated habitats sites within 10km of the site was considered as part of the permit review in 2007. We concluded there was no adverse effect or potential damage from aerial emissions from the site. Allowing the derogation will not increase the emissions loading from site and therefore presents no additional risk.

We are ensuring other measures are taken on site to manage and minimise VOC emissions in the future, including an Improvement Condition that requires the operator to implement a fugitive emissions management plan and report results to us.

7.3.4 Conclusion for BAT 52 derogation assessment

All suitable abatement options have been considered and taken forward for CBA where appropriate. Robust CBAs have been completed to support the derogation application. The existing ELV for non-methane VOCs from the VDU is lower than the BAT–AEL and will therefore be retained to ensure no deterioration. The operator has demonstrated that benzene emissions from the VDU can comply with the BAT-AEL. As this is lower than the current ELV, this has been reduced in Table S3.1a. In conclusion, the operator has demonstrated that the costs of achieving the BAT-AEL are disproportionate to the environmental benefits.

The National Derogation Panel agreed with our conclusions 6 December 2017.

8 Emissions to Water

The consolidated permit incorporates the three current discharges to controlled waters identified as W1 to W3.

Our review of the emission limits considered the BAT conclusions. The relevant waste water BAT-AEL from the BAT Conclusions is BAT 12. We have set ELVs and monitoring in accordance with Table 3 referenced in BATs 10 and 12.

In addition to the review of compliance against the relevant BAT Conclusions for emissions to water, this Permit review also provides an opportunity to consider whether the discharge to surface water will maintain River Quality Objectives (RQOs) in the receiving watercourse to ensure the water quality objectives under Water Framework Directive will be met. The operator has submitted an initial screening assessment and we agree with the outcome of this assessment which identifies further modelling is required for mercury at Outfall 1. Improvement Condition IC45 has been included in Table S1.3 Improvement Programme Requirements which requires the operator to undertake the relevant modelling and submit findings and any actions required. Details of the Improvement Conditions are included in Annex 3 below.

9 Additional IED Chapter II requirements:

Condition 3.1.4 relating to protection of soil, groundwater and groundwater monitoring, has been added in compliance with IED requirements. Conditions 4.3.1 and 4.3.2 relating to notifications have been amended in compliance with IED requirements. The Operator has confirmed that a Site Protection and Monitoring Programme is in place which includes a programme of regular soil and groundwater monitoring.

10 Review and assessment of changes that are not part of the BAT Conclusions derived permit review.

The Operator has confirmed that there are no plans to substantially refurbish or replace equipment subject to The Energy Efficiency Directive (EED).

Odorising of natural gas was previously included in Table S1.1 as a directly associated activity. This activity now falls under Part S1.2 B(a) of Schedule 1 of the Environmental Permitting Regulations 2016 and therefore the activity is now shows as in the listed activity section of Table S1.1. There are no changes to the activity carried out.

The current permit includes Table S4.5 which sets out ambient air monitoring requirements for sulphur dioxide in Holbury and Fawley. This were included to verify air quality model predictions against monitored levels and because raised levels of sulphur dioxide led to an Air Quality Management Area (AQMA) being declared in Fawley in 2005, the majority of emissions were determined to be from the Esso refinery. In addition to reduced ELVs for sulphur dioxide in the permit, the operator implemented a number of technological improvements to reduce sulphur dioxide emissions as well as a robust monitoring and response programme. The AQMA was revoked in 2013 and further sulphur reduction measures have been implemented at the site subsequently. Therefore the requirement to continue to carry out the ambient air monitoring are no longer be justified and have been removed from the permit. However, the operator should consider the benefit of retaining this for demonstrating compliance.

The operator has confirmed that the following activities are no longer required and have been removed from Table S1.1:

- S5.3 A1 (a) (i) – disposal or recovery of hazardous waste in a facility with a capacity exceeding 10 tonnes per day involving biological treatment.

This was previously included to cover the collection and treatment of biopile material. However, this activity has been separately permitted (Environmental Permit ZP3133RH issued to Biogenie Site Remediation Limited) since 04/11/2016.

ANNEX 1: Checklist

This document should be read in conjunction with the Regulation 60 Notice and additional information and variation notice.

Aspect considered	Justification / Detail
Confidential information	A claim for commercial or industrial confidentiality has been made. This was on the basis of contractual confidentiality, proprietary information, financial information relating to compliance release of information to competitors. We have accepted the claim for confidentiality. We consider that the inclusion of the relevant information on the public register would prejudice the applicant's interests to an unreasonable degree. The reasons for this are given in the notice of determination for the claim. The decision was taken in accordance with our guidance on commercial confidentiality.
Identifying confidential information	We have not identified information provided as part of the application that we consider to be confidential. The decision was taken in accordance with our guidance on commercial confidentiality.
Scope of consultation	The consultation requirements were reviewed and applied to our 'minded to' stage of the determination process. Consultation is relevant for derogations and we have consulted on our 'minded to' (draft) decision. The decision was taken in accordance with the Environmental Permitting Regulations and our public participation statement. We have reviewed our assessment in relation to the claim for confidentiality and are satisfied that the claim remains upheld and our decision is therefore unchanged.
Responses to consultation and web publicising	The web publicising and consultation responses (Annex 4) were taken into account in the decision. The decision was taken in accordance with our guidance.
Control of the facility	We are satisfied that the operator is the person who will have control over the operation of the facility after the issue of the consolidated variation notice. The decision was taken in accordance with our guidance on legal operation for environmental permits.
Applicable directives	All applicable European directives have been considered in the determination of the application.
Extent of the site of the facility	The operator has provided a plan which we consider is satisfactory, showing the extent of the site of the facility

Aspect considered	Justification / Detail
	including the location of the part of the installation to which this permit applies on that site. A plan is included in the permit and the operator is required to carry on the permitted activities within the site boundary. This has not changed as a result of this permit review.
Site condition report	The requirements are being delivered through the existing Site Protection and Monitoring Programme, which includes a programme of regular soil and groundwater monitoring.
Biodiversity, Heritage, Landscape and Nature Conservation	The Installation is within the relevant distance criteria of a site of heritage, landscape or nature conservation, and/or protected species or habitat. A full assessment of the application and its potential to affect the sites and habitats has been carried out as part of the earlier permitting process. The changes to the permit as a result of this review will result in stricter emission limits to air and water and as such we consider that changes will not affect the features of the sites and habitats. We have not formally consulted on the application. The decision was taken in accordance with our guidance.
Operating techniques	We have reviewed the techniques used by the operator and compared these with the relevant guidance notes. The permit conditions ensure compliance with the Bref for Refining of Mineral Oil and Gas and associated BAT Conclusions, and ELVs deliver compliance with BAT-AELs. Where this is not the case, the operator has sought derogations. Our assessment of these is detailed in Section 7 of this document.
Updating permit conditions during consolidation.	We have updated previous permit conditions to those in the new generic permit template as part of permit consolidation. The operator has agreed that the new conditions are acceptable.
Use of conditions other than those from the template	Based on the information in the application, we consider that we need to impose conditions other than those in our permit template, which was developed in consultation with industry having regard to the relevant legislation. The following conditions have been added: 2.3.7 which requires the operator to reduce emissions of SO_2 by treating off gas streams or ensuring equivalence is achieved through the application of an IEMT, to implement BAT Conclusion 54.

Aspect considered	Justification / Detail
	3.5.5 requires the operator to report details of flaring events over a specific threshold to provide additional information in relation to flaring events and implement BAT conclusions 55 and 56. 3.7.1 requires the operator to undertake monitoring and calculations to implement an IEMT for emissions of NO_X. To implement BAT conclusion 57. 3.7.2 requires the operator to undertake monitoring and calculations to implement an IEMT for emissions of SO_2. To implement BAT conclusion 58. 4.3.8 requires the operator to notify acid gas flaring events that meet specific criteria to implement BAT conclusions 55 and 56 by providing additional information in relation to acid gas flaring events consistently across the oil refining sector. Conditions 3.1.4 and 4.3.1 have been updated in line with current template.
Raw materials	We have specified limits and controls on the use of raw materials and fuels.
Pre-operational conditions	Not applicable.
Improvement conditions	Based on the information on the application, we consider that we need to impose improvement conditions. We have imposed improvement conditions to ensure that: • VOC emissions are monitored and assessed in accordance with an agreed plan. • Monitored TOC emissions from Outfall 2 are regularly assessed across the planned improvement programme. • Dust emissions from the FCCU are regularly reviewed and the impacts on emissions from maintenance cycles is understood. • Secondary containment measures are reviewed in line with current guidance and a timetable agreed to implement any improvements identified. • A study of the flare system to identify any improvements and opportunities to reduce baseline flaring is carried out. • A suitable IEMT document to demonstrate how the NO_X and SO_2 bubbles will be monitored and managed is agreed. • A plan detailing further actions to take (modelling) in relation to Water Framework

Aspect considered	Justification / Detail
	Directive requirements is submitted implemented as agreed. • A plan to monitor and assess levels of AOX at Outfall 2 in relation to CWW Bref requirements.
Incorporating the application	We have specified that the applicant must operate the permit in accordance with descriptions in the Regulation 60 response, including all additional information received as part of the determination process. These descriptions are specified in the Operating Techniques table in the permit.
Emission limits	We have decided that emission limits should be set for the parameters listed in the permit. These are described at the relevant BAT Conclusions in Section 6 of this document.
Monitoring	We have decided that monitoring should be carried out for the parameters listed in the permit, using the methods detailed and to the frequencies specified. These are described at the relevant BAT Conclusions in Section 6 of this document. Based on the information in the application we are satisfied that the operator's techniques, personnel and equipment have either MCERTS certification or MCERTS accreditation as appropriate, unless otherwise agreed in writing with us.
Reporting	We have specified reporting in the permit. These are described at the relevant BAT Conclusions in Section 6 of this document.
Environment management system	There is no known reason to consider that the operator will not have the management systems to enable it to comply with the permit conditions. The decision was taken in accordance with the guidance on operator competence and how to develop a management system for environmental permits.
Section 108 Deregulation Act 2015 – Growth duty	We have considered our duty to have regard to the desirability of promoting economic growth set out in section 108(1) of the Deregulation Act 2015 and the guidance issued under section 110 of that Act in deciding whether to grant this permit. Paragraph 1.3 of the guidance says: "The primary role of regulators, in delivering regulation, is to achieve the regulatory outcomes for which they are responsible. For a number of regulators, these regulatory outcomes include an explicit reference to development or growth. The growth duty establishes economic growth as

Aspect considered	Justification / Detail
	a factor that all specified regulators should have regard to, alongside the delivery of the protections set out in the relevant legislation." We have addressed the legislative requirements and environmental standards to be set for this operation in the body of the decision document above. The guidance is clear at paragraph 1.5 that the growth duty does not legitimise non-compliance and its purpose is not to achieve or pursue economic growth at the expense of necessary protections. We consider the requirements and standards we have set in this permit are reasonable and necessary to avoid a risk of an unacceptable level of pollution. This also promotes growth amongst legitimate operators because the standards applied to the operator are consistent across businesses in this sector and have been set to achieve the required legislative standards.

Annex 2: Glossary - BAT conclusions for the Refining of Mineral Oil and Gas.

1.20 Description of techniques for the prevention and control of emissions to air.

1.20.1 Dust

Technique	Description
Electrostatic precipitator (ESP)	Electrostatic precipitators operate such that particles are charged and separated under the influence of an electrical field. Electrostatic precipitators are capable of operating under a wide range of conditions. Abatement efficiency may depend on the number of fields, residence time (size), catalyst properties and upstream particles removal devices. At FCC units, 3-field ESPs and 4-field ESPs are commonly used. ESPs may be used on a dry mode or with ammonia injection to improve the particle collection. For the calcining of green coke, the ESP capture efficiency may be reduced due to the difficulty for coke particles to be electrically charged
Multistage cyclone separators	Cyclonic collection device or system installed following the two stages of cyclones. Generally known as a third stage separator, common configuration consists of a single vessel containing many conventional cyclones or improved swirl-tube technology. For FCC, performance mainly depends on the particle concentration and size distribution of the catalyst fines downstream of the regenerator internal cyclones
Centrifugal washers	Centrifugal washers combine the cyclone principle and an intensive contact with water e.g. venturi washer
Third stage blowback filter	Reverse flow (blowback) ceramic or sintered metal filters where, after retention at the surface as a cake, the solids are dislodged by initiating a reverse flow. The dislodged solids are then purged from the filter system

1.20.2. Nitrogen oxides (NO_X)

Technique	Description
Combustion modifications	
Staged combustion	– Air staging — involves substoichiometric firing in a first step and the subsequent addition of the remaining air or oxygen into the furnace to complete combustion – Fuel staging — a low impulse primary flame is developed in the port neck; a secondary flame covers the root of the primary flame reducing its core temperature
Flue-gas recirculation	Reinjection of waste gas from the furnace into the flame to reduce the oxygen content and therefore the temperature of the flame. Special burners using the internal recirculation of combustion gases to cool the root of the flames and reduce the oxygen content in the hottest part of the flames

Use of low-NO_X burners (LNB)	The technique (including ultra-low-NO_X burners) is based on the principles of reducing peak flame temperatures, delaying but completing the combustion and increasing the heat transfer (increased emissivity of the flame). It may be associated with a modified design of the furnace combustion chamber. The design of ultra-low-NOX burners (ULNB) includes combustion staging (air/fuel) and flue-gas recirculation. Dry low-NO_X burners (DLNB) are used for gas turbines
Optimisation of combustion	Based on permanent monitoring of appropriate combustion parameters (e.g. O_2, CO content, fuel to air (or oxygen) ratio, unburnt components), the technique uses control technology for achieving the best combustion conditions
Diluent injection	Inert diluents, e.g. flue-gas, steam, water, nitrogen added to combustion equipment reduce the flame temperature and consequently the concentration of NO_X in the flue-gases
Selective catalytic reduction (SCR)	The technique is based on the reduction of NO_X to nitrogen in a catalytic bed by reaction with ammonia (in general aqueous solution) at an optimum operating temperature of around 300-450 °C. One or two layers of catalyst may be applied. A higher NO_X reduction is achieved with the use of higher amounts of catalyst (two layers)
Selective non-catalytic reduction (SNCR)	The technique is based on the reduction of NOX to nitrogen by reaction with ammonia or urea at a high temperature. The operating temperature window must be maintained between 900 °C and 1 050 °C for optimal reaction
Low temperature NO_X oxidation	The low temperature oxidation process injects ozone into a flue-gas stream at optimal temperatures below 150 °C, to oxidise insoluble NO and NO_2 to highly soluble N_2O_5. The N_2O_5 is removed in a wet scrubber by forming dilute nitric acid waste water that can be used in plant processes or neutralised for release and may need additional nitrogen removal

1.20.3. Sulphur oxides (SO_X)

Technique	Description
Treatment of refinery fuel gas (RFG)	Some refinery fuel gases may be sulphur-free at source (e.g. from catalytic reforming and isomerisation processes) but most other processes produce sulphur-containing gases (e.g. off-gases from the visbreaker, hydrotreater or catalytic cracking units). These gas streams require an appropriate treatment for gas desulphurisation (e.g. by acid gas removal — see below — to remove H_2S) before being released to the refinery fuel gas system
Refinery fuel oil (RFO)	desulphurisation by hydrotreatment In addition to selection of low-sulphur crude, fuel desulphurisation is achieved by the hydrotreatment process (see below) where hydrogenation reactions take place and lead to a reduction in sulphur content

Use of gas to replace liquid fuel	Decrease the use of liquid refinery fuel (generally heavy fuel oil containing sulphur, nitrogen, metals, etc.) by replacing it with on-site Liquefied Petroleum Gas (LPG) or refinery fuel gas (RFG) or by externally supplied gaseous fuel (e.g. natural gas) with a low level of sulphur and other undesirable substances. At the individual combustion unit level, under multi-fuel firing, a minimum level of liquid firing is necessary to ensure flame stability
Use of SO_X reducing catalysts additives	Use of a substance (e.g. metallic oxides catalyst) that transfers the sulphur associated with coke from the regenerator back to the reactor. It operates most efficiently in full combustion mode rather than in deep partial-combustion mode. NB: SO_X reducing catalysts additives might have a detrimental effect on dust emissions by increasing catalyst losses due to attrition, and on NO_X emissions by participating in CO promotion, together with the oxidation of SO_2 to SO_3
Hydrotreatment	Based on hydrogenation reactions, hydrotreatment aims mainly at producing low-sulphur fuels (e.g. 10 ppm gasoline and diesel) and optimising the process configuration (heavy residue conversion and middle distillate production). It reduces the sulphur, nitrogen and metal content of the feed. As hydrogen is required, sufficient production capacity is needed. As the technique transfer sulphur from the feed to hydrogen sulphide (H_2S) in the process gas, treatment capacity (e.g. amine and Claus units) is also a possible bottleneck
Acid gas removal e.g. by amine treating	Separation of acid gas (mainly hydrogen sulphide) from the fuel gases by dissolving it in a chemical solvent (absorption). The commonly used solvents are amines. This is generally the first step treatment needed before elemental sulphur can be recovered in the SRU
Sulphur recovery unit (SRU)	Specific unit that generally consists of a Claus process for sulphur removal of hydrogen sulphide (H_2S)-rich gas streams from amine treating units and sour water strippers. SRU is generally followed by a tail gas treatment unit (TGTU) for remaining H_2S removal
Tail gas treatment unit (TGTU)	A family of techniques, additional to the SRU in order to enhance the removal of sulphur compounds. They can be divided into four categories according to the principles applied: – direct oxidation to sulphur – continuation of the Claus reaction (sub-dewpoint conditions) – oxidation to SO_2 and recovering sulphur from SO_2 – reduction to H_2S and recovery of sulphur from this H_2S (e.g. amine process)
Wet scrubbing	In the wet scrubbing process, gaseous compounds are dissolved in a suitable liquid (water or alkaline solution).

	Simultaneous removal of solid and gaseous compounds may be achieved. Downstream of the wet scrubber, the flue-gases are saturated with water and a separation of the droplets is required before discharging the flue-gases. The resulting liquid has to be treated by a waste water process and the insoluble matter is collected by sedimentation or filtration According to the type of scrubbing solution, it can be: – a non-regenerative technique (e.g. sodium or magnesium-based) – a regenerative technique (e.g. amine or soda solution) According to the contact method, the various techniques may require e.g.: – Venturi using the energy from inlet gas by spraying it with the liquid – packed towers, plate towers, spray chambers. Where scrubbers are mainly intended for SO_X removal, a suitable design is needed to also efficiently remove dust. The typical indicative SO_X removal efficiency is in the range 85-98 %.
Non-regenerative scrubbing	Sodium or magnesium-based solution is used as alkaline reagent to absorb SO_X generally as sulphates. Techniques are based on e.g.: — wet limestone — aqueous ammonia — seawater (see infra)
Seawater scrubbing	A specific type of non-regenerative scrubbing using the alkalinity of the seawater as solvent. Generally requires an upstream abatement of dust
Regenerative scrubbing	Use of specific SO_X absorbing reagent (e.g. absorbing solution) that generally enables the recovery of sulphur as a by-product during a regenerating cycle where the reagent is reused

1.20.4. Combined techniques (SOx, NOx and dust)

Technique	Description
Wet scrubbing	See Section 1.20.3
SNO_X combined technique	Combined technique to remove SOX, NOX and dust where a first dust removal stage (ESP) takes place followed by some specific catalytic processes. The sulphur compounds are recovered as commercial-grade concentrated sulphuric acid, while NO_X is reduced to N_2. Overall SO_X removal is in the range: 94-96,6 %. Overall NO_X removal is in the range: 87-90 %

1.20.5. Carbon monoxide (CO) Technique

Technique	Description
Combustion operation control	The increase in CO emissions due to the application of combustion modifications (primary techniques) for the

	reduction of NO_X emissions can be limited by a careful control of the operational parameters
Catalysts with carbon monoxide (CO) oxidation promoters	Use of a substance which selectively promotes the oxidation of CO into CO_2 (combustion
Carbon monoxide (CO) boiler	Specific post-combustion device where CO present in the flue-gas is consumed downstream of the catalyst regenerator to recover the energy It is usually used only with partial-combustion FCC units

1.20.6. Volatile organic compounds (VOC)

Technique	**Description**
Vapour recovery	Volatile organic compounds emissions from loading and unloading operations of most volatile products, especially crude oil and lighter products, can be abated by various techniques e.g.: – Absorption: the vapour molecules dissolve in a suitable absorption liquid (e.g. glycols or mineral oil fractions such as kerosene or reformate). The loaded scrubbing solution is desorbed by reheating in a further step. The desorbed gases must either be condensed, further processed, and incinerated or re-absorbed in an appropriate stream (e.g. of the product being recovered) – Adsorption: the vapour molecules are retained by activate sites on the surface of adsorbent solid materials, e.g. activated carbon (AC) or zeolite. The adsorbent is periodically regenerated. The resulting desorbate is then absorbed in a circulating stream of the product being recovered in a downstream wash column. Residual gas from wash column is sent to further treatment – Membrane **gas separation**: the vapour molecules are processed through selective membranes to separate the vapour/air mixture into a hydrocarbon- enriched phase (permeate), which is subsequently condensed or absorbed, and a hydrocarbon-depleted phase (retentate). – Two**-stage refrigeration/condensation**: by cooling of the vapour/gas mixture the vapour molecules condense and are separated as a liquid. As the humidity leads to the icing-up of the heat exchanger, a two-stage condensation process providing for alternate operation is required. – Hybrid **systems**: combinations of available techniques

	NB Absorption and adsorption processes cannot notably reduce methane emissions
Vapour destruction	Destruction of VOCs can be achieved through e.g. **thermal oxidation** (incineration) or **catalytic oxidation** when recovery is not easily feasible. Safety requirements (e.g. flame arrestors) are needed to prevent explosion. **Thermal oxidation** occurs typically in single chamber, refractory-lined oxidisers equipped with gas burner and a stack. If gasoline is present, heat exchanger efficiency is limited and preheat temperatures are maintained below 180 °C to reduce ignition risk. Operating temperatures range from 760 °C to 870 °C and residence times are typically 1 second. When a specific incinerator is not available for this purpose, an existing furnace may be used to provide the required temperature and residence times. **Catalytic oxidation** requires a catalyst to accelerate the rate of oxidation by adsorbing the oxygen and the VOCs on its surface The catalyst enables the oxidation reaction to occur at lower temperature than required by thermal oxidation: typically ranging from 320 °C to 540 °C. A first preheating step (electrically or with gas) takes place to reach a temperature necessary to initiate the VOCs catalytic oxidation. An oxidation step occurs when the air is passed through a bed of solid catalysts
LDAR (leak detection and repair) programme	An LDAR (leak detection and repair) programme is a structured approach to reduce fugitive VOC emissions by detection and subsequent repair or replacement of leaking components. Currently, sniffing (described by EN 15446) and optical gas imaging methods are available for the identification of the leaks. **Sniffing method**: The first step is the detection using hand-held VOC analysers measuring the concentration adjacent to the equipment (e.g. by using flame ionisation or photo-ionisation). The second step consists of bagging the component to carry out a direct measurement at the source of emission. This second step is sometimes replaced by mathematical correlation curves derived from statistical results obtained from a large number of previous measurements made on similar components. **Optical gas imaging methods**: Optical imaging uses small lightweight hand- held cameras which enable the visualisation of gas leaks in real time, so that they appear as 'smoke' on a video recorder together with the normal image of the component concerned to easily and rapidly locate significant VOC leaks. Active systems produce an image with a back-scattered infrared laser light reflected on the component and its surroundings. Passive systems are based on the natural infrared radiation of the equipment and its surroundings

VOC diffuse emissions monitoring	Full screening and quantification of site emissions can be undertaken with an appropriate combination of complementary methods, e.g. Solar occultation flux (SOF) or differential absorption lidar (DIAL) campaigns. These results can be used for trend evaluation in time, cross checking and updating/validation of the ongoing LDAR programme. **Solar occultation flux (SOF)**: The technique is based on the recording and spectrometric Fourier Transform analysis of a broadband infrared or ultraviolet/ visible sunlight spectrum along a given geographical itinerary, crossing the wind direction and cutting through VOC plumes. **Differential absorption LIDAR (DIAL)**: DIAL is a laser-based technique using differential adsorption LIDAR (light detection and ranging) which is the optical analogue of sonic radio wave-based RADAR. The technique relies on the back-scattering of laser beam pulses by atmospheric aerosols, and the analysis of spectral properties of the returned light collected with a telescope
High-integrity equipment	High-integrity equipment includes e.g.: – valves with double packing seals – magnetically driven pumps/compressors/agitators – pumps/compressors/agitators fitted with mechanical seals instead of packing – high-integrity gaskets (such as spiral wound, ring joints) for critical applications

1.20.7. Other techniques

Techniques to prevent or reduce emissions from flaring	**Correct plant design**: includes sufficient flare gas recovery system capacity, the use of high-integrity relief valves and other measures to use flaring only as a safety system for other than normal operations (start-up, shutdown, emergency). **Plant management**: includes organisational and control measures to reduce flaring events by balancing RFG system, using advanced process control, etc. **Flaring devices design**: includes height, pressure, assistance by steam, air or gas, type of flare tips, etc. It aims at enabling smokeless and reliable operations and ensuring an efficient combustion of excess gases when flaring from non- routine operations. **Monitoring and reporting**: Continuous monitoring (measurements of gas flow and estimations of other parameters) of gas sent to flaring and associated parameters of combustion (e.g. flow gas mixture and heat content, ratio of assistance, velocity, purge gas flow rate, pollutant emissions). Reporting of flaring events makes it possible to use flaring ratio as a requirement included in the EMS and to prevent future events. Visual remote monitoring of the flare can also be carried out by using colour TV monitors during flare events

Choice of the catalyst promoter to avoid dioxins formation	During the regeneration of the reformer catalyst, organic chloride is generally needed for effective reforming catalyst performance (to re-establish the proper chloride balance in the catalyst and to assure the correct dispersion of the metals). The choice of the appropriate chlorinated compound will have an influence on the possibility of emissions of dioxins and furans
Solvent recovery for base oil production processes	The **solvent recovery** unit consists of a distillation step where the solvents are recovered from the oil stream and a stripping step (with steam or an inert gas) in a fractionator. The solvents used may be a mixture (DiMe) of 1,2-dichloroethane (DCE) and dichloromethane (DCM). In wax-processing units, solvent recovery (e.g. for DCE) is carried out using two systems: one for the deoiled wax and another one for the soft wax. Both consist of heat-integrated flashdrums and a vacuum stripper. Streams from the dewaxed oil and waxes product are stripped for removal of traces of solvents

1.21. Description of techniques for the prevention and control of emissions to water

1.21.1. Waste water pretreatment

Pretreatment of sour water streams before reuse or treatment	Send generated sour water (e.g. from distillation, cracking, coking units) to appropriate pretreatment (e.g. stripper unit)
Pretreatment of other waste water streams prior to treatment	To maintain treatment performance, appropriate pretreatment may be required

1.21.2. Waste water treatment

Removal of insoluble substances by recovering oil	These techniques generally include: – API Separators (APIs) – Corrugated Plate Interceptors (CPIs) – Parallel Plate Interceptors (PPIs) – Tilted Plate Interceptors (TPIs) – Buffer and/or equalisation tanks
Removal of insoluble substances by recovering suspended solid and dispersed oil	These techniques generally include: – Dissolved Gas Flotation (DGF) – Induced Gas Flotation (IGF) – Sand Filtration
Removal of soluble substances including biological treatment and clarification	Biological treatment techniques may include: – Fixed bed systems – Suspended bed systems. One of the most commonly used suspended bed system in refineries WWTP is the activated sludge process. Fixed bed systems may include a biofilter or trickling filter

Additional treatment step	A specific waste water treatment intended to complement the previous treatment steps e.g. for further reducing nitrogen or carbon compounds. Generally used where specific local requirements for water preservation exist.

Annex 3: Improvement Conditions

Based in the information in the Operators Regulation 60 Notice responses and our own records of the capability and performance of the installation at this site, we consider that we need to set improvement conditions so that the outcome of the techniques detailed in the BAT Conclusions are achieved by the installation. These additional improvement conditions are set out below - justifications for them are provided at the relevant section of the decision document.

Table S1.3 Improvement programme requirements

Reference	Requirement	Date
IC39	The Operator shall submit a VOC monitoring plan to the Environment Agency for written approval. This shall include but not be limited to: • The nature of the material handled; • The sources of emissions, including point source and fugitive emissions from the storage of liquid hydrocarbons and road loading; • Justification of the monitoring techniques selected; • How the monitoring data will be recorded, assessed and reviewed; and • Identification of actions/improvements, including a timescales to implement these. The plan shall take into account the appropriate techniques for VOC monitoring specified in BAT conclusion 6 for the Refining of Mineral Oil and Gas and Environment Agency M2 and M16 Guidance Notes. The Operator shall implement the approved plan and produce and submit an annual report on the results of the monitoring undertaken under the plan.	12 months
IC40	The operator shall submit a plan to review monitored TOC emissions from emission point W2 (outfall2) to the Environment Agency for written approval. This shall include but not be limited to: • A requirement to regularly review monitoring data taking into account key milestones for the implementation of the planned improvement programme; • Assessment of trends across the planned improvement programme; and • Identification of whether a compliance at a lower ELV can be achieved. The Operator shall implement the plan from the date of approval by the Environment Agency.	9 months
IC41	The Operator shall develop a plan to review monitored dust emissions from emission point A22 (FCCU) during normal operation. The plan shall include but not be limited to: • A requirement to regularly review dust levels against data trends; • Assessment of the impacts from changes to $DeSO_X$ catalyst addition rates; • Assessment of trends and impacts from maintenance cycles; • Identification of when further investigation to determine the cause(s) is required: and • Identification of actions to be taken with appropriate timescales. The plan shall be implemented by the operator from the date of approval by the Environment Agency.	9 months

Table S1.3 Improvement programme requirements		
Reference	**Requirement**	**Date**
IC42	The Operator shall review all secondary containment measures, provided for liquid hydrocarbons that are stored or held on site (excluding those bunds in scope of the COMAH Containment Policy). The review shall verify whether all storage tanks and areas designed for the storage of drums/IBCs and other portable liquid containers, covered by this permit are sited on an impermeable base and with sufficient bunding as specified in the CIRIA C736 Guidance. Where containment provisions do not meet this standard, the operator shall identify improvements or alternative measures (such as additional primary or tertiary containment measures) to an equivalent level of protection. The Operator shall provide the Environment Agency with a written report of the review and shall implement identified improvements to a timescale agreed with the Environment Agency.	20 months
IC43	The Operator shall carry out a study of their flaring system and flare sources for the purpose of reducing baseline flaring. The study shall include: • Options to improve the determination of individual flare sources; • Identification of actions to be taken to eliminate or reduce flaring with appropriate timescales. The Operator shall submit a written report, for approval by the Environment Agency providing details of the findings of the study and a timetable for implementation of any improvements identified.	18 months
IC44	The Operator shall submit, for approval by the Environment Agency, monitoring programme for the fixed NO_X and SO_2 emissions bubble for the installation. The bubble monitoring programme shall be in accordance with the principals described in the IEMT Protocol. The monitoring protocol shall include but not be limited to: • A description of the monitoring provision, or surrogate measure, for each unit included in the bubble. • A description of the methodology used to calculate the monthly average compliance value for SO_2. • Identification of the abnormal operating conditions for each unit, and a description of how compliance with the bubble emission limit will be assessed during a period of abnormal operation. Specification of any surrogate values to be employed during periods of abnormal operation.	28/11/2018
IC45	The operator shall submit a plan detailing further assessment to be undertaken in respect of mercury from Outfall 1. The plan shall include as a minimum: • Proposals with timescales to carry out detailed modelling; and • Timetable to provide a written report detailing the findings; The report should include proposals for appropriate measures to mitigate the impact of any emissions where the assessment determines they are liable to cause pollution, including timescales for implementation of individual measures.	24 months

Table S1.3 Improvement programme requirements		
Reference	**Requirement**	**Date**
IC46	The operator shall submit a plan to monitor and assess levels of Adsorbable organically bound halogens (AOX) within the effluent discharged at Outfall 2. The plan shall include as a minimum: • A detailed sampling and monitoring schedule; • A timetable to review monitoring data and assesses results against the relevant threshold in the Common Waste Water Bref, taking into account the contribution(s) from the relevant clean/process streams; and • A timetable to provide a written report detailing results and findings and identifying any changes required to the effluent monitoring regime. The plan shall be implemented by the operator from the date of approval by the Environment Agency.	15 months

Annex 4: Advertising and Consultation on the draft decision

A) Advertising and Consultation on the Draft Decision

This section reports on the outcome of the public consultation on our draft decision carried out between 13 August 2018 to 11 September 2018.

We did not receive any representations.