3CR will replace the existing PGMR refinery on site. JM anticipate a 22-month window in which the processes will be transferred from the PGMR. During this time JM will not operate both the new and old refineries simultaneously, instead as processes are transferred to the 3CR they will cease to operate in the PGMR. Refer to the main report for details on how the transition will be managed.

This BAT Assessment is for the new 3CR process only.

Table 2.1
3CR Common Waste Gas Management and Treatment Systems BREF.

BAT Requirement	Specific Measure
General BAT conclusions	
EMS	
BAT 1. In order to improve the overall environmental performance, BAT is to elaborate and implement an environmental management system (EMS) that incorporates all of the following features: i. commitment, leadership, and accountability of the management, including senior management, for the implementation of an effective EMS; ii. an analysis that includes the determination of the organisation's context, the identification of the needs and expectations of interested parties, the identification of characteristics of the installation that are associated with possible risks for the environment (or human health) as well as of the applicable legal requirements relating to the environment; iii. development of an environmental policy that includes the continuous improvement of the environmental performance of the installation; iv. establishing objectives and performance indicators in relation to significant environmental aspects, including safeguarding compliance with applicable legal requirements; v. planning and implementing the necessary procedures and actions (including corrective and preventive actions where needed), to achieve the environmental objectives and avoid environmental risks;	The Site have an EMS accredited to ISO 14001. The site's EMS will be updated to include all the features in BAT 1 relating to the 3CR process. .

BAT Requirement	Specific Measure
vi. determination of structures, roles and responsibilities in relation to environmental aspects and objectives and provision of the financial and human resources needed; vii. ensuring the necessary competence and awareness of staff whose work may affect the environmental performance of the installation (e.g., by providing information and training); viii. internal and external communication; ix. fostering employee involvement in good environmental management practices; x. establishing and maintaining a management manual and written procedures to control activities with significant environmental impact as well as relevant records; xi. effective operational planning and process control; xii. implementation of appropriate maintenance programmes; xiii. emergency preparedness and response protocols, including the prevention and/or mitigation of the adverse (environmental) impacts of emergency situations; xiv. when (re)designing a (new) installation or a part thereof, consideration of its environmental impacts throughout its life, which includes construction, maintenance, operation and decommissioning; xv. implementation of a monitoring and measurement programme; if necessary, information can be found in the Reference Report on Monitoring of Emissions to Air and Water from IED Installations; xvi. application of sectoral benchmarking on a regular basis; xvii. periodic independent (as far as practicable) internal auditing and periodic independent external auditing in order to assess the environmental performance and to determine whether or not the EMS conforms to planned arrangements and has been properly implemented and maintained; xviii. evaluation of causes of nonconformities, implementation of corrective actions in response to nonconformities, review of the effectiveness of corrective actions, and determination of whether similar nonconformities exist or could potentially occur;	

BAT Requirement	Specific Measure
xix. periodic review, by senior management, of the EMS and its continuing suitability, adequacy and effectiveness; xx. following and taking into account the development of cleaner techniques. Specifically for the chemical sector, BAT is also to incorporate the following features in the EMS: xxi. an inventory of channelled and diffuse emissions to air (see BAT 2); xxii. an OTNOC management plan for emissions to air (see BAT 3); xxiii. an integrated waste gas management and treatment strategy for channelled emissions to air (see BAT 4); xxiv. a management system for diffuse VOC emissions to air (see BAT 19); xxv. a chemicals management system that includes an inventory of the hazardous substances and substances of very high concern used in the process(es); the potential for substitution of the substances that are listed in this inventory, focusing on those substances other than raw materials, is analysed periodically (e.g., annually) in order to identify possible new available and safer alternatives, with no or lower environmental impacts.	
BAT 2. In order to facilitate the reduction of emissions to air, BAT is to establish, maintain and regularly review (including when a substantial change occurs) an inventory of channelled and diffuse emissions to air, as part of the environmental management system (see BAT 1), that incorporates all of the following features: i. information, as comprehensive as is reasonably possible, about the chemical production process(es), including: a. chemical reaction equations, also showing side products; b. simplified process flow sheets that show the origin of the emissions;	i. The processes, reactions, flowsheets etc are described in section 3.1 of this BAT-OT ii. All waste gas streams, characteristics, emission points, monitoring and abatement techniques are identified in section 3.6 of this BAT-OT. iii. All fugitive emission sources, characteristics, emission points, monitoring and abatement techniques are identified in section 3.6 of this BAT-OT.

BAT Requirement	Specific Measure
ii. information, as comprehensive as is reasonably possible, about channelled emissions to air, such as: a. emission point(s); b. average values and variability of flow and temperature; c. average concentration and mass flow values of relevant substances/parameters and their variability (e.g., TVOC, CO, NOX, SOX, Cl2, HCl); d. presence of other substances that may affect the waste gas treatment system(s) or plant safety (e.g., oxygen, nitrogen, water vapour, dust); e. techniques used to prevent and/or reduce channelled emissions to air; f. flammability, lower and higher explosive limits, reactivity; g. monitoring methods (see BAT 8); h. presence of substances classified as CMR 1A, CMR 1B or CMR 2; the presence of such substances may for example be assessed according to the criteria of Regulation (EC) 1272/2008 on classification, labelling and packaging (CLP). iii. information, as comprehensive as is reasonably possible, about diffuse emissions to air, such as: a. identification of the emission source(s); b. characteristics of each emission source (e.g., fugitive or non-fugitive; static or moving; accessibility of the emission source; included in an LDAR programme or not); c. the characteristics of the gas or liquid in contact with the emission source(s), including: 1) physical state; 2) vapour pressure of the substance(s) in the liquid, pressure of the gas; 3) temperature; 4) composition (by weight for liquids or by volume for gases);	

BAT Requirement	Specific Measure
5) hazardous properties of the substance(s) or mixtures, including substances or mixtures classified as CMR 1A, CMR 1B or CMR 2; d. techniques used to prevent and/or reduce diffuse emissions to air; e. monitoring (see BAT 20, BAT 21 and BAT 22).	
Other than normal operating conditions (OTNOC)	
BAT 3. In order to reduce the frequency of the occurrence of OTNOC and to reduce emissions to air during OTNOC, BAT is to set up and implement a risk based OTNOC management plan as part of the environmental management system (see BAT 1) that includes all of the following features: identification of potential OTNOC (e.g., failure of equipment critical to the control of channelled emissions to air, or equipment critical to the prevention of accidents or incidents that could lead to emissions to air (critical equipment)), of their root causes and of their potential consequences; ii. appropriate design of critical equipment (e.g., equipment modularity and compartmentalisation, backup systems, techniques to obviate the need to bypass waste gas treatment during start-up and shutdown, high-integrity equipment, etc.); iii. set-up and implementation of a preventive maintenance plan for critical equipment (see BAT 1 xii.); iv. monitoring (i.e., estimating or, where this is possible, measuring) and recording of emissions and associated circumstances during OTNOC; v. periodic assessment of the emissions occurring during OTNOC (e.g., frequency of events, duration, amount of pollutants emitted as recorded in point iv.) and implementation of corrective actions if necessary; vi. regular review and update of the list of identified OTNOC under point i. following the periodic assessment of point v.; vii. regular testing of backup systems.	JM will prepare an ‘operation other than normal conditions’ OTNOC plan for the 3CR process and the associated abatement incorporating the aspects of BT3 and have this in place before commissioning of the new plant.

BAT Requirement	Specific Measure
Channelled emissions to air	
BAT 4. In order to reduce channelled emissions to air, BAT is to use an integrated waste gas management and treatment strategy that includes, in order of priority, process integrated recovery and abatement techniques.	The design of 3CR incorporates a number of process stages and has an integrated waste gas treatment strategy that comprises dedicated scrubbers for the abatement of emissions.
BAT 5. In order to facilitate the recovery of materials and the reduction of channelled emissions to air, as well as to increase energy efficiency, BAT is to combine waste gas streams with similar characteristics, thus minimising the number of emission points. The combined treatment of waste gases with similar characteristics ensures more effective and efficient treatment compared to the separate treatment of individual waste gas streams. The combination of waste gases is carried out considering plant safety (e.g., avoiding concentrations close to the lower/upper explosive limit), technical (e.g., compatibility of the individual waste gas streams, concentration of the substances concerned), environmental (e.g., maximising recovery of materials or pollutant abatement) and economic factors (e.g., distance between different production units)	The abatement system requires two scrubbers with separate emission due to the different gas streams to be treated.
BAT 6. In order to reduce channelled emissions to air, BAT is to ensure that the waste gas treatment systems are appropriately designed (e.g., considering the maximum flow rate and pollutant concentrations), operated within their design ranges, and maintained (through preventive, corrective, regular and unplanned maintenance) so as to ensure optimal availability, effectiveness and efficiency of the equipment.	The channelled emission points to air will be managed under JM's waste gas management strategy. Standard Operating Procedures (SOP) will also be in place for each scrubber to ensure that it is operated within its optimum design ranges. Each scrubber will also be operated under a schedule of preventative maintenance in line with the manufacturer's recommendations. Daily inspections will also be undertaken at the site to identify operational problems allowing corrective actions to be put in place quickly.

BAT Requirement	Specific Measure
	The system will be appropriately designed so that maximum flow rate and pollutant concentrations are considered. The scrubbers will be monitored to allow for operational control to change inputs if required.
Monitoring	
BAT 7. BAT is to continuously monitor key process parameters (e.g., waste gas flow and temperature) of waste gas streams being sent to pre-treatment and/or final treatment.	Waste gas flows are measured continuously by differential pressure between in & outflows. Temperature is constantly monitored in the quench scrubber. The other scrubbers, (draught, ammonia & chlorine) have temperature sensor in the liquid to preserve the temperature of the scrubbing liquor.
BAT 8. BAT is to monitor channelled emissions to air with at least the frequency given below and in accordance with EN standards. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality	JM will undertake monitoring for NOx, NH3, Cl2, VOCs and HCl in accordance with the directions provided in BAT 8. JM are considered to have met this condition.
Organic compounds	
BAT 9. In order to increase resource efficiency and to reduce the mass flow of organic compounds sent to the final waste gas treatment, BAT is to recover organic compounds from process off-gases by using one or a combination of the techniques given below and to reuse them.	HCl acid in condensate streams will be recycled for local 3CR use as 7M acid and chlorinated solvents in waste streams with distillation will be re-used in the process where possible.

<table>
<tr><th>BAT Requirement</th><th>Specific Measure</th></tr>
<tr><td>
<table>
<tr><th colspan="2">TECHNIQUES</th><th>DESCRIPTION</th></tr>
<tr><td>a.</td><td>Absorption (regenerative)</td><td>See Section 4.4.1.</td></tr>
<tr><td>b.</td><td>Adsorption (regenerative)</td><td>See Section 4.4.1.</td></tr>
<tr><td>c.</td><td>Condensation</td><td>See Section 4.4.1.</td></tr>
</table>
</td><td></td></tr>
<tr><td>BAT 10. In order to increase energy efficiency and to reduce the mass flow of organic compounds sent to the final waste gas treatment, BAT is to send process off-gases with a sufficient calorific value to a combustion unit that is, if technically possible, combined with heat recovery. BAT 9 has priority over sending process off-gases to a combustion unit.</td><td>Not applicable as the waste gas has insufficient calorific value.</td></tr>
<tr><td>BAT 11. In order to reduce channelled emissions to air of organic compounds, BAT is to use one or a combination of the techniques given below.
<table>
<tr><th colspan="2">TECHNIQUE</th><th>DESCRIPTION</th><th>APPLICABILITY</th></tr>
<tr><td>a.</td><td>Adsorption</td><td>See Section 4.4.1.</td><td>Generally applicable.</td></tr>
<tr><td>b.</td><td>Absorption</td><td>See Section 4.4.1.</td><td>Generally applicable.</td></tr>
<tr><td>c.</td><td>Catalytic oxidation</td><td>See Section 4.4.1.</td><td>Applicability may be restricted by the presence of catalyst poisons in the waste gases.</td></tr>
<tr><td>d.</td><td>Condensation</td><td>See Section 4.1.1.</td><td>Generally applicable.</td></tr>
</table>
</td><td>Abatement techniques for organic compounds for channelled emission points to air include a caustic scrubber and an ammonia scrubber.
The chemical released to air from the 3CR process from channelled emission points, includes:
• Ammonia (NH_3);
• Chlorine (Cl_2);
• Hydrochloric acid (HCl);
• Nitrogen oxides (NOx) and
• Volatile organic compounds (VOC).
JM will undertake monitoring for the chemicals outlined above in accordance with the directions provided in BAT 8 and ensure that the results meet the BAT AELs provided in BAT 11.</td></tr>
</table>

BAT Requirement				Specific Measure
e.	Thermal oxidation	See Section 4.1.1.	Applicability of recuperative and regenerative thermal oxidation to existing plants may be restricted by design and/or operational constraints. Applicability may be restricted where the energy demand is excessive due to the low concentration of the compound(s) concerned in the process off-gases.	
f.	Bioprocesses	See Section 4.4.1	Only applicable to the treatment of biodegradable compounds	

BAT-associated emission levels (BAT-AELs) for channelled emissions to air of organic compounds.

SUBSTANCE/PARAMETER	BAT-AEL (MG/NM^3) (DAILY AVERAGE OR AVERAGE OVER THE SAMPLING PERIOD ([1]))
Total volatile organic carbon (TVOC)	< 1-20([2])([3])([4])([5])
Sum of VOCs classified as CMR 1A or 1B	< 1-5 ([6])
Sum of VOCs classified as CMR 2	< 1-10 ([7])
Benzene	< 0.5-1 ([8])

BAT Requirement		Specific Measure
1,3-Butadiene	< 0.5-1 ([8])	
Ethylene dichloride	< 0.5-1 ([8])	
Ethylene oxide	<0.5 – 1([8])	
Propylene oxide	<0.5 – 1([8])	
Formaldehyde	1-5 ([8])	
Chloromethane	< 0.5-1 ([9])([10])	
Dichloromethane	< 0.5-1 ([9])([10])	
tetrachloromethane	< 0.5-1 ([9])([10])	
Toluene	< 0.5-1 ([9])([11])	
Trichloromethane	< 0.5-1 ([9])([10])	

(1) For activities listed under points 8 and 10, Part 1 of Annex VII of the IED, the BAT-AEL ranges apply to the extent that they lead to lower emission levels than the emission limit values in part 2 and 4 of Annex VII to the IED. (2) TVOC is expressed in mg C/Nm^3. (3) In the case of polymer production, the BAT-AEL may not apply to emissions from the finishing steps (e.g., extrusion, drying, blending) and from polymer storage. (4) The BAT-AEL does not apply to minor emissions (i.e., when the TVOC mass flow is below e.g., 100 g C/h) if no CMR substances are identified as relevant in the waste gas stream based on the inventory given in BAT 2. (5) The upper end of the BAT-AEL range may be higher and up to 30 mg C/Nm^3 when using techniques to recover materials (e.g., solvents, see BAT 9), if both of the following conditions are fulfilled: • the presence of substances classified as CMR 1A/1B or CMR 2 is identified as not relevant (see BAT 2); • the TVOC abatement efficiency of the waste gas treatment system is ≥ 95 %. (6) The BAT-AEL does not apply to minor emissions (i.e., when the mass flow of the sum of the VOCs classified as CMR 1A or 1B is below e.g., 1 g/h). (7) The BAT-AEL does not apply to minor emissions (i.e., when the mass flow of the sum of the VOCs classified as CMR 2 is below e.g., 50 g/h). (8) The BAT-AEL does not apply to minor emissions (i.e., when the mass flow of the substance concerned is below e.g., 1 g/h). (9) The BAT-AEL does not apply to minor emissions (i.e., when the mass flow of the substance concerned is below e.g., 50 g/h).	

<table>
<tr><th>BAT Requirement</th><th>Specific Measure</th></tr>
<tr><td>(10) The upper end of the BAT-AEL range may be higher and up to 15 mg/Nm^3 when using techniques to recover materials (e.g., solvents, see BAT 9), if the abatement efficiency of the waste gas treatment system is ≥ 95 %.

(11) The upper end of the BAT-AEL range may be higher and up to 20 mg/Nm^3 when using techniques to recover toluene (see BAT 9), if the abatement efficiency of the waste gas treatment system is ≥ 95 %.</td><td></td></tr>
<tr><td>BAT 12. In order to reduce channelled emissions to air of PCDD/F from thermal treatment of waste gases containing chlorine and/or chlorinated compounds, BAT is to use techniques a. and b., and one or a combination of techniques c. to e., given below.

BAT-associated emission level (BAT-AEL) for channelled emissions to air of PCDD/F from thermal treatment of waste gases containing chlorine and/or chlorinated compounds.</td><td>Dioxins and furans are not released from the scrubbers. Not applicable.</td></tr>
<tr><td>BAT 13. In order to increase resource efficiency and to reduce the mass flow of dust and particulate-bound metals sent to the final waste gas treatment, BAT is to recover materials from process off-gases by using one or a combination of the techniques given below and to reuse them.
<table>
<tr><th colspan="2">TECHNIQUES</th><th>DESCRIPTION</th></tr>
<tr><td>a.</td><td>Cyclone</td><td>See Section 4.4.1.</td></tr>
<tr><td>b.</td><td>Fabric filter</td><td>See Section 4.4.1.</td></tr>
</table></td><td>The following equipment will be used to reduce the mass flow of dust and particulates to final waste gas treatment:
• A de-mister upstream of the caustic scrubber; and
• A wet solids scrubber.</td></tr>
</table>

BAT Requirement			Specific Measure
c.	Absorption	See Section 4.4.1.	

14. In order to reduce channelled emissions to air of dust and particulate-bound metals, BAT is to use one or a combination of the techniques given below.

	TECHNIQUES	DESCRIPTION	APPLICABILITY
a.	Absolute filter	See Section 4.4.1.	Applicability may be limited in the case of sticky dust or when the temperature of the waste gases is below the dew point.
b.	Absorption	See Section 4.4.1.	General applicable.
c.	Fabric filter	See Section 4.4.1.	Applicability may be limited in the case of sticky dust or when the temperature of the waste gases is below the dew point.
d.	High-efficiency air filter	See Section 4.4.1.	General applicable.
e.	Cyclone	See Section 4.4.1.	General applicable.

The abatement on the 3CR channelled emissions consists of wet scrubbing which will remove any particulate. Lead and nickel are not present in the waste gas.

BAT Requirement				Specific Measure
f.	Electrostatic precipitator	See Section 4.4.1.	General applicable.	

BAT-associated emission levels (BAT-EALs) for channelled emissions to air of dust, lead and nickel.

SUBSTANCE/PARAMETER	BAT-AEL (MG/NM^3) DAILY AVERAGE OR AVERAGE OVER THE SAMPLING PERIOD)
Dust	< 1-5 ([1])([2])([3])([4])
Lead and its compounds, expressed as Pb	< 0.01-0.1 ([5])
Nickel and its compounds, expressed as Ni	<0.02-0.1 ([6])

BAT Requirement	Specific Measure
(1) The upper end of the range is 20 mg/Nm^3 when either an absolute or a fabric filter is not applicable. (2) The BAT-AEL does not apply to minor emissions (i.e., when the dust mass flow is below e.g., 50 g/h) if no CMR substances are identified as relevant in the dust based on the inventory given in BAT 2. (3) In the case of the production of complex inorganic pigments using direct heating, and in the case of the drying step in the production of E-PVC, the upper end of the BAT-AEL range may be higher and up to 10 mg/Nm^3. (4) Dust emissions are expected to be towards the lower end of the BAT-AEL range (e.g., below 2.5 mg/Nm^3) when the presence of substances classified as CMR 1A or 1B, or CMR 2 in the dust is identified as relevant (see BAT 2). (5) The BAT-AEL does not apply to minor emissions (i.e., when the lead mass flow is below e.g., 0.1 g/h). (6) The BAT-AEL does not apply to minor emissions (i.e., when the Ni mass flow is below e.g., 0.15 g/h).	
Inorganic compounds	
BAT 15. In order to increase resource efficiency and to reduce the mass flow of inorganic compounds sent to the final waste gas treatment, BAT is to recover inorganic compounds from process off-gases by using absorption and to reuse them.	Inorganic components are present largely in the aqueous process streams and are not present in significant quantities in the gas stream. Therefore this BATc is not relevant to the 3CR operation.

<table>
<tr><th>BAT Requirement</th><th>Specific Measure</th></tr>
<tr><td>BAT 16. In order to reduce channelled emissions to air of CO, NOx and SOx from thermal treatment, BAT is to use technique c. and one or a combination of the other techniques given below</td><td>Not applicable as thermal treatment does not occur at 3CR.</td></tr>
<tr><td>BAT 17. In order to reduce channelled emissions to air of ammonia from the use of selective catalytic reduction (SCR) or selective non-catalytic reduction (SNCR) for the abatement of NOX emissions (ammonia slip), BAT is to optimise the design and/or operation of SCR or SNCR (e.g., optimised reagent to NOX ratio, homogeneous reagent distribution and optimum size of the reagent drops).

BAT-associated emission level (BAT-AEL) for channelled emissions to air of ammonia from the use of SCR or SNCR (ammonia slip)
<table>
<tr><th>SUBSTANCE/PARAMETER</th><th>BAT-AEL (MG/NM^3)
(AVERAGE OVER THE SAMPLING PERIOD)</th></tr>
<tr><td>Ammonia (NH_3) from SCR/SNCR</td><td>< 0.5-8 ([1])</td></tr>
<tr><td colspan="2">(1) The upper end of the BAT-AEL range may be higher and up to 40 mg/Nm^3 in the case of process off-gases containing very high levels of NOX (e.g., above 5 000 mg/Nm^3) prior to treatment with SCR or SNCR.</td></tr>
</table></td><td>Not applicable as neither SCR nor SNCR are used on the 3CR process.</td></tr>
<tr><td>BAT 18. In order to reduce channelled emissions to air of inorganic compounds other than channelled emissions to air of ammonia from the use of selective catalytic reduction (SCR) or selective non-catalytic reduction (SNCR) for the abatement of NOx emissions), channelled emissions to air of CO, NOx and SOx from the use of thermal treatment, and channelled emissions to air of NOx from process furnaces/heaters, BAT is to use one or a combination of the techniques given below.</td><td>JM will use scrubbers to abate emissions of inorganic compounds from the 3CR process.
JM will remove high levels of NOx precursors via a small local NOx scrubber will be added to serve one unit operation in 3CR.</td></tr>
</table>

BAT Requirement					Specific Measure
TECHNIQUE		**DESCRIPTION**	**MAIN INORGANIC COMPOUNDS TARGETED**	**APPLICABILITY**	JM will undertake monitoring for inorganic compounds in accordance with the directions provided in BAT 8 and ensure that the results meet the BAT AELs provided in BAT 18.
Specific techniques to reduce emissions to air of inorganic compounds					
a.	Absorption	Section 4.4.1.	Cl_2, HCl, HCN, HF, NH_3, NO_x, SO_x	Generally applicable.	
b.	Adsorption	Section 4.4.1.	HCl, HF, NH. SOx	Generally applicable.	
c.	Selective catalytic reduction (SCR)	Section 4.4.1.	NOx	Applicability to existing plants may be restricted by space availability.	
D.	Selective non-catalytic reduction (SNCR)	Section 4.4.1.	NOx	Applicability to existing plants may be restricted by the residence time needed for the reaction	
Other techniques not primarily used to reduce emissions to air of inorganic compounds					

BAT Requirement					Specific Measure
e.	Catalytic oxidation	Section 4.4.1.	NH_3	Applicability may be restricted by the presence of catalyst poisons in the waste gases.	
f.	Thermal oxidation	Section 4.4.1.	NH_3, HCN	Applicability of recuperative and regenerative thermal oxidation to existing plants may be restricted by design and/or operational constraints. The applicability may be restricted where the energy demand is excessive due to the low concentration of the compound(s) concerned in the process off-gases.	

BAT-associated emission levels (BAT-AELs) for channelled emissions to air of inorganic compounds

SUBSTANCE/PARAMETER	BAT-AEL ($MG\text{-}NM^3$) (DAILY AVERAGE OR AVERAGE OVER THE SAMPLING PERIOD)
Ammonia (NH_3)	2-10 ([1]) ([2]) ([3])
Elemental chlorine (Cl_2)	<0.5-2 ([4])([5])

BAT Requirement		Specific Measure
Gaseous fluorides, expressed as HF	≤ 1 ([4])	
Hydrogen cyanide (HCN)	< 0.1 – 1 ([4])	
Gaseous chlorides, expressed as HCl	1-10 ([6])	
Nitrogen oxides (NOx)	10-150 ([7]) ([8]) ([9]) ([10])	
Sulphur oxides (SO_2)	< 3-150 ([11])([9])	

(1) The BAT-AEL does not apply to channelled emissions to air of ammonia from the use of SCR or SNCR (ammonia slip). This is covered by BAT 17. (2) The BAT-AEL does not apply to minor emissions (i.e., when the NH3 mass flow is below e.g., 50 g/h). (3) In the case of the drying step in the production of E-PVC, the upper end of the BAT-AEL range may be higher and up to 20 mg/Nm^3, when the substitution of ammonium salts is not possible due to product quality specifications. (4) The BAT-AEL does not apply to minor emissions (i.e., when the mass flow of the substance concerned is below e.g., 5 g/h). (5) In the case of NOX concentrations above 100 mg/Nm^3 , the upper end of the BAT-AEL range may be higher and up to 3 mg/Nm^3 due to analytical interference. (6) The BAT-AEL does not apply to minor emissions (i.e., when the HCl mass flow is below e.g., 30 g/h). (7) In the case of the production of explosives, the upper end of the BAT-AEL range may be higher and up to 220 mg/Nm^3 when regenerating or recovering nitric acid from the production process. (8) The BAT-AEL does not apply to channelled emissions to air of NOX from the use of catalytic or thermal oxidation (see BAT 16) or from process furnaces/heaters (see BAT 36). (9) The BAT-AEL does not apply to minor emissions (i.e., when the mass flow of the substance concerned is below e.g., 500 g/h. (10) In the case of the production of caprolactam, the upper end of the BAT-AEL range may be higher and up to 200 mg/Nm^3 in the case of process off-gases containing very high levels of NOx	

BAT Requirement	Specific Measure
(e.g. above 10 000 mg/Nm^3) prior to treatment with SCR or SNCR, when the abatement efficiency of the SCR or SNCR is ≥ 99 %. (11) The BAT-AEL does not apply in the case of physical purification or reconcentration of spent sulphuric acid.	
Diffuse VOC emissions to air	
BAT 19. In order to prevent or, where that is not practicable, to reduce diffuse VOC emissions to air, BAT is to elaborate and implement a management system for diffuse VOC emissions, as part of the environmental management system (see BAT 1), that includes all of the following features: Estimating the annual quantity of diffuse VOC emissions (see BAT 20). ii. Monitoring diffuse VOC emissions from the use of solvents by compiling a solvent mass balance, if applicable (see BAT 21). iii. Establishing and implementing a leak detection and repair (LDAR) programme for fugitive VOC emissions. The LDAR programme typically lasts from 1 to 5 years depending on the nature, scale and complexity of the plant (5 years may correspond to large plants with a high number of emission sources). The LDAR programme includes all of the following features: a. Listing of equipment identified as relevant fugitive VOC emission sources in the inventory of diffuse VOC emissions (see BAT 2). b. Definition of criteria associated with the following: o Leaky equipment. Typical criteria could be a leak threshold, above which equipment is considered leaky, and/or the visualisation of a leak with OGI cameras. This depends on the characteristics of the emission source (e.g., accessibility) and the hazardous properties of the emitted substance(s).	i. The 3CR process involves handling 14,000 litres of methyl isobutyl ketone (MiBK) annually. ii. Potential MiBK diffuse emissions will be captured in the monthly mass balance undertaken at the site. iii. There is potential for some diffuse emissions to escape during storage and transfer of MiBK. However, the amount of MiBK used in the process and subsequently having the potential to result in diffuse emissions is low. As such, it is considered disproportionate to undertake a full LDAR exercise at 3CR. Potential MiBK diffuse emissions will be captured in the annual mass balance calculations undertaken and reported for the site. iv – vii. It is considered disproportionate to undertake a full LDAR exercise at 3CR

BAT Requirement	Specific Measure
o Maintenance and/or repair actions to be carried out. A typical criterion could be a VOC concentration threshold triggering the maintenance or repair action (maintenance/repair threshold). The maintenance/repair threshold is generally equal to or higher than the leak threshold. This depends on the characteristics of the emission source (e.g., accessibility) and the hazardous properties of the emitted substance(s). For the first LDAR programme, it is generally not higher than 5 000 ppmv for VOCs other than VOCs classified as CMR 1A or 1B, and 1 000 ppmv for VOCs classified as CMR 1A or 1B. For subsequent LDAR programmes, the maintenance/repair threshold is lowered (see point vi. A.) and not higher than 1 000 ppmv for VOCs other than VOCs classified as CMR 1A or 1B, and 500 ppmv for VOCs classified as CMR 1A or 1B, targeting 100 ppmv. c. Measuring fugitive VOC emissions from equipment listed under point iii. A. (see BAT 22). D. Carrying out maintenance and/or repair actions (see BAT 23, techniques e. and f.), as soon as possible and where necessary according to the criteria defined in point iii. B. Maintenance and repair actions are prioritised according to the hazardous properties of the emitted substance(s), the significance of the emissions and/or operational constraints. The effectiveness of the maintenance and/or repair actions is verified according to point iii. C., leaving enough time after the intervention (e.g., 2 months). e. Filling in the database mentioned in point v. iv. Establishing and implementing a detection and reduction programme for non-fugitive VOC emissions that includes all of the following features: a. Listing of equipment identified as relevant non-fugitive VOC emission sources in the inventory of diffuse VOC emissions (see BAT 2). b. Monitoring non-fugitive VOC emissions from equipment listed under point iv. A. (see BAT 22). c. Planning and implementing techniques to reduce non-fugitive VOC emissions (see BAT 23, techniques a., c. and g. to j.). The planning and implementation of the techniques are prioritised according to the hazardous properties of the emitted substance(s), the significance of the emissions and/or operational constraints.	

BAT Requirement	Specific Measure
d. Filling in the database mentioned in point v. v. Establishing and maintaining a database, for diffuse VOC emissions sources that are identified in the inventory mentioned in BAT 2, for keeping record of: a. equipment design specifications (including the date and description of any design changes); b. the equipment maintenance, repair, upgrade, or replacement actions, performed or planned, and their date of implementation; c. the equipment that could not be maintained, repaired, upgraded or replaced due to operational constraints; d. the results of the measurements or monitoring, including the concentration(s) of the emitted substance(s), the calculated leak rate (as kg/year), the recording from OGI cameras (e.g., from the last LDAR programme) and the date of the measurements or monitoring; e. the annual quantity of diffuse VOC emissions (as fugitive and non-fugitive emissions), including information on non-accessible sources and accessible sources not monitored during the year. vi. Reviewing and updating the LDAR programme periodically. This may include the following: a. lowering the leak and/or maintenance/repair thresholds (see point iii. B.); b. reviewing the prioritisation of equipment to be monitored, giving higher priority to (the type of) equipment identified as leaky during the previous LDAR programme; c. planning the maintenance, repair, upgrade or replacement of equipment that could not be performed during the previous LDAR programme due to operational constraints. vii. Reviewing and updating the detection and reduction programme for non-fugitive VOC emissions. This may include the following:	

<table>
<tr><th>BAT Requirement</th><th>Specific Measure</th></tr>
<tr><td>a. monitoring non-fugitive VOC emissions from equipment where maintenance, repair, upgrade or replacement actions were implemented, in order to determine if those actions were successful;
b. planning the maintenance, repair, upgrade or replacement actions that could not be performed due to operational constraints.</td><td></td></tr>
<tr><td>BAT 20. BAT is to estimate fugitive and non-fugitive VOC emissions to air separately at least once every year by using one or a combination of the techniques given below, as well as to determine the uncertainty of this estimation. The estimation distinguishes between VOCs classified as CMR 1A or 1B and VOCs that are not classified as CMR 1A or 1B.
<table>
<tr><th colspan="2">TECHNIQUE</th><th>DESCRIPTION</th><th>TYPE OF EMISSIONS</th></tr>
<tr><td>a.</td><td>Use of emission factors</td><td>See Section 4.4.2.</td><td rowspan="2"></td></tr>
<tr><td>b.</td><td>Use of a mass balance</td><td>Estimation based on the difference in the mass of the substance inputs to and outputs from the plant/production unit, taking into account the generation and destruction of the substance in the plant/production unit. A mass balance may also consist of measuring the concentration of VOCs in the product (e.g., raw material or solvent).</td></tr>
</table></td><td>JM intend to include potential diffuse emissions to air from MiBK storage in the annual mass balance reporting.</td></tr>
</table>

BAT Requirement				Specific Measure
c.	Use of thermodynamic models	Estimation using the laws of thermodynamics applied to equipment (e.g., tanks) or particular steps of a production process. The following data are generally used as input for the model: • chemical properties of the substance (e.g., vapour pressure, molecular mass); • process operating data (e.g., operating time, product quantity, ventilation); • characteristics of the emission source (e.g., tank diameter, colour, shape).	Fugitive and/or non-fugitive	
BAT 21. BAT is to monitor diffuse VOC emissions from the use of solvents by compiling, at least once every year, a solvent mass balance of the solvent inputs and outputs of the plant, as defined in Part 7 of Annex VII to Directive 2010/75/EU and to minimise the uncertainty of the solvent mass balance data by using all of the techniques given below. **TECHNIQUES** / **DESCRIPTION**				JM will undertake the following in their annual mass balance calculations in accordance with BAT 21: a. Full quantification and identification of inputs and outputs. b. Implementation of a solvent tracking system. JM will implement a VOC tracking system for VOCs received and utilised on site with the tank levels being read and recorded at the end of the stock period. c. Monitoring of shutdowns / malfunctions / changes in flow rates that may need to be reflected in the mass balance data.

BAT Requirement			Specific Measure
a.	Full identification and quantification of the relevant solvent inputs and outputs, including the associated uncertainty	This includes: • identification and documentation of solvent inputs and outputs (e.g., channelled and diffuse emissions to air, emissions to water, solvent output in waste); • substantiated quantification of each relevant solvent input and output and recording of the methodology used (e.g., measurement, estimation by using emission factors, estimation based on operational parameters); • identification of the main sources of uncertainty of the aforementioned quantification, and implementation of corrective actions to reduce the uncertainty; • regular update of solvent input and output data.	
b.	Implementation of a solvent tracking system	A solvent tracking system aims to keep control of both the used and unused quantities of solvents (e.g., by weighing unused quantities returned to storage from the application area).	
c.	Monitoring of changes that may influence the uncertainty of the solvent mass balance data	Any change that could influence the uncertainty of the solvent mass balance data is recorded, such as: • malfunctions of the waste gas treatment system: the date and period of time are recorded; • changes that may influence air/gas flow rates (e.g., replacement of fans): the date and type of change are recorded.	

BAT Requirement	Specific Measure
BAT 22. BAT is to monitor diffuse VOC emissions to air with at least the frequency given below and in accordance with EN standards. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.	Due to the limited amount of MiBK used in the process, the potential for diffuse emissions is low. As such, it is considered disproportionate to undertake monitoring at 3CR. The potential MiBK diffuse emission will be captured in the annual mass balance undertaken at the site and JM will assess the need for monitoring based on balance model estimates for emissions to air.

TYPE OF SOURCES OF DIFFUSE VOC EMISSIONS ([1])([2])	TYPE OF VOCS	STANDARD(S)	MINIMUM MONITORING FREQUENCY
Sources of fugitive emissions	VOCs classified as CMR 1A or 1B	EN 15446	Once every year ([3])([4])([5])
	VOCs not classified as CMR 1A or 1B		Once during the period covered by each LDAR programme (see BAT 19 point iii.) ([6])
Sources of non-fugitive emissions	VOCs classified as CMR 1A or 1B	No EN standard available	Once every year
	VOCs not classified as CMR 1A or 1B		Once every year ([7])

BAT Requirement	Specific Measure
(1) The monitoring only applies to emission sources that are identified as relevant in the inventory given in BAT 2. (2) The monitoring does not apply to equipment operated under sub atmospheric pressure. (3) In the case of inaccessible sources of fugitive VOC emissions (e.g., if the monitoring requires the removal of insulation or the use of scaffolding), the monitoring frequency may be reduced to once during the period covered by each LDAR programme (see BAT 19 point iii.). (4) For the production of PVC, the minimum monitoring frequency may be reduced to once every 5 years if the plant uses VCM gas detectors to continuously monitor VCM emissions in a way that allows an equivalent level of detection of VCM leaks. (5) In the case of high-integrity equipment (see BAT 23 b.) in contact with VOCs classified as CMR 1A or 1B, a lower minimum monitoring frequency may be adopted, but in any case, at least once every 5 years. (6) In the case of high-integrity equipment (see BAT 23 b.) in contact with VOCs other than VOCs classified as CMR 1A or 1B, a lower minimum monitoring frequency may be adopted, but in any case, at least once every 8 years. (7) The minimum monitoring frequency may be reduced to once every 5 years if non-fugitive emissions are quantified by using measurements.	
BAT 23. In order to prevent or, where that is not practicable, to reduce diffuse VOC emissions to air, BAT is to use a combination of the techniques given below with the following order of priority.	a. The 3CR project will be situated in two new buildings. These buildings have been designed to minimise potential diffuse emissions from pipework (minimise pipe length, welded joints etc). b. JM are installing high quality new equipment.

BAT Requirement					Specific Measure
TECHNIQUE		**DESCRIPTION**	**TYPE OF EMISSIONS**	**APPLICABILITY**	c. Limited amounts of VOC diffuse emissions that maybe generated by MiBK stored as part of the process will be extracted to the scrubbed draft system. d. Access to equipment that has the potential to leak has been designed into the process to allow for maintenance and monitoring. e. JM are installing high quality new equipment. f. 3CR will not operate under the LDAR programme but storage vessels will be part of the site's inspection and maintenance programme. g. The 3CR process has been designed to operate efficiently, the process will be monitored, and adjustments made to inputs etc to lower the temperature and / or solvents used where possible. h. As the process is monitored operating conditions will be constantly updated to allow the most efficient running possible. i. Potential diffuse emissions generated by the 3CR are considered to be that low that no closed loop system is considered necessary. j. waste gases comprising VOCs are sent for abatement to the scrubbers.
1. Prevention techniques					
a.	Limiting the number of emission sources	This includes: • minimising pipe lengths; • reducing the number of pipe connectors (e.g., flanges) and valves; • using welded fittings and connections; • using compressed air or gravity for material transfer.	Fugitive and non-fugitive emissions	Applicability may be restricted by operational constraints in the case of existing plants.	

b.	Use of high integrity equipment	High-integrity equipment includes, but is not limited to: • valves with bellow or double packing seals or equally effective equipment; • magnetically driven or canned pumps/compressors/agitators, or pumps/compressors/agitators using double seals and a liquid barrier; • certified high-quality gaskets (e.g., according to EN 13555) that are tightened according to technique e.; • closed sampling system. The use of high-integrity equipment is especially relevant to prevent or minimise: • emissions of CMR substances or substances with acute toxicity; and/or • emissions from equipment with high-leaking potential; and/or • leaks from processes operated at high pressures (e.g., between 300 bar and 2 000 bar).	Fugitive emissions	Applicability may be restricted by operational constraints in the case of existing plants. Generally applicable to new plants and major plant upgrades.	

BAT Requirement					Specific Measure
		High-integrity equipment is selected, installed and maintained according to the type of process and the process operating conditions.			
c.	Collecting diffuse emissions and treating off-gases	Collecting diffuse VOC emissions (e.g., from compressor seals, vents and purge lines) and sending them to recovery (see BAT 9 and BAT 10) and/or abatement (see BAT 11).	Fugitive and non-fugitive emissions	Applicability may be restricted: • for existing plants; and/or • by safety concerns (e.g., avoiding concentrations close to the lower explosive limit).	
2. other techniques					

BAT Requirement					Specific Measure
d.	Facilitating access and/or monitoring activities	To ease maintenance and/or monitoring the access to potentially leaky equipment is facilited, e.g., by activities, installing platforms, and/or drones are used for monitoring.	Fugitive emissions	Applicability may be restricted by operational constraints in the case of existing plants.	
e.	Tightening	• Tightening of gaskets by personnel that is qualified according to EN 1591-4 and using the designed gasket stress (e.g., calculated according to EN 1591-1); • installing tight caps on open ends; • using flanges selected assembled according to EN 13555.	Fugitive emissions	Generally applicable.	
f.	Replacement of leaky equipment and/or parts	This includes the replacement of: • gaskets; • sealing elements (e.g., tank lid); • packing material (e.g., valve stem packing material).	Fugitive emissions	Generally applicable.	

BAT Requirement					Specific Measure
g.	Reviewing and updating process design	This includes: • reducing the use of solvents and/or using solvents with lower volatility; • reducing the formation of side products containing VOCs; • lowering the operating temperature; • lowering the VOC content in the final product.	Non-fugitive emissions	Applicability may be restricted in the case of existing plants due to operational constraints.	
h.	Reviewing and updating operating conditions	This includes: • reducing the frequency and duration of reactor and vessel openings; • preventing corrosion by lining or coating of equipment, by painting pipes (for external corrosion) and by using corrosion inhibitors for materials in contact with equipment.	Non-fugitive emissions	Generally applicable.	

BAT Requirement					Specific Measure
i.	Using closed systems	This includes: • vapour balancing (see Section 4.4.3); • closed systems for solid/liquid and liquid/liquid phase separations; • closed systems for cleaning operations; • closed sewers and/or wastewater treatment plants; • closed sampling systems; • closed storage areas. Off-gases from closed systems are sent to recovery (see BAT 9 and BAT 10) and/or abatement (see BAT 11)	Non-fugitive emissions	Applicability may be restricted by operational constraints in the case of existing plants and/or by safety concerns.	

BAT Requirement					Specific Measure
j.	Using techniques to minimise emissions from surfaces	This includes: • installing oil creaming systems on open surfaces; • periodically skimming open surfaces (e.g., removing floating matter); • installing anti-evaporation floating elements on open surfaces; • treating wastewater streams to remove VOCs and send the VOCs to recovery (see BAT 9 and BAT 10) and/or abatement (see BAT 11); • installing floating roofs on tanks; • using fixed-roof tanks connected to a waste gas treatment.	Non-fugitive emissions	Applicability may be restricted by operational constraints in the case of existing plants.	
Process furnace/heaters					
BAT 36. In order to prevent or, where that is not practicable, to reduce channelled emissions to air of CO, dust, NOx and Sox, BAT is to use technique c. and one or a combination of the other techniques given below.					Not applicable, process furnace or heaters not to be used on the 3CR process.