MOSSMORRAN & BRAEFOOT BAY INDEPENDENT

AIR QUALITY MONITORING REVIEW GROUP

2017 Annual Report

FINAL REPORT

12th October 2018

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MOSSMORRAN & BRAEFOOT BAY INDEPENDENT AIR QUALITY MONITORING REVIEW GROUP

2017 Annual Report

EXECUTIVE SUMMARY

The Mossmorran & Braefoot Bay Independent Air Quality Monitoring Review Group (Review Group) advises Fife Council regarding the monitoring of air emissions arising from operations at the Mossmorran plants and the Braefoot Bay terminal facilities operated by Shell UK Limited (Shell) and ExxonMobil Chemical Limited (ExxonMobil). The Review Group do this by reviewing air quality data collected from a number of sources, as well as considering the potential impact that wind turbines and any major plant changes could have on air quality. The Review Group liaises with representatives from community councils and the local health service.

The facilities at Mossmorran and the ExxonMobil facility at Braefoot Bay operate under Pollution Prevention and Control permits issued by the Scottish Environment Protection Agency (SEPA). These permits specify the conditions for protection of the environment under which the facilities must operate. Fife Council is required by the Environment Act 1995 (Part IV) to periodically review and assess air quality in its area to ensure air quality standards and objectives for prescribed pollutants are not exceeded. For the Mossmorran plants and Braefoot Bay terminal facilities, this process includes taking account of the Review Group findings.

During 2017, there were no plant changes at the Mossmorran and Braefoot Bay facilities that would be anticipated to adversely affect local air quality.

Flaring is undertaken to protect the plant safety during planned and unplanned maintenance work. An extended period of flaring from the Mossmorran plant occurred in June 2017 and Final Warning Letters were served on ExxonMobil and Shell by SEPA in April 2018 relating to this. The Review Group understands that ExxonMobil have put new controls in place to prevent recurrence and that they continue to assess opportunities for further improvement. The overall quantities flared at the Mossmorran plants were lower in 2017 than those reported in 2016. There is no evidence of a longer-term trend towards increased flaring.

Concentrations of pollutants in air monitored along the Fife coastline were low and there has been an overall reduction in their levels over the last decade. No air quality issues in the vicinity of Mossmorran or Braefoot Bay were identified in Fife Council's 2018 Air Quality Annual Progress Report. The Review Group considers that the wind farm at Little Raith Farm has no negative impact on the dispersion of air emissions from Mossmorran.

Overall, the Review Group concluded that, based on the available data reviewed in 2017, that emissions from the Shell and ExxonMobil Plants at Mossmorran and Braefoot Bay continue to pose no significant risk to the health of members of the local community. The Review Group however recognises that there are still concerns expressed by local communities with regard to perceived air quality and health issues and will continue to liaise with relevant stakeholders to address these.

MOSSMORRAN & BRAEFOOT BAY INDEPENDENT AIR QUALITY MONITORING REVIEW GROUP

2017 Annual Report

1 INTRODUCTION

1.1 MOSSMORRAN & BRAEFOOT BAY INDEPENDENT AIR QUALITY MONITORING REVIEW GROUP

The Mossmorran & Braefoot Bay Independent Air Quality Monitoring Review Group (Review Group) was formed to provide advice and recommendations to Fife Council[1] regarding the monitoring of air emissions arising from the operations at the Mossmorran plants and the Braefoot Bay terminal facilities (operated by Shell UK Limited (Shell) and ExxonMobil Chemical Limited (ExxonMobil)). The constitution and terms of reference of the Review Group are described in Appendix 1. Appendix 2 lists the Review Group members during 2017.

Previous air quality monitoring undertaken by the National Physical Laboratory (NPL) on the behalf of BP Exploration North Sea Region, has demonstrated that concentrations of benzene and other hydrocarbons were low in the vicinity of the facilities. The Review Group concluded in 1999 that its work was nearing completion and that further air quality monitoring was probably not required. However, the Review Group was reconstituted in 2001 following concern expressed by local communities and highlighted in media reports, with regard to perceived air quality and cancer-related health issues in the vicinity of Mossmorran and Braefoot Bay. The Review Group continues to liaise with local communities, via representatives from community councils and representatives of the local health service.

1.2 MOSSMORRAN PLANTS AND THE BRAEFOOT BAY TERMINAL FACILITIES

Shell operates the Mossmorran Natural Gas Fractionation (FNGL) Plant that extracts natural gasoline, ethane, propane and butane from natural gas liquids pumped from the St Fergus gas plant at Peterhead. The plant at Mossmorran comprises three identical process units that are fed directly from the pipeline. Large atmospheric pressure tanks store propane, butane and gasoline. Underground pipelines supply these products to the Braefoot Bay deep-water loading facility, where they are loaded on to tankers. The Shell FNGL plant has continued to supply approximately 10% of the total volume of produced propane and butane to the adjacent Avanti Gas Road Loading Terminal. The neighbouring Fife Ethylene Plant (FEP) operated by ExxonMobil was the first plant to use natural gas liquids from the North Sea as feedstock. It takes the ethane gas, which would otherwise be left as a component of natural gas used in homes, and processes – or 'cracks' it into ethylene, a much higher value product used to manufacture automotive, packaging and sporting products. FEP has the capacity to produce 830,000 tonnes of ethylene per year and is one of approximately 40 ethylene crackers within the whole of Europe.

[1] Formerly Fife Regional Council and Dunfermline and Kirkcaldy District Councils

1.3 REGULATORY FRAMEWORK

The facilities at Mossmorran and the ExxonMobil facility at Braefoot Bay operate under Pollution Prevention and Control permits issued by the Scottish Environment Protection Agency (SEPA). These permits specify the conditions for protection of the environment under which the facilities must operate. Appendix 3 summarises the regulatory and Policy changes relating to air quality in 2017.

1.4 AIM OF REVIEW GROUP ANNUAL REPORT

The aims within this Annual Report are to:

- Outline any substantive changes in the facilities at Mossmorran and Braefoot Bay and their likely impact on local air quality;
- Describe any changes in air quality regulation and changes in knowledge on health effects of benzene or any other possible emissions from the plants;
- Comment on the emissions from the facilities;
- Summarise the available data on flaring during 2017;
- Review other information about local air quality; and
- Continue to review the potential impact of installed and planned wind turbines in the vicinity of the Mossmorran site on pollutant dispersion.

As a new addition to the Annual Report, a summary of relevant ongoing initiatives and plant updates that have taken place up to the date of publication of the Review Group 2017 report is also included.

2 OBSERVATIONS OF THE REVIEW GROUP IN 2017

The main observations of the Review Group in 2017 were as follows.

i) There were no major changes to the ExxonMobil FEP or Shell Plants during 2017 that would be anticipated to adversely affect local air quality.

ii) Monitoring by ExxonMobil of their boiler and flare stacks is being carried out in a manner to provide additional information to support a Best Available Techniques (BAT) assessment. Monitoring is being undertaken for sulphur oxides (SO_x) and nitrogen oxides (NO_x) from boilers and noise and vibration from the flare.

iii) There were three results for NOx emissions exceeding the Emission Limit Values (ELVs) by 0.2%-2.6% at the ExxonMobil Mossmorran facility in 2017. All particulate matter emissions were within the limits set by SEPA (Appendix 4).

iv) Appendix 5 provides details of the flaring report. This contains background information on the impacts of flaring as well as a summary of the 2017 flaring events and subsequent investigations. For both facilities, there are no obvious trends towards more or less flaring events over time. The total quantities of gas flared in 2017 at the ExxonMobil and Shell facilities were lower than in 2016. Shell FNGL's demand for the natural gas purge (a key contributor the flared gas volumes) was reduced by just over one quarter in 2017 following reinstatement of nitrogen generators at the end of 2016. Fewer total plant shutdowns or Module turnarounds at Shell FNGL in 2017

also mean the quantity of operational gas flaring was reduced by around 28% compared with 2016.

v) An unplanned flaring event occurred in June 2017, which led to several days of flaring. Appendix 5 provides further details on this event.

vi) A meeting of the Review Group to consider the June flaring incident was held on 25th July 2017. It was agreed at this meeting that the Review Group would assess options for improving communications with local communities in order to address any concerns relating to local air quality issues. The Review Group also agreed to liaise with the Mossmorran Community and Safety Committee to determine how other environmental issues may be further examined in the future.

vii) Final Warning Letters were served on both companies by SEPA in April 2018 relating to the unplanned flaring incidents during June 2017[2]. This was the result of SEPA's investigation that identified that both Shell and ExxonMobil had breached a condition of their PPC permit relating to smoke from flaring, as a result of lack of available steam. In addition ExxonMobil failed to implement Best Available Technique (BAT) with respect to management and maintenance which could have reduced the emissions from the installation.

viii) No air quality data are available relating to the above flaring events. NHS Fife have not received reports from members of the public of adverse health effects attributed to these flaring events. However, NHS Fife are aware of public concerns expressed to SEPA about sleep disturbance, anxiety and general well-being that are reported to be associated with the flaring activity.

ix) The page on the SEPA website dedicated to the Mossmorran and Braefoot Bay complexes that contains general information and bulletins on operational matters[3] continues to be available.

x) New controls have already been put in place by Shell and ExxonMobil to prevent reoccurrence and both companies continue to work with the Regulator to assess any further improvement opportunities.

xi) Under the European Union Emissions Trading Scheme (EU ETS) companies operating in Scotland have to declare to SEPA how much carbon dioxide (CO_2) is emitted each year and this must be verified by a third-party registered verifier. Once emissions are verified, operators must surrender allowances for every tonne of CO_2 they emit during a year. If the operators have insufficient allowances they have to buy the credits to pay for the CO_2 emitted. ExxonMobil and Shell's submissions to SEPA are shown in Appendix 6. Shell self-reported an error in the accuracy of the annual reportable emissions for the years 2013 to 2015. This historic data has been corrected and verified by SEPA. CO_2 is a greenhouse gas and has no direct effects on human health at environmental concentrations.

[2] https://www.sepa.org.uk/media/351882/fwl-2018-1610-exxonmobil-chemical-limited-18_04-24-sent-r.pdf, https://www.sepa.org.uk/media/351883/fwl-2018-1609-shell-uk-limited-r.pdf

[3] https://www.sepa.org.uk/regulations/air/air-quality/mossmorran-and-braefoot-bay-complexes/

xii) Fife Council's Air Quality team did not identify any new issues in the vicinity of Mossmorran or Braefoot Bay in their 2018 Air Quality Annual Progress Report. The Council continues to undertake detailed monitoring at several locations elsewhere in Fife where earlier investigation had shown that traffic emissions are leading to elevated levels of nitrogen dioxide (NO_2) and particulates (as PM_{10}). This report is to be submitted to the relevant Council Committee for approval later in 2018 and following this will be published on the Fife Council website at www.fifedirect.org.uk/airquality.

xiii) NPL on the behalf of BP Exploration North Sea Region, and subsequently INEOS FPS from 1st November 2017, monitored hydrocarbon levels on the Forth coastline during 2017 (06/01/2017-05/01/2018). Samples were collected over 2 week periods using passive samplers at 12 locations between the Forth Bridges and West Wemyss including four locations between Dalgety Bay and Burntisland. Samples were analysed for iso-butane, n-butane, iso-pentane, n-pentane, n-hexane, n-heptane, benzene, toluene, xylene and total hydrocarbons (C4-C10). These hydrocarbons are emitted from a variety of sources around the Forth including the operations at Hound Point Terminal but also traffic and other industrial sites such as the operations of ExxonMobil and Shell at Braefoot Bay and Mossmorran. The results of this monitoring indicate that concentrations of benzene over the 12 month period were low (annual means range from 0.3-0.4 ppb) and well within the air quality standard. Concentrations of other hydrocarbons were also low, but there are no air quality standards for these substances. The substance present in the greatest concentrations at most locations was n-butane for which annual mean concentrations ranged from 1.6 ppb to 7.4 ppb. Annual mean concentrations of other individual substances ranged from <0.3 ppb to 3.4 ppb. Annual mean concentrations of total hydrocarbons (C4 to C10) at different locations ranged from 8-22 ppb.

xiv) BP have commissioned monitoring along the Fife coastline for many years and there has been an overall reduction in the levels of hydrocarbons, including benzene, present in air over the last decade. Concentrations at any one locality are highly dependent on the weather. The measurements made in 2017 indicate that concentrations of most of the monitored substances were very similar to 2016 at most locations.

xv) The Review Group has continued to review the possible impact of the wind farm (9 turbines, 126.5 m height to blade tip) at Little Raith Farm (north of Auchtertool and immediately north of the Mossmorran site perimeter) with regard to pollutant dispersion during flaring episodes at Mossmorran. A benzene monitoring programme for the existing wind farm at Little Raith was carried out from 2011, and it was concluded in 2013 that benzene concentrations in Cowdenbeath and Lochgelly were below the Scottish Air Quality Objective before and after the installation of the wind farm. Measured concentrations of benzene have not increased since the installation of the wind farm, and at 2013 concentrations were below typical rural outdoor locations. Fife Council had accepted the findings of the benzene monitoring report. The reporter agreed that the community's concern about benzene was a valid planning matter but concluded that there was no evidence to indicate that the turbines would have an adverse impact on local concentrations of benzene.

xvi) During 2017, Fife Council received no new applications for proposed wind turbines within the vicinity of the Mossmorran site.

xvii) NHS Fife confirmed that there is no evidence of higher-than-expected cancer rates in the area surrounding Mossmorran once the effects of the Scottish index of multiple deprivation are taken into account[4]. This assertion is based on the rates of new cancer registrations for each of the nine interzones (statistical geographical areas) in the Mossmorran Defined Area for the years 2002-2014 and on the "Cancer Mortality Rates Surrounding Mossmorran Chemical Plant", 2011. Routine health and wellbeing data are available for each interzone at http://www.scotpho.org.uk/comparative-health/profiles/online-profiles-tool.

xviii) The Review Group are not aware of any new technical data that relate to the impact of wind turbines on the dispersion of stack emissions. Given the low levels of benzene that were measured in the local area following commissioning of the Little Raith wind farm, the Review Group does not believe that it is necessary or appropriate to instigate a continuous monitoring programme for benzene.

3 RECENT FACILITY ACTIVITIES AND UPDATES

Following feedback from wider stakeholder consultation, this new section of the report provides some recent facility updates.

It should be noted that these updates are broader and not explicitly related to air quality issues.

i) There was a flaring event at the FEP plant in October 2017.

ii) Until the time of reporting, unplanned flaring incidents occurred at the FEP plant in March and May 2018. The 23-27 March 2018 incident was due to a process upset that required a re-start of the plant. The 19-24 May was due to a mechanical issue with an onsite pump.

iii) ExxonMobil FEP was originally built to process gas from the Brent field in the North Sea, and over the years investment has enabled the plant to process gas from other fields. Since 2017, supplies of gas from the mature fields of the North Sea, have been supplemented by gas imported from the United States, securing the future additional feedstock of the plant.

iv) Investment in ExxonMobil FEP is ongoing and in the period 2014 – 2017 capital projects to the value of £85,000,000 have been implemented at the plant.

[4] For all cancers combined, the most deprived areas have incidence rates that are almost a third higher than the least deprived areas. http://www.isdscotland.org/Health-Topics/Cancer/Publications/2015-11-17/2015-11-17-CancerMortality-Report.pdf. Accessed 16/03/2016.

4 RECENT REVIEW GROUP ACTIVITIES

This new section of the report provides information on the more recent activities of the Review Group.

i) Some members of the Review Group have participated in a series of meetings (12th January, 20th April, 8th June and 31st August 2018) organised by Lesley Laird, Member of Parliament for Kirkcaldy and Cowdenbeath and Professor Wilson Sibbett (Chair of the Review Group). These meetings, which have also included representatives from community councils, ExxonMobil, Shell, Mossmorran Community and Safety Committee, SEPA, Fife Council and HSE, have sought to identify community concerns about the plants activities and flaring events. Focussed discussions have taken place to identify solutions that will improve the communication of information to relevant communities.

ii) The Review Group considers that these meetings have been a valuable initiative and will continue to participate and contribute to relevant follow-up action within their remit.

iii) The Review Group are already actively taking action in response to some of the above meetings discussions, e.g. the inclusion of the 'Recent activities and updates' sections of this report. The Review Group has had initial correspondence with NHS Fife with a view to holding a meeting to discuss any relevant community-related health concerns (within the Reviews Group's remit) where appropriate strategies might be required to address these issues.

5 CONCLUSIONS OF THE 2017 REVIEW GROUP REPORT

i) PPC permit breaches occurred at both ExxonMobil FEP and Shell FNGL in June 2017 when a loss of steam supply led to dark smoke from the elevated flare. No air quality data is available relating to the specific above flaring events and NHS Fife have not advised the Review Group of any adverse health effects reported by the general public related to these flaring events. The Review Group, in conjunction with other stakeholders, will be reviewing the current air quality related monitoring arrangements.

ii) The quantities flared at the Mossmorran plants were lower in 2017 than those reported in 2016 and there is no evidence of a longer-term trend towards increased flaring.

iii) In the areas around Mossmorran and Braefoot Bay, the 2010 air quality objective for benzene is being readily satisfied.

iv) The Review Group are not aware of any new information describing the impact of wind turbines on the dispersion of stack emissions. Given the low levels of benzene that were measured in the local area following commissioning of the Little Raith windfarm, the Review Group does not believe that it is necessary or appropriate to instigate a continuous monitoring programme for benzene.

v) There is no evidence of higher than expected cancer rates in the Mossmorran area once the effects of the Scottish index of multiple deprivation are taken into account.

vi) The work undertaken in 2017 demonstrates that, based on the available data, emissions from the facilities at Mossmorran and Braefoot Bay continue to pose no significant risk to the health of members of the local community.

APPENDIX 1. THE REVIEW GROUP: CONSTITUTION AND TERMS OF REFERENCE

The Review Group reports to Fife Council, which requires its operating costs to be financed by ExxonMobil Chemical Limited (ExxonMobil) and Shell UK Limited (Shell). The Review Group members are appointed by Fife Council.

Professor Sibbett continues as Independent Chair, with representatives from Fife Council, SEPA and the Institute of Occupational Medicine (IOM) participating as members. The Review Group also includes a representative from NHS Fife, Public Health Department and two members represent the local Community Councils. This is designed to ensure that timely and informative communications can be provided in respect of any relevant health issues that might arise in the local communities. Representatives of ExxonMobil and Shell attend the Review Group meetings by invitation.

The full constitution and terms of reference of this reconstituted group are given below. Briefly, the Review Group's approach to carrying out its functions has been re-assessed, allowing it to take less involvement in the monitoring of air quality, but instead to focus attention on the review of such data. Of particular relevance are issues relating to any health concerns raised by residents within the local communities and a key role is assisting with the communication of information regarding environmental air quality.

Detailed Constitution and Terms of Reference

1.0 TITLE

1.1 The Group is known as the Mossmorran & Braefoot Bay Independent Air Quality Monitoring Review Group (referred to below as the Review Group).

2.0 INTRODUCTION

2.1 The Review Group was formed to provide advice and recommendations to Fife Council (formerly Fife Regional Council and Dunfermline and Kirkcaldy District Councils) regarding the monitoring of air emissions arising from the operations at the Mossmorran plants and the Braefoot Bay terminal facilities. Specific terms of reference which previously pertained were as required by planning conditions applying to the operation of the plants.

2.2 The Review Group's approach to carrying out its functions has been re-assessed, allowing it to take less involvement in the monitoring of air quality, with its primary responsibilities being re-directed towards reviewing such data. Of particular relevance are issues relating to any health concerns raised by residents within the local communities, and a key role is assisting with communications of air quality related information.

3.0 TERMS OF REFERENCE

3.1 The Review Group (as reconstituted in terms of para. 2.2 above) has the following remit:

(i) To provide advice on air quality related monitoring arrangements.

(ii) To review air quality monitoring data obtained at sites in the vicinity of the Mossmorran complex and the Braefoot Bay terminal.

(iii) To consider, advise and make recommendations on the outcome of monitoring data. The Review Group intends by inclusion in its membership of public health representation that timely and informative communications can be provided in respect of any relevant health issues that might arise in the local communities.

(iv) To submit reports to Fife Council and to make presentations as appropriate to representatives of the Community Councils that are local to the Mossmorran plants and the Braefoot Bay terminal. The Review Group intends inclusion in its membership of representation from the local Community Councils to assist with this communications related responsibility.

3.2 These terms of reference shall not imply any responsibility for, control over, or restriction of the statutory or common law positions of Fife Council, Shell UK Limited (Shell), ExxonMobil Chemical Limited (ExxonMobil), or any other local authority, statutory authority or agency, or company, or institution, nor derogate from the rights, powers and responsibilities of such authorities, agencies, companies or institutions.

4.0 APPROACH

4.1 The Review Group's approach will be based on:

(i) Making the Minutes of its meetings publicly available;

(ii) Ensuring that all reports produced by, or on behalf of, the Review Group are fully documented and contain source references to all relevant data;

(iii) Providing regular and non-technical summaries on its activities;

(iv) Informing the local communities through submissions to existing liaison structures (i.e. primarily the Mossmorran & Braefoot Bay Community & Safety Committee) and through direct presentations by Review Group members as appropriate, and

(v) Being open to approaches from local communities and individuals.

5.0 MEMBERSHIP

5.1 Membership of the Review Group comprises appropriate representation from the following:

- An Independent Chair
- Fife Council officials
- Institute of Occupational Medicine (IOM)
- Scottish Environment Protection Agency (SEPA)
- NHS Fife Public Health Department

- Community Councils on the Mossmorran & Braefoot Bay Community & Safety Committee (inland and coastal)

5.2 The Review Group will invite representatives of Shell and ExxonMobil to attend meetings, and may invite others to address group members on issues related to the terms of reference set out at paragraph 3.1 above.

5.3 The Review Group Secretary (see para. 6.2 below) shall maintain a current register of members, for distribution and information purposes.

5.4 ExxonMobil and Shell maintain a list of Community Council contacts who are notified of flaring.

6.0 OFFICE BEARERS

6.1 The Independent Chair may be nominated by any member of the Review Group. If any change in the appointment as Chair is proposed, the agreement of Fife Council will be required.

6.2 The Review Group approves the appointment of a Secretary, who prepares a record of meetings and is responsible, in consultation with the Chair, for preparing agenda papers, summoning the meetings, and circulating a record of meetings to the membership.

6.3 The finalisation of reports by the Review Group shall be as determined by the Chair.

7.0 MEETINGS

7.1 The Review Group will meet as frequently as is considered necessary by the Chair (normally at least once a year), having regard to the remit set out at paragraph 3.1 above.

7.2 The Secretary shall send to all members and others, as appropriate, a record of the previous meeting, together with notice and agenda papers for all meetings of the Review Group, at least seven days before the day of the meeting.

7.3 Business shall be in keeping with the terms of reference set out at paragraph 3.1 above.

8.0 FINANCE

8.1 The companies, having met the cost of monitoring work previously undertaken in fulfilment of planning conditions, shall meet relevant costs based on the advice of the Review Group.

8.2 The local authority shall meet any reasonable costs of the administration of the Review Group.

APPENDIX 2. MEMBERSHIP OF THE REVIEW GROUP

This Appendix contains information provided by Fife Council, membership as at December 2017.

Name	Designation/ Representing	Address
A. MEMBERS		
Prof. Wilson Sibbett	Independent Chair	School of Physics & Astronomy, University of St Andrews
Mary Stewart	Major Business & Customer Service Fife Council	Enterprise, Planning and Protective Services, Glenrothes
Kenny Bisset	Fife Council (Enterprise, Planning and Protective Services)	Enterprise, Planning and Protective Services, Glenrothes
Dr Karen Galea	Institute of Occupational Medicine (IOM)	Research Avenue North, Riccarton, Edinburgh
Ian Brocklebank	Scottish Environment Protection Agency (SEPA)	Operations Technical Support Unit East, Scottish Environment Protection Agency, Edinburgh Office, Silvan House, 231 Corstorphine Road, Edinburgh, EH12 7AT
Dr Chris McGuigan	NHS Fife (Public Health)	Cameron House, Windygates
Elizabeth Beattie	Crossgates & Mossgreen Community Council	Crossgates (Inland)
William Dryburgh	Aberdour Community Council	Aberdour (Coastal)
B. BY INVITATION		
Norman White	Shell UK Limited	Fife NGL Plant, Mossmorran
Teresa Waddington	Shell UK Limited	Fife NGL Plant, Mossmorran
John Raine	Shell UK Limited	Fife NGL Plant, Mossmorran
Ben Lindsay	Shell UK Limited	Aberdeen
Isabel Matson	Shell UK Limited	Fife NGL Plant, Mossmorran
Jan Prentice	Shell UK Limited	Fife NGL Plant, Mossmorran
Kylie Bishop	Exxon Mobil Chemical Limited	Fife Ethylene Plant, Mossmorran
Gillian Doel	Exxon Mobil Chemical Limited	Fife Ethylene Plant, Mossmorran
Catherine Cubitt	Exxon Mobil Chemical Limited	Fife Ethylene Plant, Mossmorran
Cllr Linda Erskine	Lochgelly, Cardenden and Benarty Ward	Fife House, Glenrothes
Cllr Rosemary Liewald	Lochgelly, Cardenden and Benarty Ward	Fife House, Glenrothes

Name	Designation/ Representing	Address
Cllr Mary Bain Lockhart	Lochgelly, Cardenden and Benarty Ward	Fife House, Glenrothes
Cllr Lea Mclelland	Lochgelly, Cardenden and Benarty Ward	Fife House, Glenrothes
Cllr Lesley Backhouse	Burntisland, Kinghorn and Western Kirkcaldy Ward	Fife House, Glenrothes
Cllr Gordon Langlands	Burntisland, Kinghorn and Western Kirkcaldy Ward	Fife House, Glenrothes
Cllr Kathleen Leslie	Burntisland, Kinghorn and Western Kirkcaldy Ward	Fife House, Glenrothes
Cllr Alistair Bain	Cowdenbeath Ward	Fife House, Glenrothes
Cllr Alex Campbell	Cowdenbeath Ward	Fife House, Glenrothes
Cllr Gary Guichan	Cowdenbeath Ward	Fife House, Glenrothes
Cllr Darren Watt	Cowdenbeath Ward	Fife House, Glenrothes
Cllr Lesley Laird	Inverkeithing and Dalgety Bay Ward	Fife House, Glenrothes
Cllr David Barratt	Inverkeithing and Dalgety Bay Ward	Fife House, Glenrothes
Cllr Dave Dempsey	Inverkeithing and Dalgety Bay Ward	Fife House, Glenrothes
Cllr Alice McGarry	Inverkeithing and Dalgety Bay Ward	Fife House, Glenrothes
Stephen Bygrave	British Petroleum	Hound Point
Rachel Morrell	Ineos Ltd	Grangemouth Petrochemical Complex
Mark Armitage	Auchtertool Community Council	Auchtertool
Alexander Macdonald	Burntisland Community Council	Burntisland
David A. Taylor	Cardenden & Kinglassie Community Council	Cardenden
Secretary Cowdenbeath Community Council c/o Brunton House Cowdenbeath	Cowdenbeath Community Council	Cowdenbeath
Paul Vincent	Dalgety Bay & Hillend Community Council	Dalgety Bay
Steven Murray	Lochgelly Community Council	Lochgelly
Amelia Howie	Lumphinnans Community Council	Lumphinnans

APPENDIX 3. REGULATORY AND POLICY CHANGES RELATING TO AIR QUALITY IN 2017

This Appendix contains information provided by SEPA.

Pollution Prevention and Control (PPC) permit conditions take account of relevant Best Available Technique (BAT) reference documents (BREF), notes published by the European IPPC Bureau[5] and the BAT Conclusions contained within them.

During 2016 BAT Conclusions were published for Large Combustion Plant (July 2017) and Large Volume Organic Chemicals (December 2017). This will require ExxonMobil to comply with the BAT-Associated Emission Limit Values in the Conclusions within 4 years of publication of the next Refinery BAT Reference Document (date to be confirmed).The PPC permit for the Shell NGL Plant is currently being reviewed following the issue of the Refineries BREF in October 2014.

The European Commission adopted a new Clean Air Policy Package in December 2013, consisting of a new Clean Air Programme for Europe (CAFÉ) with new air quality objectives for the period up to 2030, a revised National Emission Ceilings (NEC) Directive with stricter national emission ceilings for the six main pollutants, and a proposal for a new Directive to reduce pollution from medium-sized combustion installations. The new CAFÉ programme aims to improve the implementation of existing EU legislation with a focus on achieving compliance with existing air quality standards by 2020 at the latest (this is only an issue for transport-related NO_2 in Scotland and it is likely the country will be fully compliant by the end of 2020), and on using a revised NEC Directive to bring down pollution emissions in the period to 2030. The targets for 2030 will require additional EU action to reduce emissions at source. There is also a focus on climate change mitigation by reducing levels of pollutants that contribute significantly to climate impacts as well as to air pollution and promoting measures that tackle air pollutants and climate gases simultaneously (such as ammonia and nitrous oxide). Progress on achievement of the objectives and implementation of the programme will be reviewed on a five-yearly basis, with the first review by 2020. Progress towards the new air policy targets for 2030 will be assessed using the indicators in which they are expressed.

The NECs set in the old NEC Directive for 2010 onwards for SO_2, NO_x, non-methane volatile organic compounds (NMVOCs) and ammonia shall apply until 2020 and new national emission reduction commitments ("reduction commitments") have been set out that are applicable from 2020 and 2030 for SO_2, NO_x, NMVOC, ammonia, fine particulate matter ($PM_{2,5}$) and methane as well as intermediate emission levels for the year 2025 applicable to the same pollutants. (A revised NECD – 2016/2284/EU was transposed into UK legislation on 31/01/2018 and came into effect on 1 July 2018 - www.legislation.gov.uk/uksi/2018/129/made). UK Government (including Scottish Government) have until March 2019 to produce a projection of emissions for submission to the EC. Defra have produced a draft UK Clean Air Strategy setting out the measures required to meet future NECD targets – this is for England only. Scottish Government will be reviewing its Cleaner Air for Scotland Strategy (by 2020) to introduce further measures to ensure compliance with NECD targets (mostly related to agriculture (PM/NH_3) and

[5] http://eippcb.jrc.ec.europa.eu/reference/

combustion (PM). Some of the measures from Defra's strategy may be adopted in the review of CAFS. As a rule of thumb, Scotland's emissions are estimated to be approximately 10% of the UKs as a whole. Particular emphasis will be placed on reduction of black carbon as part of the overall reduction in emissions of $PM_{2.5}$. The Scottish Government recently introduced a new air quality objective for $PM_{2.5}$[2], committing to include in legislation as Scottish objectives**,** World Health Organisation guideline values of 10 µg/m3 annual averages (This was introduced in 2016 and the new $PM_{2.5}$ objective must be met by 31/12/2020. $PM_{2.5}$ monitoring is being added to the network to gain an understanding of levels)**.**

The Gothenburg Convention on Long-Range Transboundary Air Pollution (the LRTAP Convention) agreed in 1979 under the auspices of the UN Economic Commission for Europe (UNECE) is the main international legal framework for cooperation and measures to limit and gradually reduce and prevent air pollution and its adverse effects with a specific focus on long-range transboundary air pollution. The EU's new international obligations agreed under the amended Gothenburg Protocol will be transposed in 2020 with further reduction obligations arising in 2025, in order to achieve 2030 targets. (These requirements have been introduced via the revised NECD and therefore are already in place).

The 2013 EU Clean Air Policy Package is unlikely to lead to any changes in permit conditions for the plants at Mossmorran and Braefoot Bay prior to 2020. The longer term implications will depend on how the Scottish Government decides to implement the required emissions reductions.

[2] Cleaner Air for Scotland The Road to A Healthier Future. Nov 2015. http://www.gov.scot/Resource/0048/00488493.pdf

APPENDIX 4. REGULATED EMISSIONS TO AIR

This Appendix contains information provided by Shell and ExxonMobil.

SEPA authorises the operations carried out by Shell and ExxonMobil at Mossmorran under the Pollution Prevention and Control (PPC) (Scotland) Regulations 2012. The PPC permits are based on the concept of Integrated Pollution Prevention and Control (IPPC) and define limits for emissions from the facilities at Mossmorran to air, water and land. SEPA has set permit conditions that ensure that Best Available Techniques (BAT) are employed by the companies to prevent or reduce the impact of emissions on the environment. ExxonMobil's ethylene bulk storage at Braefoot Bay is also authorised under the PPC Regulations for emissions to air only.

Periodic testing is required at defined emission points at the facilities to verify that they are continuing to operate as designed, and within regulatory consent levels.

For airborne emissions from Mossmorran, the Shell and ExxonMobil permits require that the stacks (or chimney's) from furnaces, boilers and a gas turbine are tested and analysed. The results of the periodic analysis are checked against defined emission limits, and the results and outcomes are reported to SEPA. If the results are within the consented limits it indicates the plant is operating as designed. SEPA periodically reviews the emission limits to ensure alignment with Best Available Technique as required by legislation. If an emission limit is exceeded the cause is investigated and follow-up initiated to prevent reoccurrence.

Testing of emissions must also conform to required standards. SEPA performs periodic compliance inspections to verify the quality and source of the data and can perform their own testing to verify results where required.

The emissions monitoring measurements for 2017 submitted to SEPA are summarised for each regulated Shell and ExxonMobil source at Mossmorran in Tables A4.1 to A4.4. The Emission Limit Values (ELVs) set by SEPA for each emission source, are also shown. During 2017;

- 120 tests were performed on regulated air emission points at ExxonMobil at Mossmorran and 117 results were within the limits set by SEPA. Three results for NOx emissions from furnaces 2, 5 and 6 exceeded the ELV by 0.2%-2.6%. SEPA was notified and the results investigated. An improvement plan is in place and follow-up test work undertaken to identify a response plan.
- Tests were performed on regulated air emission points at Shell at Mossmorran and all results were within the limits set by SEPA.
- Continuous flow meters and analysers recorded the quantity of hydrocarbon flared from ExxonMobil and Shell at Mossmorran. Three flaring events occurred which were reportable to SEPA and investigated in accordance with permit conditions.
- A mass balance methodology regulated by EU guidance and enforced by SEPA was used to calculate CO_2 emissions from ExxonMobil and Shell at Mossmorran. This calculation is independently verified and reviewed by SEPA prior to submission into the EU Emissions Trading Scheme.

Smoke (or soot) occurs when there is incomplete combustion (not enough oxygen to burn the fuel completely). During complete combustion, everything is burned, producing just water and carbon dioxide. When incomplete combustion occurs, not everything is burned. Smoke is a collection of these tiny unburned particles. Smoke has regulated consent limits during normal operation at the Mossmorran complex. This is commonly measured as 'particulate matter' and results for these emissions tests are summarised in Table A4.1-A4.3.

In 2017, all particulate matter emissions were within the limits set by SEPA

During abnormal operations (i.e. when flaring as a result of a process upset), excess gas is combined with steam and air before being fully combusted (burnt) at the flare.

A smoke limit for the flare is defined by SEPA to indicate operational expectations, i.e. how quickly the plant must provide steam to support effective combustion. In 2017;

- ExxonMobil at Mossmorran exceeded the 15min smoke limit at the flare tip on the 18th June. The associated process upset was due to a temporary interruption of the gas feed from the supplier. Because of the loss of the gas feed the steam header pressure was reduced, impacting the volume of steam provided to the flare between 19:27 and 19:55 hours (27 minutes of smoky flaring). The exceedance was investigated by SEPA (see Section 4 of main report).

Table A4.1: Emissions from Regulated Sources at Shell FNGL plant during 2017 (mg/m^3 at 3% O_2, 273K Dry) – Furnace stacks 1-3

	CO Concentration (mg/m^3)				NO_x Concentration (mg/m^3)				SO_2 Concentration (mg/m^3)			
	ELV	**2017 Average**	**2017 Maximum**	**2017 Minimum**	**ELV**	**2017 Average**	**2017 Maximum**	**2017 Minimum**	**ELV**	**2017 Average**	**2017 Maximum**	**2017 Minimum**
Furnace 1	100	<6	<6	<6	150	98.9	109	74.9	10	<10	<10	<10
Furnace 2	100	<6	<6	<6	150	116.6	134.2	86.6	10	<10	<10	<10
Furnace 3	100	<6	<6	<6	150	96.7	115.2	82.2	10	<10	<10	<10

Table A4.2: Emissions from Regulated Sources at ExxonMobil Mossmorran during 2017 (mg/m^3 at 3% O_2, 273K Dry) from Furnaces 1-7 and Gas Turbine Exhaust Stack

	CO Concentration (mg/m^3)				NOx Concentration as NO2 (mg/m^3)				SO2 Concentration (mg/m^3)			
	Authorised PPC Emissions Limit	**Average**	**Max**	**Min**	**Authorised PPC Emissions Limit**	**Average**	**Max**	**Min**	**Authorised PPC Emissions Limit**	**Average**	**Max**	**Min**
Furnace 1	No limit	7.9	28.3	0.0	350	257.0	320.0	186.3	No limit	0.9	3.5	0.0
Furnace 2	No limit	18.5	28.5	11.2	350	314.6	350.9	287.8	No limit	8.3	23.0	0.0
Furnace 3	No limit	38.0	129.2	0.0	350	245.6	306.0	156.3	No limit	2.3	3.5	0.0
Furnace 4	No limit	0.3	1.2	0.0	350	286.2	317.6	235.3	No limit	1.4	3.0	0.0
Furnace 5	No limit	0.6	2.5	0.0	350	294.7	358.7	203.8	No limit	3.6	8.6	0.0
Furnace 6	No limit	2.1	3.7	1.3	350	291.8	359.3	191.5	No limit	2.9	8.9	0.0
Furnace 7	No limit	1.1	4.2	0.0	350	252.6	323.0	169.0	No limit	2.6	7.3	0.0
Gas Turbine Stack	No limit	12.0	17.3	5.8	550	359.3	528.2	235.8	No limit	5.2	8.7	0.0

No limit: no emission limit applied by SEPA

Table A4.3: Emissions from Regulated ExxonMobil Sources at Mossmorran during 2017 – Measured CO and NOx Values (mg/m^3) at 3% O_2, 273K Dry) from Boiler stacks

	CO Concentration (mg/m^3)		NOx Concentration as NO2 (mg/m^3)		
	Authorised PPC Emissions Limit (mg/m^3)	**Result (mg/m^3)**	**Authorised PPC/LCPD Emissions Limit**	**LCPD fuel weighted consent (mg/m^3)**	**Result (mg/m^3)**
Boiler A	200	5.0	Limit is fuel weighted (450 on liquid fuel, 300 on gas).	300.0	205.5
		0.9		300.0	229.0
Boiler B	200	6.0	Limit is fuel weighted (450 on liquid fuel, 300 on gas).	301.2	224.1
		0.3		300.0	194.9
Boiler C	200	5.6	Limit is fuel weighted (450 on liquid fuel, 300 on gas).	300.0	222.3
		0.7		409.4	137.0

Table A4.4: Emissions from Regulated ExxonMobil Sources at Mossmorran during 2017 – Measured SO_x and PM_{10} Values (mg/m^3) at 3% O_2, 273K Dry) from Boiler stacks

	SOx (mg/m^3)			PM_{10} (mg/m^3)		
	Authorised PPC/LCPD Emissions Limit	**LCPD fuel weighted consent (mg/m^3) [1]**	**Concentration (mg/m^3)**	**Authorised PPC/LCPD Emissions Limit**	**LCPD[1] fuel weighted consent (mg/m^3)**	**Concentration (mg/m^3)**
Boiler A	Limit is fuel weighted (350 on liquid fuel, 35 on gas).	35.0	1.8	Limit is fuel weighted (50 on liquid fuel, 5 on gas).	5.0	0.7
		35.0	1.0		5.0	1.5
Boiler B	Limit is fuel weighted (350 on liquid fuel, 35 on gas).	37.5	1.7	Limit is fuel weighted (50 on liquid fuel, 5 on gas).	5.4	1.0
		35.0	1.2		5.0	1.6
Boiler C	Limit is fuel weighted (350 on liquid fuel, 35 on gas).	35.0	1.8	Limit is fuel weighted (50 on liquid fuel, 5 on gas).	5.0	0.9
		264.8	140.8		37.8	2.6

[1] The LCPD fuel weighted consent is calculated based on the proportion of each fuel type (oil or gas) being utilised in the boilers.

APPENDIX 5. FLARING REPORT

This Appendix contains information provided by Shell and ExxonMobil.

A5.1 Background information on flaring at the Mossmorran complex

The flares at the Mossmorran complex are part of the safety system and are used to burn off gas that cannot be processed due to the volumes involved or the gas being off specification. This might be due to scheduled maintenance requiring the plant to be 'gas free' prior to entry; or, following an unplanned interruption in production. The flare systems include:

- two 80 metre high flares at Shell FNGL;
- one 100 metre high flare at ExxonMobil FEP;
- two ground flares operated by Shell FNGL, but used by both sites as required.

The ground-level flares, owned and operated by Shell, are used in preference to the high-level flares to minimise noise and light nuisance for local residents. On some occasions, the ExxonMobil elevated flare has to be used because the ground-level flare is in use by Shell or unavailable.

During flaring, excess gas is combined with steam and air before being burnt off. This is accepted as industry best practice, producing water vapour and CO2 when combustion is optimised. This is essentially just like burning natural gas in the cooker at home.

The Shell FNGL facility and ExxonMobil FEP facility have several distinct differences which impact how and when they may flare.

1. Process units
   Shell FNGL comprises three identical process units which operate side-by-side, just like three separate plants operating alongside one another. If one unit is unavailable, the remaining two can still operate so a disruption does not normally result in flaring. ExxonMobil FEP is a single process unit, more like a conveyor belt. If any one part is unavailable then the process cannot continue and must halt.

2. Process complexity
   Shell FNGL separates raw natural gas into individual products including ethane, propane and butane. This is accomplished through a series of fractionation towers which use the different boiling points of the different hydrocarbons to separate off at different points - much like separating a bag of mixed sweets into their different flavours.

   ExxonMobil FEP is a much more complex chemical process. The plant takes ethane and processes it – or 'cracks' it – into ethylene. It does this by heating the ethane up so hot (more than 750'C) that it breaks

apart the molecular bonds holding it together. It then cools the gas to minus 160'C to convert it into a liquid. This is like taking one flavour from the packet of sweets and turning it into a completely different sweet! The temperature extremes mean that the process of shutting down and starting up the ExxonMobil FEP plant is very involved and takes a significant amount of time. This means that an interruption in production is more likely to result in flaring.

3. Integration with the North Sea
   Gas from the North Sea is piped to the Shell/ExxonMobil processing plant at St Fergus, where natural gas is fed into the national grid and natural gas liquids (NGLs) are piped to Mossmorran in Fife for further processing. The ExxonMobil FEP is the very last facility connected to the North Sea, and therefore 'end of the line' to manage large volumes of product. It takes approximately 4 days for a molecule of gas from a reservoir in the North Sea to reach Mossmorran through the pipelines. This means that if a process upset at Mossmorran occurs, it takes at least 4 days to stop feed from reaching Mossmorran. Even if the facilities were able to request this immediately, the connection to the national grid means that offshore production would still need to continue to ensure Scotland has available natural gas for heating, power and hot water. Therefore the decision to stop feed must be very carefully planned, as it is for planned maintenance periods which occur periodically.

During a process upset, the ability to continue operating (i.e. on a different unit) and the time it takes to start up and shut down are key elements that impact whether flaring occurs and for how long. Feed rates have to be managed through the whole supply network up to the offshore platforms in the North Sea, and upsets could have an impact on the natural gas supply for the whole of Scotland.

A5.2 Impact of Flaring and historic trends

A modelling study undertaken in 2009 by ENTEC assessed the impact of emissions during flaring and normal process emissions from the FEP plant and FNGL plant at Mossmorran. The non-technical summary for this modelling study is included an Annex 1 to this Appendix.

The following pollutants were assessed:

- carbon monoxide (CO);
- oxides of nitrogen (NOx as NO2);
- fine particulate matter (PM10 and PM2.5);
- sulphur dioxide (SO2);
- volatile organic compounds (VOCs) including benzene and 1, 3 butadiene.

The study concluded that the long and short term predicted environmental concentrations of all of the pollutants considered were well within the air

quality standards (in place at the time the modelling study was undertaken and unchanged since then) for the protection of human health.

The modelling work supports the findings of an earlier ambient monitoring study undertaken by FEP to assess emissions of VOCs and fine particulate matter (PM10) between 21 August 2008 and 1 October 2008.

The National Physical Laboratory (NPL) carried out a monitoring study in 2008 and the data was submitted to the Review Group for independent analysis. This included a period of elevated flaring on 5 and 6 September 2008 during which specific VOC samples were collected.

Measured concentrations of PM10, benzene and 1,3 butadiene were all within the relevant air quality standards for the protection of human health.

The non-technical summary of the report from the NPL study is included as Annex 2 in this Appendix.

As shown in Figures A5.1 and A5.2, the quantity flared varies from year to year depending on circumstances. The longer term data does not indicate any trend (either increase or decrease) in flaring rates. Overall, the quantity of gas flared in 2017 was lower than that in 2016. There has been no significant variation from conditions assessed during the prior mentioned study and modelling work.

Figure A5.1: Total quantities (tonnes) flared annually at the ExxonMobil FEP between 1996 and 2017

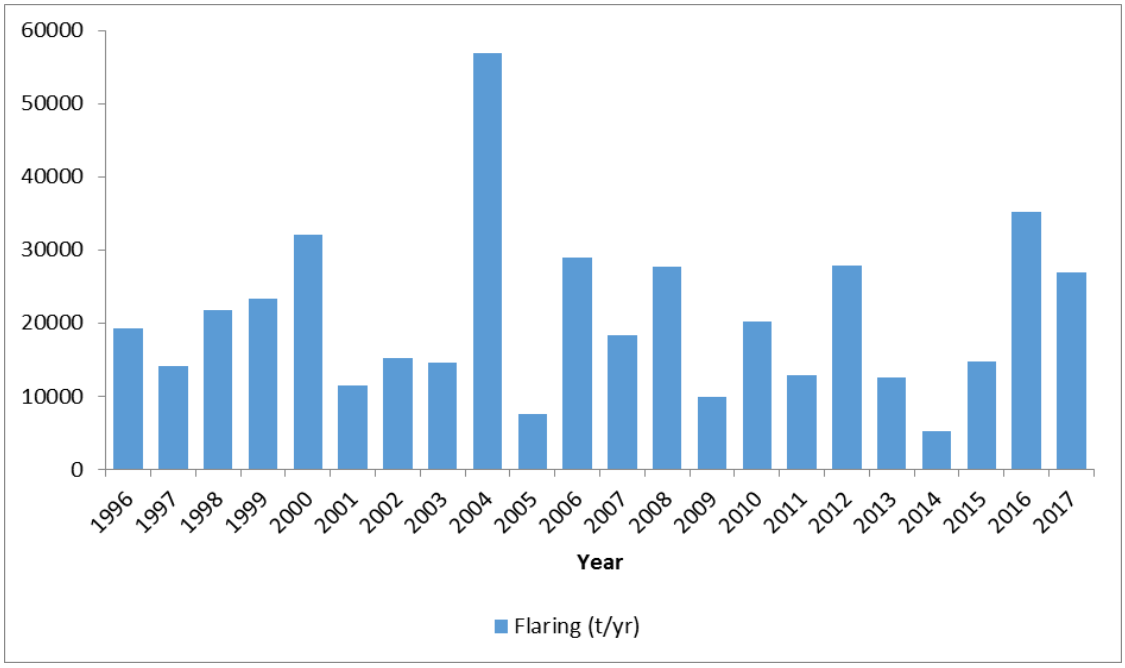
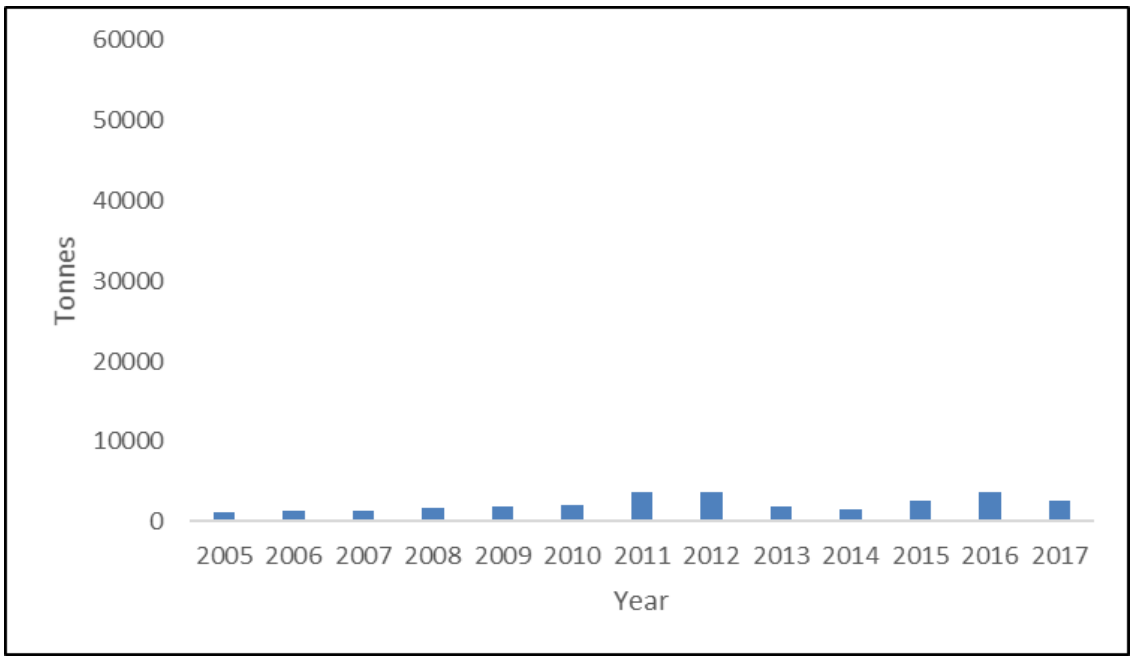


Figure A5.2: Total quantities (tonnes) flared annually at Shell FNGL plant between 2005 and 2017



A5.3 Flaring Events in 2017

A5.31 ExxonMobil Fife Ethylene Plant

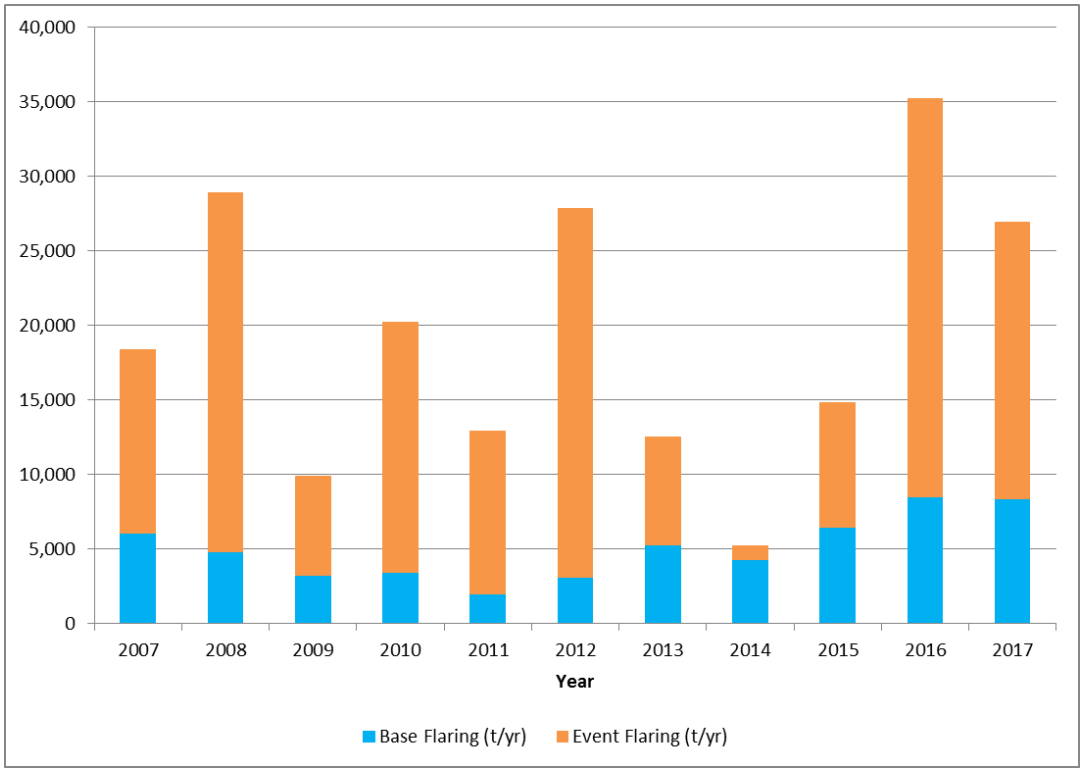
Table A5.1, indicates the quantities flared by the ExxonMobil FEP during 2017, with Figure A5.3 providing details of the total quantities of event and base flaring per annum at the FEP plant between 2007 and 2017.

Table A5.1 Quantities Flared (tonnes) from ExxonMobil FEP in 2017

Month	Ground Flaring[1] (tonnes)	Elevated Flaring (tonnes)	Total (tonnes)	Reason
January	764	68	832	
February	451	0	451	
March	611	191	803	
April	584	3	587	
May	453	48	500	
June	3754	8940	12695	12th Jun - pump failure; 18th Jun - loss of feed
July	685	38	723	
August	727	69	796	
September	557	113	670	
October	1736	4919	6655	27th Oct - ethylene release
November	1121	40	1160	
December	1059	18	1078	
Total	**12,502**	**14,447**	**26,950**	

[1] Flaring is preferentially routed through the Shell ground flares where available.

Figure A5.3: Total event and base flaring quantities (tonnes) annually at the ExxonMobil FEP between 2007 and 2017



FEP experienced three unplanned process upsets, which resulted in major flaring in 2017. Major flaring events are defined in the sites operational permit as those which exceed 5T/H for more than 30 minutes. Major flaring events are reported to SEPA immediately and an investigation undertaken to identify root cause and prevent reoccurrence. All three major flaring events were investigated by both ExxonMobil and SEPA. The results of SEPA's investigation are summarised in Section 4 of the main body of the report:

The following provides a brief overview of the three events;

1. **Monday 12th June -** At 00:27 hours on Monday 12th June, a pump which forms part of the steam condensate system for the propane refrigeration compressor driver suffered mechanical failure. The resulting power reduction to the compressor led to shutdown of the recovery section of the plant and subsequent elevated flaring. Repair of the condensate return system was completed and start-up sequence executed.

   Elevated flaring began at 00:46 hours on Monday 12th June and ceased at 09:23 hours on Saturday 17th June. Approximately 7.1kT of hydrocarbon was sent to the elevated flare, and 2.7kT of hydrocarbon to ground flares.

2. **Sunday 18th June -** At 18:26 hours on Sunday 18th June feed was lost from ExxonMobil's supplier. The loss of feed impacted production, resulting in the shutdown of the Process Gas Compressor (PGC) and elevated flaring at 19:15 hours. At 22:00 hours ethane feed from the supplier was reinstated and the restart sequence commenced.

   Elevated flaring began at 19:15 hours on Sunday 18th June and ceased at 02:00 hours on Tuesday 20th June. Approximately 1.8kT of hydrocarbon was sent to the elevated flare and 0.5kT hydrocarbon to ground flares. From 19:27 – 19:55 hours on Sunday 18th June, insufficient steam was available to the flare, resulting in a smoky flare greater than Ringlemann 2 for 27 minutes (see Appendix 4 for further information on permitted emission limits for smoke).

3. **Friday 27th October –** At approximately 14:15 hours on Friday 27th October a minor release of ethylene from a block valve flange downstream of the Ethylene Refrigeration Compressor was identified. The compressor was shutdown to isolate and fix the leak which necessitated elevated flaring, the fire service were in attendance as a precautionary measure. Elevated flaring began at 17:24 hours on Friday 27th October and ceased at 23:54 hours on Monday 30th October. Approximately 4.9kT of hydrocarbon was sent to the elevated flare and 1.3kT hydrocarbon to ground flares.

In the autumn of 2017, ExxonMobil used a drone to carry out a full investigation the FEP elevated flare tip. This inspection showed no issues with the operational condition of the flare tip at FEP.

A5.32 Shell Fife Natural Gas Liquids Plant

The total annual mass flared at the FNGL Plant, operated by Shell during 2017 totalled 2607 tonnes, a decrease of 978 tonnes from the 3586 tonnes flared in 2016. The quantity flared varies from year to year depending on circumstances (Fig A5.3).

Table A5.2 indicates the quantities flared at the Shell FNGL Plant during 2017.

Pilot gas is used to ensure complete combustion of gas disposed through the flare. Pilot gas tonnage includes that used by ExxonMobil in Shells Ground flare (Table 5.1). Since 2016 Nitrogen is used as the Purge gas and thus no longer included in the data reported above. See A5.1 "Ground" column for quantities flared in Shell Ground Flare by ExxonMobil FEP.

In the second half of 2017 Shell FNGL carried out refurbishment of Elevated Flare A, this will be available for service from Q2 2018. Elevated Flare A had been out of service for several years and its refurbishment now will ensure the integrity and performance of the flare system. It will also allow Elevated Flare B to be taken out of service for maintenance planned in 2019.

Table A5.2: Quantities Flared from the Shell FNGL Plant in 2017

Month	Ground Flaring (tonnes)	Elevated Flaring (tonnes)	Purge & Pilot for Ground & Elevated flares (tonnes)	Total (tonnes)
January	0.0	10.95	229.13	240.07
February	0.0	8.20	232.19	240.39
March	0.0	12.09	175.49	187.58
April	0.0	29.34	163.50	192.84
May	0.0	9.07	204.47	213.54
June	0.0	49.46	215.05	264.50
July	0.0	25.34	235.21	260.55
August	0.0	18.06	233.06	251.11
September	0.0	10.76	195.43	206.19
October	0.0	11.76	142.78	154.54
November	0.0	10.41	175.87	186.28
December	0.0	5.47	204.76	210.23
Total	0.0	**200.90**	**2406.93**	**2607.82**

In early 2018, maintenance of Ground Flare A was carried out including extensive repair and upgrade work. Maintenance was already completed on Ground Flare B in 2017, so work this year will further improve their reliability and availability for both Exxon Mobil and Shell operations.

ANNEX 1: Non-technical summary of local air quality modelling studies for the Fife Ethylene Plant and Mossmorran Fractionation Plant

The Review Group originally produced this non-technical summary concerning the ENTEC modelling study for the 2009 Review Group report. This summary has been unaltered for inclusion in the current version of the report.

Local air quality modelling studies for the Fife Ethylene Plant and Mossmorran Fractionation Plant

Non Technical summary

Introduction

1) ExxonMobil and Shell jointly commissioned the independent consultants Entec to undertake comprehensive modelling studies to assess the impact of emissions from flaring episodes at the Mossmorran Fractionation Plant and the Fife Ethylene Plant (FEP) in order to meet conditions within the environmental permits for the two plants. Both plants were required to assess the impact of emissions from flaring episodes in order to characterise the environmental impact and ensure that Best Available Techniques are being employed to minimise impacts.

2) Dispersion modelling is a tool that enables the assessment of the air pollution impacts of events such as flaring. The impacts of flaring events are difficult to assess through air quality monitoring because they are typically unplanned. Modelling is particularly important in the estimation of worst case effects as even planned intervals of flaring are unlikely to coincide with the weather conditions that would give rise to the highest potential pollutant concentrations. Modelling also allows the prediction of impacts at any location within the area included for study, whereas cost and practicality limit monitoring to a few discrete locations within the area of interest.

3) The assessments considered carbon monoxide (CO), oxides of nitrogen (NOx as NO_2), PM_{10}, $PM_{2.5}$, sulphur dioxide and volatile organic compounds (VOCs) including benzene, 1,3-butadiene, butane, hexane, styrene and toluene.

4) The assessments included both short term and long term air quality impacts. Predicted impacts were compared against the Scottish Government's air quality objectives for CO, NO_2, PM_{10}, $PM_{2.5}$, 1,3-butadiene and benzene and the Environment Agency's Environmental Assessment Levels for the remaining pollutants. These standards and assessment levels are set for the protection of human health.

5) Background pollutant concentrations are up to 40% of the relevant objectives or assessment levels (depending on pollutant) for short term peak events (15 minutes, 1 hour or 24 hours) and up to 57% of the relevant objectives or assessment levels for annual mean concentrations.

Simultaneous flaring at both plants

6) Impacts were modelled for a theoretical worst-case scenario resulting in the simultaneous flaring of the highest quantities of gas at both sites. This could arise if planned flaring on the Shell site arising from the shut down of a single module was combined with a simultaneous gas turbine failure at the FEP.

7) The maximum predicted short term peak environmental concentrations of the study pollutants as assessed from the sum of the maximum predicted increment and background concentration for each pollutant in ambient air were all less that 48% of the relevant air quality objective or environmental assessment level. The predicted increments in pollutant concentrations arising from flaring were less than 15% of the short term objective for NO_2, less than 10% of the short term objective for PM_{10} and less than 5% of the short term environmental assessment level for benzene. The predicted increments of other pollutants were much smaller in relation to relevant objectives and assessment levels. The predicted increments in pollutant concentrations arising from flaring were smaller than background concentrations of pollutants.

8) The predicted impacts of flaring on annual mean concentrations of air pollutants were assessed by considering the likely frequency and duration of flaring episodes during the year. The predicted increments in pollutant concentrations arising from flaring were less than 10% of the annual mean objectives for NO_2 and benzene and less than 4% of the annual mean objectives for PM_{10} and $PM_{2.5}$. The predicted increments of other pollutants were much smaller in relation to relevant objectives and assessment levels. The predicted annual mean concentrations (background plus increment) were less than 59% of the relevant air quality objective or assessment level.

Flaring at the Fife Ethylene Plant

9) The study considered the following three potential scenarios:

Base load flaring – routine flaring due to normal operation of the plant;
Planned flaring – flaring during a planned shut down of the installation: and
Unplanned flaring – flaring arising from a process problem, leading to the propane compressor or gas turbine tripping.

10) The modelling took account of variations in emissions from other point sources on site arising during flaring episodes.

11) The maximum predicted short term peak environmental concentrations of the study pollutants were all less that 48% of the relevant National Air Quality Standard or Environmental Assessment Level. The predicted increments in pollutant concentrations arising from flaring were up to about 15% of the short term objective for NO_2 and less than 5% of the short term objectives/assessment levels for PM_{10} and benzene. The predicted increments of other pollutants were much smaller in relation to relevant objectives and assessment levels. The predicted increments in pollutant concentrations arising from flaring were smaller than the background concentrations of pollutants.

12) The predicted impacts of flaring on annual mean concentrations of air pollutants were assessed by considering the likely frequency and duration of flaring episodes during the year. The predicted increments in pollutant concentrations arising from flaring were less than 10% of the annual mean objectives for NO_2 and benzene and less than 5% of the annual mean objectives for PM_{10} and $PM_{2.5}$. The predicted increments of other pollutants were much smaller in relation to relevant objectives and assessment levels. The predicted annual mean concentrations (background plus increment) were less than 59% of the relevant air quality objective or assessment level.

13) The output from the modelling study are consistent with the results of air pollution monitoring undertaken around the Mossmorran complex before, during and after a period of planned maintenance and related

flaring activity between 21 August and 1 October 2008 and reviewed in the 2008 Annual Report.

14) The predicted short term impacts on concentrations of NO_2, CO and PM_{10} during unplanned flaring at the Fife Ethylene Plant were greater than those predicted for combined flaring at both sites. This is because part of the FEP gas stream would be sent to the Shell ground flares if there is a turbine trip at the FEP while the Fractionation Plant is operating normally. The Shell Ground Flares have a lower effective release height that the FEP elevated flare and therefore have poorer dispersion characteristics resulting in higher ground level concentrations. The visual and noise impacts of the ground level flares are, however, much smaller than those of the high level flare and it is considered appropriate to send part of the gas stream to the ground level flares in order to minimise these impacts.

Conclusion

5) The results of the modelling studies indicate that both peak and long term predicted environmental pollutant concentrations arising as a result of planned or unplanned flaring activities at the Mossmorran Plants, are well within relevant air quality standards and assessment levels. The contribution of flare emissions to the total pollutant concentrations around the Mossmorran plants is small relative to background levels of air pollution arising from other sources, such as road traffic. These predictions are consistent with the results of air pollution monitoring undertaken around the Mossmorran complex before, during and after a period of planned maintenance and related flaring activity in 2008.

ANNEX 2: Non-technical summary of atmospheric monitoring study at ExxonMobil Fife Ethylene Plant Mossmorran

The Review Group originally produced this non-technical summary for the 2008 Review Group report concerning the NPL monitoring study. This summary has been unaltered for inclusion in the current version of the report.

Atmospheric Monitoring Study at ExxonMobil Fife Ethylene Plant Mossmorran

Non-Technical summary

Introduction

1) ExxonMobil recently commissioned a study of air quality around the Mossmorran complex before, during and after a period of planned maintenance and related flaring activity. The study assessed the quality of the air at 8 different locations, including three residential areas. The assessment was carried out by the National Physical Laboratory between 21 August and 1 October 2008.

2) It was important to ensure that the monitoring devices were positioned at locations where pollutants are most likely to be carried by the wind. Whilst the prevailing wind in Fife generally comes from the south west, north easterly winds are also quite common. Monitoring devices were therefore located in Lochgelly, Auchertool and Cuttlehill (near Cowdenbeath). A range of pollutants were monitored, but the two of most concern (with regards to human health) were benzene and particulate matter (microscopic material that is carried in the atmosphere).

Benzene

3) The measured concentrations of benzene in the residential areas when flaring was underway were almost identical to those that were obtained when there was no flaring in progress. There was no evidence to show that flaring activity increased the concentrations of benzene at the residential areas.

4) The measured concentrations of benzene at the residential areas were consistently lower than the maximum permitted level that has been introduced to protect human health. This Scottish air quality standard is more stringent than the one that applies in England, Wales and other parts of Europe.

Particulate Matter

5) The monitoring study measured the concentrations of microscopic material carried in the atmosphere. If the activities on the Mossmorran site were adding to the local concentrations, this would have been detected by the monitoring device that was located downwind of the plant at the time. However, the study found that monitors at all locations measured similar concentrations over the same time period, thus suggesting that the material is likely to have been carried in from areas outside Fife. This 'background' level will consist of a wide range of materials that have been created by human and natural activities (for example: dust from agricultural activities, sea salt, smoke from domestic fires, fungal spores and sand from the Sahara).

6) Again, the Scottish air quality standards for particulate matter are more stringent than those that apply to the rest of the United Kingdom and Europe. The measured concentrations indicate that the local concentrations of particulate matter were lower than the maximum permitted levels that have been set to protect the most sensitive individuals in society.

7) The Scottish Government has published a method (6) that is used to assess how a pollutant is likely to affect a person who is sensitive to the effects of air pollution. All the measured concentrations of particulate matter are typical of a rural environment and they all fell into the lowest categories of the Air Pollution Bandings and Index.

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[6]) http://www.scottishairquality.co.uk/about.php?n_action=standards&t=5

8) There is no evidence to indicate that the activities on the Mossmorran site were making a measurable contribution to the levels of particulate matter in the residential areas.

Other Hydrocarbons

9) The assessment also measured a range of hydrocarbons that included 1,3-butadiene. These concentrations were generally so low, that they could not be detected by the monitoring equipment.

Conclusion

10) The monitoring study concluded that there was no evidence to show that maintenance and flaring activities on the Mossmorran site were having a detrimental impact on the quality of the air in Lochgelly, Auchtertool or Cuttlehill. A copy of the monitoring study was submitted to Fife Council's Environment Enterprise and Transportation Committee on 28th May, 2009.

APPENDIX 6. EU EMISSIONS TRADING SCHEME CO_2 SUBMISSIONS

This Appendix contains information provided by Shell and ExxonMobil.

Table A6.1 shows the ExxonMobil EU ETS submissions for CO_2 emissions from the Fife Ethylene Plant for the period 2005-17. The reporting of CO_2 emissions changed with the implementation of EU ETS Phase III. Phase III in addition to that reported in Phase II also now includes CO_2 produced from flaring, the propane which is used to fuel the Braefoot Bay Vapour Control Unit on the C5+ system and the use of diesel on all permanent equipment i.e. fire pumps, emergency generators, Braefoot Bay air compressor. CO_2 emissions were marginally higher in 2017 than previous years due to higher production rates and the process upsets resulting in unplanned flaring. CO_2 emissions are a combustion product and are proportional to the plants throughput and planned maintenance.

Figures for 2013 – 2015 were re-submitted to the regulator in 2016 following identification of over-reporting of CO2 (~10,000T over the three years). The updated figures are included below.

Table A6.1: ExxonMobil EU ETS returns for CO_2 emissions, 2005-2017

Year	Emissions Trading Scheme	Phase
	CO_2 tonnes	
2005	216,014	Phase I
2006	241,301	Phase I
2007	240,933	Phase I
2008	708,368	Phase II
2009	629,114	Phase II
2010	642,619	Phase II
2011	647,401	Phase II
2012	599,662	Phase II
2013	679,492	Phase III
2014	727,292	Phase III
2015	812,418	Phase III
2016	885,853	Phase III
2017	892,964	Phase III

Phase I - CO_2 emissions from Boilers and Gas Turbine Exhaust
Phase II - CO_2 emissions from all emissions sources excluding flaring
Phase III - CO2 emissions from all emissions sources

Table A6.2 overleaf shows the Shell FNGL EU ETS submissions for CO_2 emissions from 2005-17.

In March 2017 Shell self-reported an error in the accuracy of the annual reportable emissions for the years 2013 to 2015. The cause was investigated, which was in the metering and data transfer of volumes of fuel used by a single propane unit at the plant. Shell had under reported propane unit volumes by approximately 0.5% of total plant volumes for the period, and as a consequence not surrendered sufficient allowances to cover their annual reportable emissions from the installation under the ETS over the three year period. Shell has since submitted revised data and surrendered allowances to correct the situation.

The revised and verified data for the years 2013-2015 are included in Table A6.2.

Table A6.2: **Shell FNGL plant EU ETS returns for CO_2 emissions, 2005-2017**

Year	**Emissions Trading Scheme**	**Phase**
	CO_2 tonnes	
2005	0	Phase I
2006	0	
2007	154,270	
2008	176,834	Phase II
2009	156,212	
2010	154,189	
2011	138,891	
2012	127,481	
2013	133,040*	Phase III
2014	140,559*	
2015	151,455*	
2016	196,106	
2017	197,088	

* Revised historic data due to miscalculation identified by Shell and verified by SEPA

Phase I - CO_2 emissions from Boilers and Gas Turbine exhaust
Phase II - CO_2 emissions from all emissions sources excluding flaring
Phase III - CO_2 emissions from all emissions sources

APPENDIX 7. GLOSSARY

Concentration Units

ppb: parts per billion by volume, concentration unit for gases and vapours, equivalent to one cubic millimetre of gas mixed with one cubic metre of air.

ppm: parts per million by volume, concentration unit for gases and vapours, equivalent to one cubic centimetre of gas in a cubic metre of air, 1ppm = 1,000 ppb.

µg/m³: microgram per cubic metre, mass concentration unit for particulates and gases. There are 1,000,000 micrograms in a gram and 25,000,000 micrograms in an ounce.

mg/m³: milligram per cubic metre, mass concentration unit for particulates and gases, 1 mg/m^3 = 1,000 $\mu g/m^3$.

Pollutants

Particulate Matter (PM): is the term used to describe solid or liquid particles suspended in the atmosphere[7]. Particle size determines how deep a particle can penetrate into the lungs. Some ultrafine particles may pass into the blood stream from the lungs.

PM_{10}: This is the fine fraction of airborne dust, defined by international convention that can be deposited in the lung. It is the fraction of airborne dust around which the UK air quality standard is defined. There are many sources, including road traffic, agriculture, industry and many personal activities. It includes particles that are approximately less than 10 µm in diameter.

$PM_{2.5}$: This is a subfraction of PM_{10} sometimes referred to as "high risk respirable". It is the fraction of airborne particles that can penetrate to the gas exchange region of the lungs. $PM_{2.5}$ is largely comprised of particles generated by combustion plus particles that form as a result of reactions in the atmosphere. These include particles that form from sulphur dioxide and nitrogen oxides.

Benzene: This aromatic hydrocarbon is a minor component of petrol. Fuel distribution and car exhausts are the major contributors to benzene levels in the air. It is present in cigarette smoke, some foods and drinks and widely in nature. Benzene has been classified as a cancer causing chemical[8].

[7] Air Quality ($PM_{2.5}$ particulate air pollution) and Mortality in Scotland. : A Briefing Paper, HPS April 2014. http://www.documents.hps.scot.nhs.uk/environmental/briefing-notes/air-quality-and-mortality-2014-04.pdf

[8] Benzene: General Information , Public Health England https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/561046/benzene_general_information.pdf

1,3-Butadiene: Butadiene is a hydrocarbon that arises in air solely from human activity. It is an important industrial chemical, being used in synthetic rubber manufacture and is found in some liquid petroleum gases. Its main sources in the environment are, however, from road traffic emissions. 1,3-Butadiene is *probably carcinogenic to humans (Group 2A)*[9].

Carbon dioxide (CO_2): This gas is released from combustion processes and is an important greenhouse contributing to atmospheric warming. It is not hazardous to human health at atmospheric concentrations.

Nitrogen dioxide (NO_2)*:* This gas is produced by the reaction of oxygen and nitrogen during combustion. Vehicle emissions are a major source. It is well known as an irritant to the respiratory system and, more recently, has been found to affect health at concentrations that can be found in the environment and indoors. Nitric oxide always occurs when nitrogen dioxide is formed. The two gases together are known as *oxides of nitrogen,* sometimes described in shorthand form as NO_x*.*

VOCs or volatile organic compounds: Carbon-based (or organic) chemicals that readily evaporate. Many hydrocarbons, including benzene, butane, pentane and hexane are VOCs.

Organisations/facilities

SEPA: Scottish Environment Protection Agency

FEP: Fife Ethylene Plant - ExxonMobil Chemical Limited (ExxonMobil)'s production facility at Mossmorran

Fife NGL Plant: Fife Natural Gas Liquids Plant – comprises Shell UK Limited (Shell)'s production facility at Mossmorran for the fractionation of liquefied natural gas

NPL: National Physical Laboratory

Other

BAT: Best Available Techniques

BREF: Best Available Techniques Reference Document

ELV: Emission Limit Value

EU ETS: European Union Emissions Trading Scheme

IED: Industrial Emissions Directive

[9] International Agency for Research on Cancer (IARC). (1999) IARC monographs on the evaluation of carcinogenic risks to humans. Vol. 71. 1,3-Butadiene. Re-evaluation of some organic chemicals, hydrazine and hydrogen peroxide (part one). Lyon, France: International Agency for Research on Cancer, pp. 109-225.

Interzone: this is a national small area statistical geography. There are 103 interzones in Fife. Alternative name for the same area is Intermediate Zone.

IPPC: Integrated Pollution Prevention and Control

Mossmorran Defined Area: is a created geographical area which includes the interzones lying within a 5 km radius of Mossmorran, that is Lochore and Crosshill, Lochgelly East, Lochgelly West and Lumphians, Cowdenbeath North, Cowdenbeath South, Hill of Beath, Kelty East. In addition interzones Ketly West and Balingry have been included as these are surrounded on two or more sides by interzones that are within the 5km radius.

PPC: Pollution Prevention and Control

VCU: Vapour control unit