Our Ref: LEK 12659

31st March 2021

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Report Number: LEK 12659

Dear [redacted],

SOCOTEC Odour Assessment report
Please find enclosed the report relating to the recent Odour Assessment & OMP review which is a full and thorough review of the 2017 report and the original Odour Management Plan.

An account for this work will be forwarded to you under separate cover. The work was undertaken according to our General Conditions of Contract.

If we can be of any further assistance to you in this matter, please do not hesitate to contact me.

Yours sincerely

On behalf of **SOCOTEC**

[redacted]

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ExxonMobil Chemical Limited

Odour Assessment Report
Mosmorran
March 2021

Carried out for:

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Beverkae House
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Report No: LEK 12659

Issue date: 27th August 2020

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SUMMARY

ExxonMobil Chemical Limited placed a contract with SOCOTEC UK Limited to undertake a review of an existing odour assessment and odour management plan relating to operations at their Fife Ethylene Plant (FEP) located at Mossmorran. The review is a requirement of the applicable permit to operate.

The findings of the 2017 assessment have been reviewed, confirmed and updated where necessary by a site visit, discussions with key personnel, assessment of relevant documentation and consideration of latest relevant guidance. The review generally indicates few changes from the original.

Six potential odour sources, where odours may arise from the operation or the substances employed, have been confirmed. In most cases an odour discharge is only likely where there is operational abnormality or accidental release, although there are two sources where there is a frequent or continuous odour discharge.

Based on the odour control measures in place, the odour potential of the operations and the history of odour complaints it is considered that that the risk of a significant odour release and subsequent off site impact is low. The review has not identified any operations or procedures that are in need of change.

It is recommended that review and audit of procedures needs to be maintained in order to ensure that the operations continue to be well managed and incorporate operational experience and best practice. All systems are considered to constitute best available technique.

1 INTRODUCTION

ExxonMobil Chemical Limited placed a contract with SOCOTEC UK Limited to undertake a review of an existing odour assessment and odour management plan relating to operations at their Fife Ethylene Plant (FEP) located at Mossmorran. The review is a requirement of the applicable permit to operate.

1.1 Scope of study

ExxonMobil's operations at FEP are subject to PPC permit PPC/A/1013494. This permit has specific requirements regarding the management of odours:

3.2.2

Subject to Condition 3.2.3, at least every 4 years, the Operator shall carry out a systematic assessment of odour emissions associated with the Permitted Activities, the purpose of which shall be to identify methods of reducing odour emissions and their impact. Each assessment shall be recorded and reported to SEPA.

3.2.3

Not withstanding Condition 3.2.2 the first systematic assessment of odour shall be carried out by 31 March 2009.

3.2.4

The Operator shall by 31 March 2009 produce an odour management plan which shall specify the methods to be implemented for the purposes of reducing odour emissions associated with the Permitted Activities in accordance with the findings of the first assessment required under Condition 3.2.2 above and estimated dates for implementation of those methods ('the Odour Management Plan"). The Odour Management Plan shall be reviewed at least every 4 years and updated, as necessary, to take account of any subsequent assessment or assessments carried out in accordance with Condition 3.2.2 above.

3.2.5

The Odour Management Plan and all actions taken in accordance with the Odour Management Plan shall be recorded.

In accordance with the requirements of conditions 3.2.3 and 3.2.4 ExxonMobil commissioned an assessment of odours at the FEP which resulted in the production of an odour management plan. This was undertaken by Entec UK Limited and is presented in report 23111-02, 24 March 2009[1]. This assessment was reviewed by ESG in April 2013[2] and further reviewed by ESG in April 2017[3].

The purpose of the current study is to fulfil the four-yearly review requirements of conditions 3.2.2. and 3.2.4. These conditions require:

- A systematic assessment of odour releases with a view to reducing emissions and their impact.
- A review and update of the odour management plan to account for any changes made as a result of the latest odour assessment and any amendments to relevant legislation or guidance.

There are therefore two distinct items of work reported herein:

- Assessment of odours (section 2)
- Odour management plan (Section 5)

1.2 Study methodology

The production of the odour management plan necessarily follows from the assessment of odours.

The current odour assessment[2] provides a thorough assessment of the processes which have the potential to release odorous substances. It was therefore considered that the starting point should be the existing assessment with a review to determine current relevance with amendments where necessary to cover any changes to existing processes and any new processes since publication in 2017. This was achieved by:

Familiarisation by a desktop review of the assessment

Site visit to the FEP to confirm the relevance of the existing assessment including:

- interviews with appropriate ExxonMobil staff
- a walk over assessment of the general site and surrounding environment
- assessment of relevant records (complaints, reported releases)
- assessment of relevant procedures within the management system

Assessment of other external factors (meteorological conditions, recent industrial and residential developments in locality).

Review of changes to relevant legislation and guidance since report publication.

The above has allowed all aspects of the original assessment to be reviewed and to be updated as necessary. This review follows the same methodology and basic layout of the original assessment for continuity with any changes incorporated and highlighted. More recent information is now available on reported releases and complaints. This historical data is reproduced to provide evidence as to the findings of the assessment and the overall potential for releases of odour for the FEP and the likely impact.

From this assessment the odour management plan is produced. This again follows the layout and methodology of the 2013 plan with amendments as necessary.

The above aspects are covered in the following sections of this report:

2.1 Identification of potential for odour release
2.2 Specific process details, control measures and odour potential
2.3 The local environment (receptors and odour dispersion)
2.4 Complaints and complaint management
2.5 Recommendations including response to previous recommendations
3 Conclusions
5 Odour management plan

The production of the odour assessment and subsequent odour management plan has been undertaken with consideration for current guidance available within the following documents:

Technical guidance note IPPC H4 – Horizontal guidance for odour – Part 1[4]
Technical guidance note IPPC H4 – Horizontal guidance for odour – Part 2[5]
H4 Odour Management – Additional guidance[6]
Odour guidance 2010 – SEPA[7]
BREF – Production of large volume organic chemical, December 2017[8]

2 ASSESSMENT OF ODOUR EMISSIONS

The Fife Ethylene Plant uses steam cracking of natural gas liquids to produce ethylene.

At St Fergus North Sea natural gas is processed to remove methane for distribution. The remaining liquids are piped to the Fife Natural Gas Liquids plant, operated by Shell, where ethane is extracted and sent to the neighbouring FEP for processing. In addition, this supply is now supplemented with ethane from the Ineos Grangemouth facility with supply having commenced in late 2017. Ethane derived from imported shale gas is transported to the FEP using an existing pipeline. The availability of this additional source of ethane has generally resulted sustained higher production rates and will do so into the future, albeit in this recent period the plant was in full shutdown between August 2019 and mid February 2020.

The ethane sent to FEP from St Fergus still contains carbon dioxide and some hydrogen sulphide which is removed by the feed treatment process using an amine-based solution wash. The resulting ethane is then either processed immediately or put to temporary storage. Propane can be used to supplement the ethane.

Ethane is processed in seven furnaces where it is mixed with steam at around 800^{o}C to breakdown into ethylene and a range of other gases. The reaction is quenched rapidly once maximum conversion to ethylene has been achieved.

The ethylene stream is further cooled to around 25^{o}C by passage through a heat exchange system and a water quench tower. Some by-products such as tars will condense and be removed in the water stream. The water is cooled, cleaned and reused.

The gas stream is then compressed in a series of gas and steam turbines to reduce temperature where the stream becomes liquid. Within the compressor train a caustic wash tower removes any remaining hydrogen sulphide and carbon dioxide. The stream then enters a series of three distillation towers to separate ethylene from other hydrocarbons present. In the first tower (de-methaniser) hydrogen and methane are removed. These are used as fuel gas for the furnaces and gas turbine. In the second tower (de-ethaniser) a hydrocarbon mixture termed C_5+ is removed. This is a valuable by-product which is recovered and subsequently shipped off site. The remaining stream largely contains ethylene, acetylene and ethane. This stream is passed to the acetylene converters where hydrogen is added in a catalytic reaction to convert acetylene to ethylene. The stream then passes to the final tower (ethylene splitter) where the ethylene and ethane is separated. Ethane is recycled back to the furnaces, whilst the ethylene product is pumped off site for distribution or shipping.

The annual production capacity of the FEP is around 800,000 tonnes of ethylene and C_5+. The availability of the additional source of ethane is expected to continue to result in sustained production rates close to the annual capacity into the future.

The raw materials used in the process are not particularly odorous. The main odour risk arises from by-products of the process and the reagents used. The main control measure is containment, although there are some necessary vents and lagoons where process by products are exposed to ambient atmosphere and have the potential to pose an odour nuisance. In addition, a failure of the containment procedures, particularly during transfer of reagents and spent material has a significant potential for odour emission.

An assessment of the current process arrangement, raw materials, products and reagents indicated no significant changes since 2017.

2.1 Substances and Operations

In the following section the substances and operations which have been identified as posing a potential odour release risk are identified:

Substance	Operation and location	Odour potential
Adip X (amine-based reagent)	Area D Feed treatment process (removal of CO_2 and H_2S from incoming raw gas stream)	Hydrogen sulphide release from process. Adip X has a low odour.
Sulphide additive (DMS)	Area A DMS delivery and transfer Additive to furnaces (steam cracking of ethane)	DMS is highly odorous.
C_5+	Area N Transfer of C_5+ product from storage to tanker	C_5+ is not highly odorous.
H_2S, other gaseous sulphides, mercaptans	Area J Caustic wet oxidation (treats spent caustic from wash tower)	Hydrogen sulphide, other sulphides and mercaptans will vent to atmosphere and are highly odorous.
H_2S, other gaseous sulphides, mercaptans	Area K Caustic neutralisation (Treatment of caustic solution from wet oxidation)	Hydrogen sulphide, other sulphides and mercaptans are highly odorous.
Light hydrocarbons	Area K Effluent treatment	Flash evaporation of light hydrocarbons can cause a release which has a low odour potential.

In the above table the substances which have the potential for release from the process and which could present an odour risk are identified. The risk of a release and the severity of the impact are governed by the quantity present and the containment and control processes that are in place. These are discussed in detail in Section 2.2.

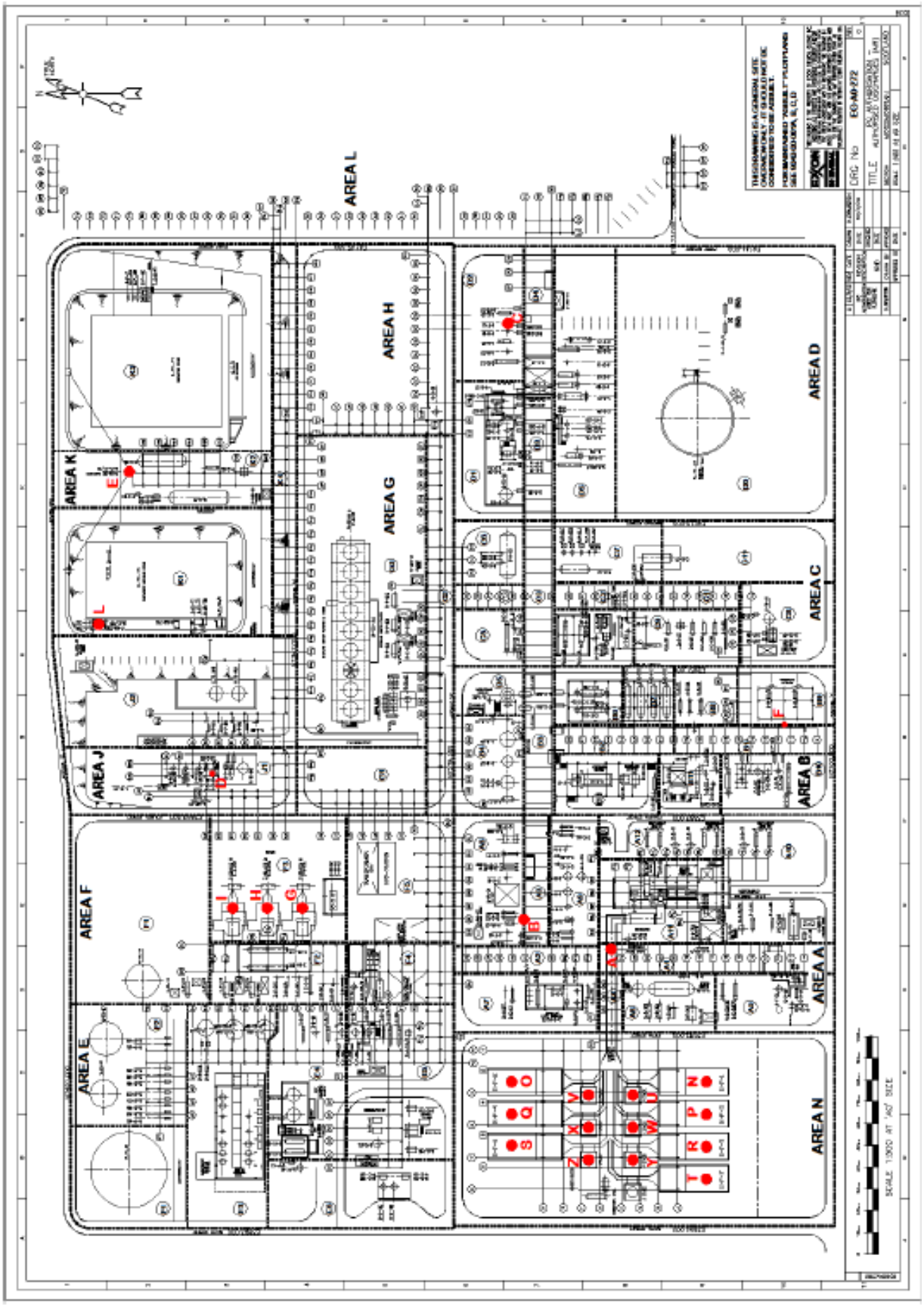
The Sulphide additive (DMS) has the potential for the most significant odour, whilst sulphides and mercaptans are also very odorous. The hydrocarbons produced, both C_5+ and the lighter hydrocarbons finding their way into the effluent treatment system, have a lesser odour potency, but could still cause a nuisance.

Figure 2.2.1 provides a site plan which identifies the locations of the process areas highlighted above and also the locations of the point sources discussed in the following section.

2.2 Risk, Controls and Improvements

In section 2.1 the substances that have a significant potential to cause odour nuisance and the processes where they arise have been identified. In this section these processes are examined in more detail to identify the risk of emission, the control measures in place to prevent release and possible improvements to reduce the risk of release and/or the impact of a release.

Figure 2.1.1 Fife Ethylene Plant site plan



2.2.1 Feed treatment process – Area D

Raw ethane received from the Fife Natural Gas Liquids plant can have a hydrogen sulphide content of up to 40 ppm. The Ethane received from Grangemouth is very low H2S and can be transferred straight to the furnaces. The feed treatment process is designed to remove both hydrogen sulphide and carbon dioxide from the FNGL raw ethane prior to cracking in a regenerative absorption process using an amine wash. Adip–X is an amine-based solvent comprising methyl diethanolamine (MDEA) as the main reactant, piperazine as the accelerator and water. Adip-X is considered only slightly odorous.

In the regeneration system carbon dioxide and hydrogen sulphide absorbed in the solvent are stripped and passed to the site boilers. This results in an exhaust stream comprising carbon dioxide and sulphur dioxide. As shown by emissions measurements completed biannually (by SOCOTEC) boiler exhaust concentrations of sulphur dioxide are routinely comfortably below the 5 mg/m^3 permit limit. Where there are operational issues with the boilers the stripped gas may be directly vented to atmosphere via the feed treatment process high level vent (A14).

The solvent will eventually degrade and requires off site regeneration. This involves transfer to a tanker, with a subsequent delivery of recovered solvent.

Odour may therefore arise from:

- Handling and transfer of both regenerated and spent solvent
- Direct venting of stripped gases or failure to efficiently combust stripped gases leading to exhaust emissions containing sulphide
- Fugitive or accidental losses from the process containment releasing either solvent or stripped gas

Table 2.2.1 summarises the odour release risk and the preventative control measures in place, together with possible process improvements, where applicable.

Venting via A14 is reported on an annual basis to SEPA as summarised below.

Year	Mass of hydrogen sulphide vented (T)	Comments
2017	0.169	NGL feed changes.
2018	0.804	Flow below minimum for boilers.
2019	1.423	NGL feed changes (none vented Aug-Dec as plant offline).
2020	5.765	Unable to be routed via boilers.

Estimated releases are based on an assumed hydrogen sulphide concentration of 100 ppm. Venting has been variable over the period 2017-20 but has generally increased in recent years. Despite significant increases in venting at certain times, in particular in particular during 2020, there have been no directly attributable on-site or off site odour complaints coinciding with the releases. This suggests that either the concentration assumed for this vent is an overestimate and/or the dispersion is such that there is insignificant impact.

Throughout the period 2017 to 2020 there have been no significant reported losses of solvent during loading, offloading or transfer. A review of the complaint history during the period 2017-2020 has identified only one minor incident of odour impact on-site and none from off-site which could be directly attributed to the operation of the feed treatment process.

Table 2.2.1 Feed treatment process review

Operation	Solvent handling	Boiler operation	Fugitive and accidental losses
Controls	Adip-X has a low odour potential. Storage and feed system is fully enclosed and subject to a periodic inspection and leak test schedule. Off loading is relatively infrequent (around 3 times per year). Operating procedures and staff training are well developed. Handling system vents to A14 in event of over pressure. Steam sparge used to aid dispersion Leak detection and repair procedure is in place to detect and remedy fugitive losses.	Extensive monitoring and control of parameters critical to efficient combustion are in place. Boiler trips are investigated and systematic failures identified and addressed to minimise failures and down time. Additional monitoring is undertaken periodically to confirm efficient conversion of H_2S to SO_2. A8, A9 and A10 are high level stacks designed for good dispersion of combustion emissions. Stripped gas stream is vented to A14 in event of boiler failure.	Adip-X has a low odour potential. Under normal operation the feed treatment process is closed loop with no loss of solvent. Process system is fully enclosed and subject to a periodic inspection and leak test schedule. System vents to A14 in event of over pressure in handling system or boiler trip. Steam sparge is used to aid dispersion
Emission significance	Adip-X has a low odour potential.	In normal operation H_2S is almost totally converted to SO_2.	Adip-X has a low odour potential. H_2S has a high odour potential, however loss through venting is historically low and with no attributable complaints.
Improvements	Continued periodic review and audit of operating procedures under EMS/OIMS.	Continued review and investigation of boiler trips in order to minimise occurrence. Continued review of monitoring data to ensure efficient combustion.	Continued periodic review and audit of operating procedures under EMS/OIMS.
Comments	No odour complaints have been attributed to handling operations in the review period. Current arrangements are considered to be BAT. No significant releases of solvent have been reported	No odour complaints have been attributed to boiler operations in the review period. Some venting due to boiler operating difficulties does occur and this is reported to SEPA. Current arrangements are considered to be BAT.	Only 1 minor on-site incident that could be attributed to fugitive or accidental losses in the review period. There are no records of significant fugitive or accidental losses from the system. Current arrangements are considered to be BAT.

The most significant risk is likely to be the venting of stripped gas in the event of a boiler trip. Boiler operation is already subject to review and there is continuing effort to improve availability and reduce boiler trips. Whilst this would assist in reducing incidents of stripped gas venting it is evident from the lack of complaints during some of the sustained venting episodes that this release may not be significant in terms of odour impact.

Other than the ongoing review, monitoring and auditing of the feed treatment process, no other improvements are recommended. The current arrangements are considered to constitute best available technique (BAT).

2.2.2 Addition of DMS to furnaces – Area A

A Sulphurous additive (DMS) is added to a side stream of the raw ethane feed to the pyrolysis furnaces. The additive assists in reducing fouling and hence prolonging radiant tube life within the furnaces. The compound is highly odorous and its release would be expected to have a high odour impact particularly within the site boundary and possibly outside the site depending on prevailing conditions and release position. The additive is delivered to the FEP by road tanker, transferred to a storage tank and subsequently metered to the raw gas slipstream and then into the furnace. There are several potential pathways for the release of odour:

- During delivery and transfer to storage
- During metering to the raw gas slipstream and transfer to the furnaces
- Potential for release of DMS to downstream processes due to abnormal furnace operation
- Fugitive or accidental losses of DMS from the process

Table 2.2.2 summarises the odour release risk and the preventative control measures in place, together with possible process improvements, where applicable.

The most significant risk of release of DMS is in the handling of the material during delivery, transfer and dosing. Deliveries are typically only around once a month. The delivery system has been designed with the minimum of leak points and uses dry break couplings and high specification piping. Nitrogen is used to avoid displacement venting during transfer. Over pressure venting is directed to the flare. The delivery operation is subject to environmentally critical procedures, due to the high risk of odour release and the flammability of the additive, to ensure no release to either the atmosphere or sewer. Operating procedures require that the tanker is not open to atmosphere and that measures are in place to deal with any spills. There have been no reported losses of DMS during the review period. An ongoing leak detection and repair programme is in place which is effective in identifying leakage and reducing fugitive losses.

DMS is dosed to the ethane slipstream in very low volumes with target levels of total Sulphur kept low (target <150ppm Suphur). Under normal furnace operation this will be mixed with the main ethane stream and converted to hydrogen sulphide. The hydrogen sulphide is subsequently removed by caustic washing in the compression stages which follow cracking in the furnaces (see 2.2.4). The furnace control systems are well developed and the furnaces have a well established operating performance which gives confidence in the expected efficiency of DMS conversion.

The assessment concludes that, whilst there is a high odour risk associated with exposure of DMS to the ambient atmosphere, the systems in place and their inspection and management have been proven to be effective in containing the material. There have been no reported losses of DMS during handling in the review period. The furnace operation is well managed and there appears to be little risk that abnormal

operation might give rise to an unabated release of DMS which would be significantly odorous. In the review period there have been no complaints attributable to the delivery, transfer and metering of DMS. The current arrangements are considered to constitute BAT. Other than the ongoing review, monitoring and auditing of the DMS handling procedures, no other improvements are recommended.

Table 2.2.2 DMS operations process review

Operation	DMS handling	Furnace operation	Fugitive and accidental losses
Controls	Environmentally critical controls are applied to the delivery, transfer and metering of DMS. Storage &metering system is fully enclosed and subject to a periodic inspection and leak test schedule. Deliveries are relatively infrequent (around once per month). Nitrogen displacement is used to prevent DMS venting. Any over pressure in the system is vented to the high level flare. Operating procedures & staff training well developed	Extensive monitoring and control of parameters critical to efficient furnace operation are in place. Furnaces have a proven performance which is highly efficient in converting DMS to H_2S. The dosing rate of DMS is relatively low and constant.	The delivery, transfer and dosing system is fully contained and is subject to a programme of leak detection and repair. Environmentally critical controls are applied to the handling operations. Relatively small quantities of DMS are transferred on a day-to-day basis which minimises and limits the potential impact of an accidental release. The handling and dosing systems are designed to a high standard specifically to minimise losses.
Emission significance	DMS is highly odorous, although the risk is considered low in view of proven suitability of the preventative systems in place.	In normal operation DMS will be almost totally converted to H_2S, hence there is little risk of release to downstream processes. No such release has been detected.	DMS is highly odorous, although the risk of accidental release is considered low in view of proven management procedures in place.
Improvements	Continued periodic review and audit of operating procedures under EMS/OIMS.	Continued periodic review and audit of operating procedures under EMS/OIMS. Furnace performance data should continue to be monitored to ensure efficient furnace operation.	Continued periodic review and audit of operating procedures under EMS/OIMS.
Comments	No odour complaints have been attributed to DMS handling operations in the review period. Current arrangements are considered to be BAT. No significant releases of DMS have been reported.	No odour complaints have been attributed to DMS breakthrough from furnace operations in the review period. Current arrangements are considered to be BAT.	No odour complaints have been attributed to fugitive or accidental losses in the review period. Current arrangements are considered to be BAT.

2.2.3 C_5+ handling – Area N

Following cracking and cooling in the compressor train the gas/liquid enters a series of distillation columns for separation. A by-product of the second (de-ethaniser) column is a mixture of hydrocarbons termed C_5+. This is a valuable by-product of the process which is recovered, stored and then subsequently tankered off site for further processing. C_5+ comprises benzene and a range of higher hydrocarbons which have a moderately distinctive odour.

There are several potential pathways for the release of odour from the production, transfer, storage and loading of C_5+:

- During transfer to storage
- During storage
- During transfer and tanker loading
- Fugitive or accidental losses of C_5+ handling process

C_5+ is stored in the C_5+ storage tank which is within a concrete bund. When discharging to a road tanker transfer occurs on a weighbridge and is computer-controlled with a two arm system allowing transfer of liquid to the tanker and return of vapour to the storage drum. The entire operation is a closed loop, preventing exhaust to the ambient air. Any over pressure of the transfer system is vented to the high level flare. There is the option of using C_5+ in the site fuel system if there is any oversupply, although this is not generally employed in view of the high value of the product.

Table 2.2.3 summarises the odour release risk and the preventative control measures in place, together with possible process improvements, where applicable.

Although C_5+ is just moderately odorous, there is the potential for odour impact, although probably more within the site boundaries and neighbouring site rather than further afield, due to the low elevation of any release and its moderate odour. C_5+ is also highly flammable and as such strict controls to minimise the potential for losses are necessary. The most significant risk of odour is in the handling of the materials both during transfer to the storage tank and transfer from the storage tank and loading. Loading occurs up to three times a day, although the risk is mitigated by the high integrity transfer systems, computer controlled filling, adherence to well developed procedures and an ongoing leak detection and repair programme. Significant quantities of C_5+ are stored on site, although the tank is subject to regular inspection and the area is bunded.

It is concluded that the risk of odour release is low as is the likely impact of any release. Good procedures and well designed systems minimise the risk of a significant release during handling operations. The material is also only moderately odorous. There have been no reported significant losses of C_5+ either during handling or storage over the review period and no odour complaints attributable to general C_5+ operations. In the review period there were 3 minor (on-site) odour incidents recorded where odour was detected locally in or around the C_5+ area.

The current arrangements are considered to constitute BAT. Other than the ongoing review, monitoring and auditing of the C_5+ handling and storage procedures, no other improvements are recommended.

Table 2.2.3 C_5+ operations process review

Operation	C_5+ handling and storage	Fugitive and accidental losses
Controls	Handling and storage system is fully enclosed with liquid and return gas streams. Any over pressure in the system is vented to the high level flare. Loading operations are also tripped. Operating procedures and staff training are well developed. Tanker filling is computer-controlled with high level detection to warn of overfill. Dry break couplings prevent losses on disconnect. Leak detection and repair procedures are in place to detect and remedy fugitive losses.	The transfer, storage and loading systems are fully contained and are subject to a programme of leak detection and repair. Well developed procedures are applied to the handling operations. The handling and storage systems are designed to a high standard specifically to minimise losses of this valuable and very flammable material.
Emission significance	C_5+ is only moderately odorous. In view of this and the well developed systems in place, this is considered a low odour risk.	In view of the proven management procedures in place the risk of accidental loss and subsequent odour impact is considered low.
Improvements	Continued periodic review and audit of operating procedures under EMS/OIMS.	Continued periodic review and audit of operating procedures under EMS/OIMS.
Comments	No odour complaints have been attributed to C_5+ operations in the review period. Current arrangements are considered to be BAT.	There was 3 minor internal odour incidents logged that may be attributed to fugitive or accidental losses from the C_5+ operations in the review period. Current arrangements are considered to be BAT.

2.2.4 Wet air oxidation – Area J

Cracked gas leaving the furnaces is fed into a series of compressors for cooling. Between the fourth and fifth compressor the gas passes through a caustic wash tower for removal of carbon dioxide and any hydrogen sulphide present (including that from DMS addition – see section 2.2.2). This essentially removes all remaining hydrogen sulphide from the gas stream. The spent caustic is removed from the bottom of the tower and passed to a wet air oxidation system for neutralisation and disposal.

The wet air oxidation system consists of three reactors where sulphides are oxidised to sulphate using plant air. The system vents through the caustic oxidisers vent (A12). This stream will inevitably contain trace amounts of hydrogen sulphide and possibly other sulphide and mercaptans and represents a continuous odour discharge. The treated caustic is then passed to the caustic neutralisation sump where it is cooled and neutralised before passing to the CPI separator (see sections 2.2.5 and 2.2.6).

There are two potential pathways for the release of odour from the wet air oxidation process:

- Inefficient operation of the system, due to system failure or overloading, resulting in increased vent discharges and/or poor oxidation of sulphides

- Poor dispersion of vent discharges leading to increased ambient concentrations of odour (sulphides and mercaptans)

The likelihood of overloading of the oxidation system due to increased flow from the furnaces is low as furnace operation is tightly controlled at a steady state. In addition, the DMS feed into the furnaces is highly stable (see section 2.2.2), hence the sulphide loading is relatively stable. Inefficient oxidiser operation due to operational problems could give rise to both increases in venting of sulphides and the presence of sulphide in the treated caustic (see section 2.2.5). The operation of the oxidation system is tightly controlled and monitored with an element of redundancy (2 operational reactors and 1 stand by reactor) should problems arise. In practice the sulphide loading is relatively stable, the strength of the caustic absorption liquor is tightly controlled and reactor temperatures are continuously monitored and maintained by steam addition. In such circumstances it is considered that the odour release risk is relatively low.

A12 does represent a continuous odorous discharge, although historical measurements indicate that the sulphide content is negligible. It is understood that no measurements from this point have been made in the review period. The discharge point is not at a high level and as such it would be expected that any impact for this source would be greatest within the site boundary.

Table 2.2.4 summarises the odour release risk and the preventative control measures in place, together possible process improvements, where applicable.

There have been no complaints, either internal or external, that can be attributed to operations at the wet air oxidiser. It is considered that the control system represents BAT. Continued review, monitoring and auditing of the procedures in place is recommended.

Table 2.2.4 Wet air oxidation process review

Operation	Inefficient/abnormal operation	Poor dispersion
Controls	DMS is added to the furnaces at a relatively low and constant rate hence the oxidiser sulphide loading is low and predictable. Oxidiser operating conditions (caustic strength, reaction temperatures) are tightly controlled. With the stable feed stream sulphide absorption efficiency is consistent. Important operating parameters are monitored and as such any abnormal operation can be detected quickly. Redundant capacity is available with two operational reactors and one stand by. The oxidiser effluent sulphide content is monitored. This will provide an indication of sulphide vent releases as the two streams are in equilibrium. There is a storage facility for spent caustic giving a three day window for any remedial action on the oxidiser system or downstream neutralisation system should there be any major operational problem.	The oxidiser vent is not particularly elevated and as such any occurrence of odour would be expected to be strongest within the site boundary. Wind direction is relatively predictable (see section 2.3) and stable. This provides a fairly well defined dispersion path. Human off-site receptors are relatively distant minimising the risk of nuisance from this point (see section 2.3). It is expected that the sulphide loading to the oxidiser vent is relatively low due to the tight control measures in place. Odour risk is likely to be minimal during normal operation and as such the need for effective dispersion may not be a major concern.
Emission significance	H_2S is highly odorous, although under normal operation the continuous discharge stream has a low sulphide content. In view of the low level of sulphide present and the control measures in place this release is not considered a significant odour risk.	Whilst the A12 vent is a continuous discharge of potentially odorous gas, the measures in place provide adequate control.
Improvements	Continued periodic review and audit of operating procedures under EMS/OIMS.	The expected low odour significance of this release and a lack of attributable complaints indicates that there is little risk due to poor dispersion.
Comments	Whilst the oxidiser vent is a continuous source of odour, there is no record of complaints attributable to this point within the review period. It is considered that this is due to the good control of oxidiser operation and the associated upstream and downstream systems. Current arrangements are considered to be BAT.	No odour complaints have been attributed to discharges from the oxidiser vent. The effectiveness of dispersion is unknown as there appears to have been no serious losses of sulphide via this vent and hence no information upon which to base an impact assessment.

2.2.5 Caustic neutralisation – Area K

Treated caustic solution from the oxidation unit is passed to the spent caustic neutralisation sump where it is neutralised with sulphuric acid.

The caustic leaving the oxidiser first passes to a separator where absorbed gases may be returned to the oxidiser vent (A12), whilst the caustic is filtered and cooled before passing to the neutralisation sump. Here it is mixed with sulphuric acid to produce sodium sulphate.

The feed stream has a continuous sulphide monitor to detect the presence of sulphide in the effluent stream. This is an indication of poor oxidiser performance and also warns of potential problems in the neutralisation sump where reaction with sulphuric acid will release hydrogen sulphide. The neutralisation sump is equipped with hydrogen sulphide monitors to warn of the presence of hydrogen sulphide in the air.

The most significant pathway for the release of odour from the neutralisation sump is:

- sulphide in the treated caustic from the wet air oxidation process reacting with sulphuric acid to release hydrogen sulphide

Poor oxidation performance could lead to the presence of unoxidised sulphide in the treated caustic solution which will subsequently be released as hydrogen sulphide upon reaction with sulphuric acid. This will occur as an ambient release around the neutralisation area. The control of the wet oxidation system and its consistent performance has been discussed in Section 2.2.4. Furthermore, the caustic stream from the oxidisers is monitored for sulphide and there is a hydrogen sulphide alarm in the neutralisation area. It is concluded that, although the presence of sulphide is possible, it is unlikely in view of the controls in place on the oxidiser. Whilst a release of hydrogen sulphide via this mechanism is possible the duration would be relatively short in view of the monitoring and control measures in place. Any release is likely to be largely low elevation and confined to the neutralisation area and as such is unlikely to have any significant impact beyond the site boundary.

Table 2.2.5 summarises the odour release risk and the preventative control measures in place, together with possible process improvements, where applicable.

There have been no external complaints on internal odour incidents that can be attributed to operations at the neutralisation area during the review period. There is no record of complaints from staff working in this area or instances of personal alarms detecting which might be expected in an alarm situation.

The current arrangements are considered to represent BAT. Continued review, monitoring and auditing of the procedures in place is recommended. Significant reliance is placed on the monitors in the inlet stream and neutralisation area and as such these need to be carefully maintained.

Table 2.2.5 Caustic neutralisation process review

Operation	Sulphide slippage in effluent stream
Controls	The sulphide content of the caustic stream entering the neutralisation sump is monitored. The normal content is below the limit of detection. Procedures are in place to minimise hydrogen sulphide release should a high sulphide content be detected in the caustic stream. The neutralisation area is continually monitored for the presence of hydrogen sulphide. There is a storage facility for spent caustic giving a three day window for any remedial action on the oxidiser system or downstream neutralisation system should there be any major operational problem.
Emission significance	H_2S is highly odorous, although under normal operation the risk of release is minimal. Release in the event of operational difficulties would be a relatively short event and would be largely confined within the site. The odour risk to off-site receptors is considered low.
Improvements	Continued periodic review and audit of operating procedures under EMS/OIMS. This should include the sulphide/H_2S monitoring systems which are crucial to the control of the odour risk.
Comments	No odour complaints have been recorded which can be attributed to neutralisation operations. There have been only 2 minor on site odour incidents recorded in the period. Current arrangements are considered to be BAT.

2.2.6 Effluent treatment - Area K

Waste water from the FEP site is collected and treated in the rainwater holding pond and the firewater pond. A modified API (American Petroleum Institute) separator is situated between the firewater and rain water holding ponds. Passage through this removes oil and suspended solids from the water. These collect in the separator and are subsequently skimmed to a further corrugated plate interceptor (CPI) for further separation.

There is a continuous discharge to the rainwater holding pond of hot water from the cracker quench circuit. This will lead to flash evaporation of lighter fractions in the oily skimmings in the API separator and to flash evaporation of any hydrocarbon also present in the blow down. The CPI separator may also be susceptible to the flash evaporation of lighter hydrocarbons.

The sludge that builds up in the API and CPI separators is periodically removed, dewatered and then removed from site for further processing and disposal. This operation has been demonstrated to have little associated odour risk.

The main risk of odour in these operations comes from the release of light hydrocarbons:

- Hydrocarbons present in the API and CPI separator which can flash off in the presence of hot water from blow down.

- Flashing of hydrocarbons present in the water entering the API separator when released to the open sump.

The main control measure is the effort to reduce site hydrocarbon losses to the water system. Records indicated the following estimated hydrocarbon losses to the water system over the review period, although it should be understood that loses are also highly dependent on throughput.

2017 9.4 kg/day
2018 13.4 kg/day
2019 9.8 kg/day
2020 20.2 kg/day

Whilst the discharges recorded were up a little on average on the low levels achieved during the 2013 to 2017 review period they are still consistently and comfortable below the consent limit of 60 kg/day.

Skimmings from the API are frequently removed to the CPI in order to minimise potential odour release. The API separator was recently cleaned in December 2020.

A low level hydrocarbon-based odour is generally present around the effluent treatment area. This is a low level area source and as such it would not be expected that the odour would carry far from the site boundary. There have been no external odour complaints in the review period and only 2 minor on site odour incidents recorded in the period around the Effluent treatment area. In previous review periods there have been occasional complaints, which were most likely attributable to odour from the effluent treatment area, received from the neighbouring Shell plant and from areas around the site boundary although this has not been the case in this period. It is notable that there are a number of ground flares around this area, operated by Shell, which can also be an odour source.

The current arrangements are considered to represent BAT. Continued review, monitoring and auditing of the associated procedures in place is recommended. It is important that the above measures are continued in order to maintain the current low level of hydrocarbon losses to the water system.

This source of odour is unlikely to be fully eliminated and, depending on conditions, there may be occasional mild odour impact on the site boundary. However this is unlikely to be noticeable beyond the processing complex. The current measures aimed at reducing hydrocarbon losses and removing material with odour potential should assist in reducing occurrences. The wastewater system performance is monitored and triggers exist to indicate if maintenance is required.

Table 2.2.6 Effluent treatment process review

Operation	Flash evaporation of hydrocarbons
Controls	Procedures are in place to reduce the release of hydrocarbons to the site water systems. Monitoring is in place to warn of significant hydrocarbon contamination. The API separator skimmings are removed to the CPI separator on a frequent basis to minimise odour potential.
Emission significance	The lighter hydrocarbons released from the effluent treatment area have a low odour profile. The release is at low level and as such there is likely to be little significant impact beyond the site boundary.
Improvements	Continued periodic review and audit of operating procedures under EMS/OIMS. This should include an assessment of degradation of API separator performance with time and consideration of most appropriate cleaning frequency.
Comments	No external odour complaints were recorded in the review period with only 2 minor on-site odour incidents recorded in the period. Minimising hydrocarbon losses to the water system and more frequent removal of solids should assist in reducing the odour risk. It is considered that there is no significant risk of odour impact from these operations far beyond the site boundary. Current arrangements are considered to be BAT.

2.3 Odour release impact

In assessing the risk of odour nuisance it is important to understand the likely receptors and how any odours might be dispersed from the site. Such understanding is important when considering the effectiveness of control measures and when investigating complaints. The FEP is not the only potential source of odour in the local area and as such it is necessary to clearly understand whether the odour is typical of that from the site and how it might be transported to the complainant in order that it can be clearly attributed to a process operation and the circumstance of its release addressed.

2.3.1 Odour receptors

The immediate neighbour of the FEP site is the Shell NGL plant which shares the PPC installation boundary. The site is likely to be impacted by any low level odour releases, although this site also has potential odour sources of its own. There is also a poultry farm to the south west which has a distinctive odour. The main areas of human habitation are Lochgelly (around 3.5 km to the north) and the smaller town of Auchtertool (around 3 km to the east). There are seven residential properties within 3.5 km of the nearest FEP site boundary to the east/north east of the site in the direction of the prevailing wind as shown in Table 2.3.1 and in Figure 2.3.1.

Table 2.3.1 Locations of human receptors

No.	Location	Easting (m)	Northing (m)	Distance from nearest FEP boundary
1	Newton Farm	320377	689934	1.4 km E
2	Kirkton Cottages	321076	690016	2.1 km E
3	Walton	320041	690552	1.1 km NE
4	Easter Lochead	319252	691385	1.4 km N
5	Little Raith	320590	691656	2.2 km NE
6	Auchertool School	321786	690609	2.8 km E
7	Glenniston	321432	692051	3.2 km NE

2.3.2 Meteorology

The closest suitable meteorological station is Edinburgh Gogarbank which is around 20 km south of the FEP. Measurements for the review period (2017 to 2020) are illustrated in the composite windrose in Figure 2.3.2. This shows that the wind is predominantly from the south west and is blowing towards the north east.

2.3.3 Impact of releases

Based on the meteorology, it is unlikely that habitation to the west of FEP will be significantly affected by any releases as the wind is predominantly in the opposite direction. Lochgelly is also unlikely to see significant impact. The highlighted receptors together with Auchertool are the most likely to experience odour impact should a significant release occur. However, the majority of potential odour releases at the FEP are at a low elevation and as such it is considered that the neighbouring Shell NGL site is the most likely to be affected. An assessment of complaints received during the review period (see Section 2.4) tends to confirm these general conclusions and indeed there were no external odour complaints even from the neighbouring Shell plant during the review period.

Figure 2.3.1 Receptors around the FEP

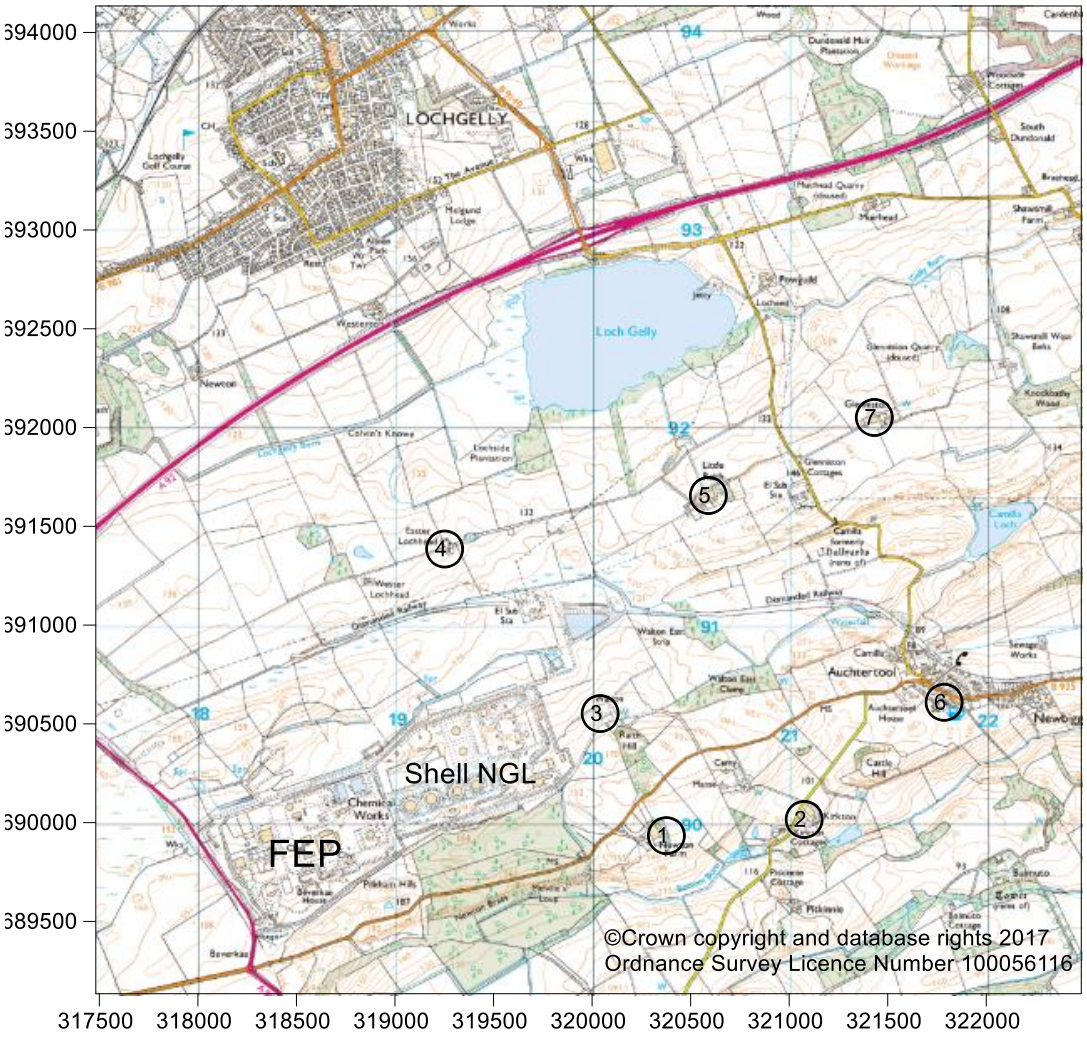
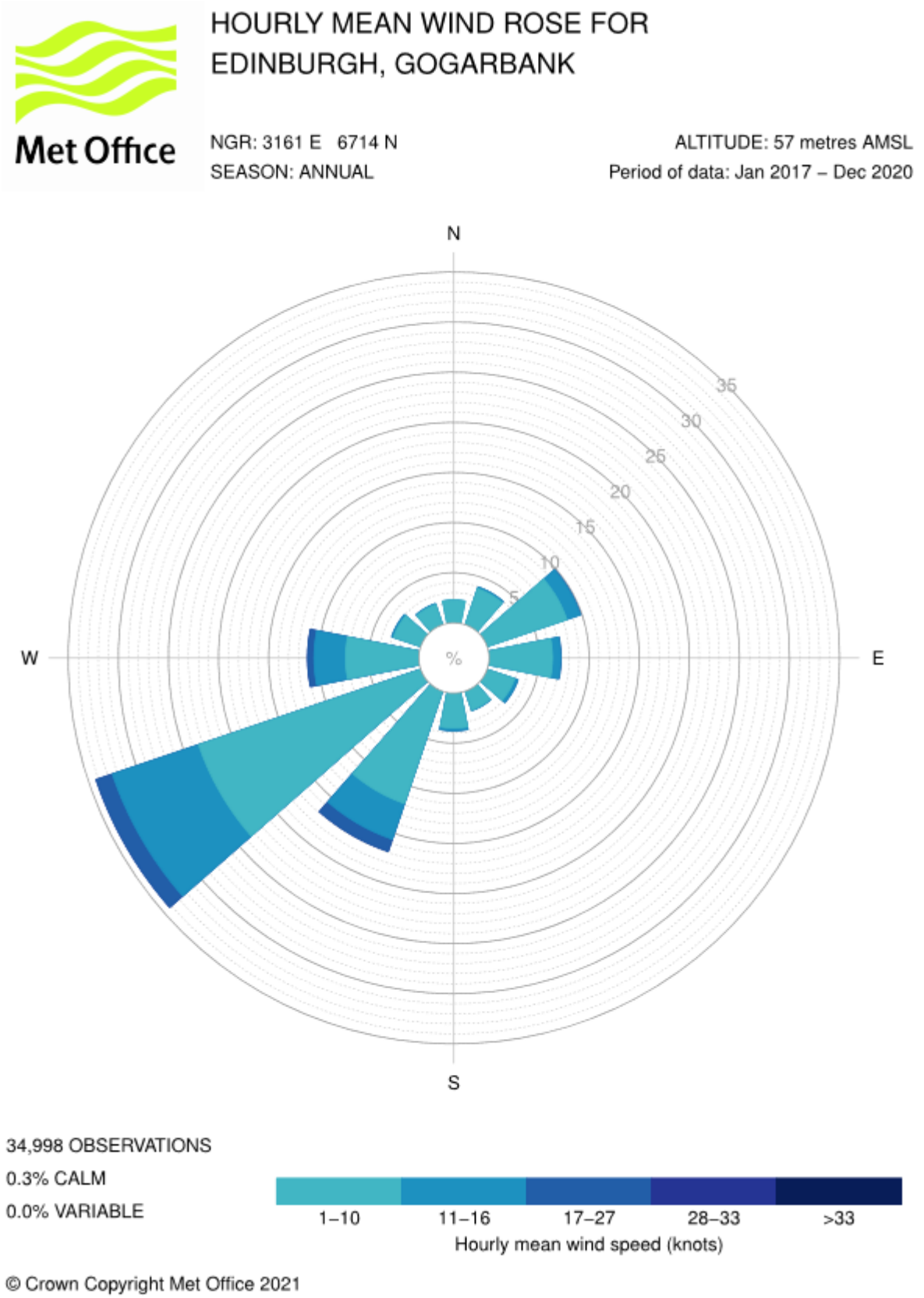


Figure 2.3.2 Composite windrose for Edinburgh Gogorbank (2017 to 2020)



2.4 Odour complaints and complaints procedures

ExxonMobil operate an environmental complaints procedure which covers odours, but also other aspects such as noise and accidental releases. The procedure requires that all complaints received are dealt with professionally, effectively and promptly. All complaints and subsequent follow-up actions are recorded and stored electronically. The objective is to ensure good community relations and as such this often involves home visits from ExxonMobil staff to discuss issues and ensure a resolution. The findings of these investigations form the basis for preventative measures with the aim of the minimisation of environmental impact leading to complaints, and compliance with statutory and corporate requirements.

The specific procedure for dealing with an odour complaint is as follows:

- Complaint acknowledgement and recording by recipient
- Investigation by shift manager, including a visit to the complainant if appropriate and any required immediate site operation action
- Notification of the site environment manager and SEPA if appropriate
- Site management team reviews previous 24 hours' records at 8 am each morning or earlier in the event of a serious complaint
- Appointment of an incident team if appropriate
- Where appropriate involvement of ExxonMobil public affairs department to manage external meetings
- Review of incident and plans to prevent recurrence

Records have been supplied by ExxonMobil detailing the complaints and indicating that the above procedure has been followed in all cases.

Since there were in fact no external complaints received from human receptors outside of the site boundary a review has been carried out on all internal odour incidents as logged and a summary provided below in table 2.4. The records that have been supplied by ExxonMobil detailing incidents and indicate that the procedures described above have been followed in all cases.

A review of all odour incidents shows that 8 of these (as listed below) were attributed to areas of interest as detailed earlier in this report. A detailed review of these has revealed no systemic issues with consistent evidence that even minor odours detected locally on site are routinely reported, investigated and with close out actions put in place to remove the odour source.

The overall conclusion is that off site complaints directly attributable to operations at FEP are extremely rare and indeed there were zero in fact in this 4 year review period. This tends to indicate that the sources identified and discussed in section 2.2 do not have a significant odour impact during normal operation. Furthermore process control is such that during the long-term there have been no major losses causing significant odour release or impact.

Table 2.4 Odour complaint history 2017 to 2020

It should be noted that no external odour complaints were raised or recorded in the review period. However, the site also keeps thorough records of any on-site odour incidents and notifications raised so a summary (below) is provided of any incidents in the review period that are attributable to the 6 areas of potential Odour source covered in this review.

FEP reference number	Date	Location of Odour incident	Description	Attributed
1227704	25th Feb 2019	Area A	Strong Smell of DAC	DAC running under the insulation of the minimum flow line to Q-D-01
1252735	2nd June 2019	Area A	Smell of Gas	Q-A-502 vent had been left open allowing process gas to vent to atmosphere
1069114	2nd Aug 2017	Area D	Smell of C5+	Unattributed
1395520	26th Jan 2021	Area K (Flare System area – near Effluent treatment)	Strong Smell of Benzene odour	Leak in vicinity of G-ANH-04
1399163	11th Feb 2021	Area K (Flare System area – near Effluent treatment)	Strong Smell	Leak from pipe rack attributed to WDH line to G-D_51
1025885	8th Jan 2017	Area N	Smell of Hydrocarbons	3 downstream feed line drains being open and uncapped on KF05
1207210	16th Dec 2018	Area N	Strong smell of Hydrocarbons	Noted in process of starting K-F-06 up after maintenance
1212041	8th Jan 2019	Area N	Smell of Hydrocarbons	KF02 burner deck. On inspection a sizeable leak on the 1" line was noted

2.4.1 Process management systems

Fife Ethylene Plant (FEP) conducts all operations under the ExxonMobil Environment Policy. It carefully measures performance and strives to continually enhance it by improving systems and investing in technology. FEP uses a structured framework known as the Operations Integrity Management System (OIMS) to identify and control risks associated with the design, construction and operation of its facilities. The design of the ExxonMobil OIMS, policies and practices has been attested to align with the intent of ISO 14001 Environmental Management Systems.

For many of the processes reviewed it is considered essential that the provisions of OIMS be continually reviewed and audited to ensure these are effective and reflect current requirements (e.g. BAT) and address any issues arising from complaints or external inspections (e.g. SEPA).

2.5 Recommendations

In assessing the potential odour sources and the associated preventative measures in section 2.2, the following recommendations have been made:

It is crucial to the continued efficient management of operation and controls that procedures continue to be audited and reviewed ensuring that these incorporate most recent operational experience and best practice.

Whilst no external complaints were received at the site in the review period there were a number of minor local odour incidents recorded and the site should continue to utilise this effective 'early warning system' going forwards to ensure the likelihood of future external complaints remains low.

3 CONCLUSIONS

This report is a review of the odour assessment undertaken in 2017. The findings of this assessment have been reviewed, confirmed and updated where necessary by a site visit, discussions with key personnel, assessment of relevant documentation and consideration of latest relevant guidance.

The review generally indicates no significant changes in terms of process arrangements and operating procedures between 2017 and 2021 which are relevant to potential odour releases.

The review has confirmed six potential odour sources, where odours may arise from the operation or the substances employed. In most cases an odour discharge is only likely where there is operational abnormality or accidental release, although there are two sources where there is a frequent or continuous odour discharge.

The review has found that adequate equipment design, operating and maintenance procedures, monitoring and control measures have been employed to minimise the potential for abnormal events which could lead to an odour discharge. No such events have been directly reported for the review period.

Whilst there is a known odour discharge at two positions, measures are in place to minimise the impact. The complaints history over the review period indicates that these sources have not had a noticeable impact with no external complaints received, suggesting that either the release is not significant or dispersion is effective.

The odour complaint history indicates that complaints are very rare and previous reviews have shown that any off-site complaints are likely to arise from effluent treatment operations. The wind direction is fairly predictable and likely receptors for any odour release are well defined. It is notable that there were no odour complaints even from the adjacent Shell plant during this period, as had occasionally been the case in previous reviews.

Based on the odour control measures in place, the odour potential of the operations and the history of odour complaints it is considered that that the risk of an odour release and subsequent off-site impact is low. The review has not identified any operations or procedures that are in need of change.

The ongoing review and audit of procedures needs to be maintained in order to ensure that the operations continue to be well managed and incorporate operational experience and best practice. All systems are considered to constitute BAT.

4 REFERENCES

1. ExxonMobil Chemicals Mossmorran FEP Plant, Assessment of Odour Emissions, March 2009, Entec UK Limited.

2. ExxonMobil Chemicals Mossmorran FEP Plant, Assessment of Odour Emissions, April 2013, Environmental Scientifics Group Limited, 2 April 2013.

3. ExxonMobil Chemicals Mossmorran FEP Plant, Assessment of Odour Emissions, April 2017, Environmental Scientifics Group Limited, 18 April 2017.

4. IPPC H4, Draft Horizontal Guidance for Odour, Part 1 Regulation and Permitting, October 2002, Environmental Agency/SEPA.

5. IPPC H4, Draft Horizontal Guidance for Odour, Part 2 Assessment and Control, October 2002, Environmental Agency/SEPA.

6. Additional guidance for H4 Odour Management, March 2011, Environment Agency

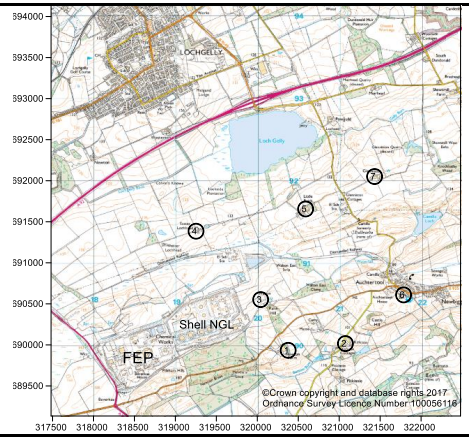
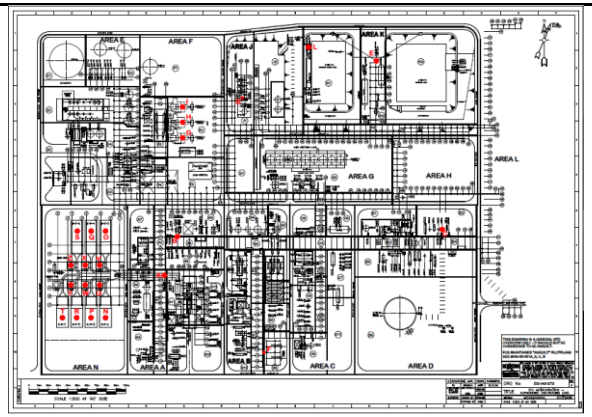
7. Odour guidance 2010, January 2010, SEPA.

8. IPPC Reference document on best available techniques in the large volume organic chemical industry, December 2017, European Commission.

5 ODOUR MANAGEMENT PLAN

An odour management plan for the FEP was developed in 2009. This plan has been reviewed and is typically updated if the review finds any areas for improvement. In this period the review has indicated that the majority of processes and their associated control measures have not changed significantly since 2009 and this, coupled with the fact that no odour complaints have been received in the period means that no significant updates are required to the Odour management plan.

The format employed is that proposed in SEPA's odour guidance 2010[7], which is very similar to the form of the 2009 odour management plan.

<table>
<tr><th colspan="4">Odour Management Plan</th></tr>
<tr><td>Company name</td><td>Exxon Mobil Chemical Limited</td><td colspan="2">Site/Environmental Manager</td></tr>
<tr><td rowspan="3">Address</td><td rowspan="3">Fife Ethylene Plant
Beverkae House
Mossmorron
Cowdenbeath
Fife, KY4 8EP</td><td colspan="2">Working hours (0900-1700)</td></tr>
<tr><td colspan="2">Point of contact</td></tr>
<tr><td colspan="2">Telephone number</td></tr>
<tr><td rowspan="3">Purpose</td><td rowspan="3">To manage and minimise the on-site and off-site impact of potentially odorous operations</td><td colspan="2">Out of hours</td></tr>
<tr><td colspan="2">Point of contact</td></tr>
<tr><td colspan="2">Telephone number</td></tr>
<tr><td>Location</td><td>The Fife Ethylene Plant (FEP) is located to the south of Lochgelly. The primary human receptors for odours from the FEP (based on known meteorology) are considered to be:
1. Newton Farm
2. Kirkton Cottages
3. Walton
4. Easter Lochead
5. Little Raith
6. Auchertool School
7. Glenniston</td><td>Process description</td><td>The overall process produces ethylene and other by-products from raw ethane. Potentially odorous operation are:
• Ethane solvent wash (Feed treatment process)
• Pyrolysis furnace operation
• Handling of C_5+ by product
• Oxidation and neutralisation of caustic effluent streams
• Effluent and waste water treatment</td></tr>
<tr><td>Location plan</td><td> 
</td><td>Site Plan</td><td>  </td></tr>
</table>

Odour source	Release point	Failure event			Resultant actions
		Scenario	**Potential outcome**	**Preventative/mitigation measures**	
Area D	**Point source**				
Solvent handling	Feed treatment process vent (A14)	Over pressure during delivery and transfer leads to venting.	Adip-X is vented to A14	Adip-X has a low odour potential and hence there is a low odour risk. Safety considerations require a vent for over pressure incidents. Overpressure events are monitored and reviewed to determine cause and to minimise occurrence. Steam sparge is used to aid dispersion from A14.	None – measures are considered BAT.
	Fugitive				
	Tanker delivery area	Hose or coupling failure leads to spillage of Adip-X. Operator error leads to spillage of Adip-X	Adip-X is released to the loading area.	Adip-X has a low odour potential and hence there is a low odour risk. Odour impact confined to loading area. Loading events are infrequent. System is fully enclosed and subject to a programme of leak detection and repair. Operating procedures and staff training are well developed.	None – measures are considered BAT. Significant spillages are reported.
Boiler operation	**Fugitive**				
	Feed treatment process vent (A14)	Boiler trip leads to venting of stripped gases (H_2S)	Stripped gas stream containing H_2S will be redirected to the Feed treatment process vent (A14)	Safety considerations require a vent for over pressure incidents Steam sparge is used to aid dispersion from A14. Boiler trips and subsequent venting incidents are recorded and investigated in order to identify systematic failures and remedial measures to minimise failures and downtime. Losses of H_2S are estimated and reported.	None – measures are considered BAT. Venting incidents and loss of H_2S are reported.

Odour source	Release point	Failure event			Resultant actions
		Scenario	Potential outcome	Preventative/mitigation measures	
	Boiler exhaust stacks A8, A9, A10	Abnormal boiler operation leads to failure to combust stripped gas (H_2S).	Stripped gas containing H_2S is released, uncombusted, to atmosphere via the boiler exhaust stacks.	Extensive monitoring and control of the parameters critical to efficient boiler operation are in place. Statutory monitoring of the boiler exhaust is undertaken quarterly confirming efficient conversion of H_2S to SO_2. A8, A9 and A10 are high level stacks designed for good dispersion of combustion emissions.	None – measures are considered BAT.

Odour source	Release point	Failure event			Resultant actions
		Scenario	Potential outcome	Preventative/mitigation measures	
Area A	**Point source**				
Furnace operation	Wet oxidiser vent (A12)	Poor furnace operation could lead to release of unconverted DMS to downstream processes.	Release of DMS to the wet oxidiser inlet could result in increased releases of odorous material at the wet oxidiser vent (A12).	There is extensive monitoring and control of parameters critical to efficient furnace operation. Furnaces have proven performance and are highly efficient in converting DMS to H_2S. The dosing rate of DMS is relatively low and constant.	None – measures are considered BAT.
DMS handling	**Fugitive**				
	Tanker delivery area	Hose or coupling failure leads to spillage of DMS. Operator error leads to spillage of DMS	Highly odorous DMS is released around tanker delivery area.	Deliveries are infrequent at around 2 per month. The handling system is fully contained. Nitrogen displacement is used to prevent venting of DMS. Overpressure is directed to the high level flare. Environmentally critical controls and procedures are applied to handling operations. DMS handling systems are designed to a high standard specifically to minimise losses. The handling systems are subject to an ongoing programme of leak detection and repair.	None – measures are considered BAT Significant spillages are reported.
DMS addition	DMS metering system	Leakage from DMS metering system can result in release of DMS.	Highly odorous DMS is released in area around metering system.	Relatively small quantities of DMS are injected limiting the odour impact of a leak. Environmentally critical controls and procedures are applied to metering operations. DMS handling systems are designed to a high standard specifically to minimise losses. The metering systems are subject to an ongoing programme of leak detection and repair.	None – measures are considered BAT. Significant releases are reported.

Odour source	Release point	Failure event			Resultant actions
		Scenario	Potential outcome	Preventative/mitigation measures	
Area N	**Fugitive**				
C_5+ handling and storage	Tanker loading area	Hose or coupling failure leads to spillage of C_5+. Operator error leads to spillage of C_5+.	C_5+ is released, although this is not considered particularly odorous and low impact would be expected.	Handling and storage system is fully enclosed with liquid and return gas streams. Any over pressure in the system is vented to the high level flare. Loading operations are also tripped. Operating procedures and staff training are well developed. Tanker filling is computer-controlled with high level detection to warn of overfill. Dry break couplings prevent losses on disconnect. The transfer, storage and loading systems are fully contained and are subject to a programme of leak detection and repair. The handling and storage systems are designed to a high standard specifically to minimise losses of this valuable and very flammable material.	None – measures are considered BAT Significant spillages are reported.
	Transfer system and storage area	Leak in transfer or storage system leads to release of C_5+.			

Odour source	Release point	Failure event			Resultant actions
		Scenario	Potential outcome	Preventative/mitigation measures	
Area J	**Point source**				
Caustic wet air oxidation	Oxidiser vent A12	Inefficient operation of oxidiser. Elevated sulphide loading to the wet oxidiser.	Increased emissions of highly odorous H_2S, other sulphides and mercaptans from oxidiser vent (A12).	Oxidiser operating conditions, (caustic strength, reaction temperatures) are tightly controlled. With the stable feed stream sulphide absorption efficiency is consistent. Important operating parameters are monitored and as such any abnormal operation can be detected quickly. Redundant capacity is available with two operational reactors and one stand by. The oxidiser effluent sulphide content is monitored. This will provide an indication of sulphide vent releases. There is a storage facility for spent caustic giving a three day window for any remedial action on the oxidiser system or downstream neutralisation system should there be any major operational problem. DMS is added to the furnaces at a relatively low and constant rate hence the oxidiser sulphide loading is low and predictable.	None – measures are considered BAT.
	Oxidiser vent (A12)	Poor dispersion of continuous odour stream from A12 vent.	Increased impact of odour releases.	The oxidiser vent is not particularly elevated and as such any occurrence of odour would be expected to be strongest within the site boundary. Wind direction is relatively predictable and stable providing a fairly well defined dispersion path. Human off-site receptors are relatively distant minimising the risk of nuisance from this point. It is expected that the sulphide loading to the oxidiser vent is relatively low due to the tight control measures in place. Odour risk is likely to be minimal during normal operation and as such effective dispersion may not be a major concern.	None – measures are considered BAT.

Odour source	Release point	Failure event			Resultant actions
		Scenario	Potential outcome	Preventative/mitigation measures	
Area K	**Fugitive**				
Caustic neutralisation	Neutralisation sump area	Sulphide present in the caustic stream due to abnormal operation of the wet air oxidiser.	Release of highly odorous H_2S to neutralisation sump area as a result of the reaction of sulphide with sulphuric acid during neutralisation.	The sulphide content of the caustic stream entering the neutralisation sump is monitored. The normal content is below the limit of detection. Procedures are in place to minimise H_2S release should high sulphide content be detected in the caustic stream. The neutralisation area is continually monitored for the presence of H_2S. There is a storage facility for spent caustic giving a three day window for any remedial action on the oxidiser system or downstream neutralisation system should there be any major operational problem.	None – measures are considered BAT. Sulphide and H_2S monitor alarms are monitored and reported.
Effluent treatment	Contaminated storm water sewer , API separator and CPI separator	Lighter hydrocarbons in the API and/or CPI separators can flash evaporate when contacted with hot blow down water. Entrained hydrocarbons in water entering the API separator may flash evaporate when reaching open sump areas.	Release of low odour level hydrocarbons around the effluent treatment area.	Procedures are in place to reduce the release of hydrocarbons to the site water systems. Monitoring is in place to warn of significant hydrocarbon contamination. The API separator skimmings are removed to the CPI separator on a frequent basis to minimise odour potential. The lighter hydrocarbons released from the effluent treatment area have a low odour profile. The release is at low level and as such there is likely to be little significant impact beyond the site boundary.	None – measures are considered BAT.

END OF REPORT