IPPC BAT Conclusions

COMMISSION IMPLEMENTING DECISION (EU) 2016/902 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for common waste water and waste gas treatment / management systems in the chemical sector.

General Considerations:

A) Best Available Techniques

The techniques listed and described in these BAT conclusions are neither prescriptive nor exhaustive. Other techniques may be used that ensure at least an equivalent level of environmental protection. Unless otherwise stated, the BAT conclusions are generally applicable.

B) Emission levels associated with BAT

Emission levels associated with the best available techniques (BAT-AELs) for emissions to water given in these BAT conclusions refer to values of concentrations (mass of emitted substances per volume of water), expressed in µg/l or mg/l. Unless otherwise stated, the BAT-AELs refer to flow-weighted yearly averages of 24-hour flow-proportional composite samples, taken with the minimum frequency set for the relevant parameter and under normal operating conditions. Time-proportional sampling can be used provided that sufficient flow stability is demonstrated. The flow-weighted yearly average concentration of the parameter (c_w) is calculated using the following equation:

$$c_w = \sum_{i=1}^{n} c_i q_i \,/ \sum_{i=1}^{n} q_i$$

Where
n =number of measurements;
c_i =average concentration of the parameter during i^{th} measurement;
q_i =average flow rate during i^{th} measurement.

3. Abatement efficiencies

In the case of total organic carbon (TOC), chemical oxygen demand (COD), total nitrogen (TN) and total inorganic nitrogen (N_{inorg}), the calculation of the average abatement efficiency referred to in these BAT conclusions (see Table 1 and Table 2) is based on loads and includes both pre-treatment (BAT 10 c) and final treatment (BAT 10 d) of waste water.

C) Definitions

For the purposes of these BAT conclusions, the following definitions apply:

Term used	Definition
New plant	A plant first permitted at the site of the installation following the publication of these BAT conclusions or a complete replacement of a plant following the publication of these BAT conclusions.
Existing plant	A plant that is not a new plant.
Biochemical oxygen demand (BOD5)	Amount of oxygen needed for the biochemical oxidation of the organic matter to carbon dioxide in 5 days. BOD is an indicator for the mass concentration of biodegradable organic compounds.
Chemical oxygen demand (COD)	Amount of oxygen needed for the total oxidation of the organic matter to carbon dioxide. COD is an indicator for the mass concentration of organic compounds.
Total organic carbon (TOC)	Total organic carbon, expressed as C, includes all organic compounds.
Total suspended solids (TSS)	Mass concentration of all suspended solids, measured via filtration through glass fibre filters and gravimetry.
Total nitrogen (TN)	Total nitrogen, expressed as N, includes free ammonia and ammonium (NH_4-N), nitrites (NO_2-N), nitrates (NO_3-N) and organic nitrogen compounds.
Total inorganic nitrogen (N_{inorg})	Total inorganic nitrogen, expressed as N, includes free ammonia and ammonium (NH_4-N), nitrites (NO_2-N) and nitrates (NO_3-N).
Total phosphorus (TP)	Total phosphorus, expressed as P, includes all inorganic and organic phosphorus compounds, dissolved or bound to particles.

Adsorbable organically bound halogens (AOX)	Adsorbable organically bound halogens, expressed as Cl, include Adsorbable organically bound chlorine, bromine and iodine.
Chromium (Cr)	Chromium, expressed as Cr, includes all inorganic and organic chromium compounds, dissolved or bound to particles
Copper (Cu)	Copper, expressed as Cu, includes all inorganic and organic copper compounds, dissolved or bound to particles.
Nickel (Ni)	Nickel, expressed as Ni, includes all inorganic and organic nickel compounds, dissolved or bound to particles.
Zinc (Zn)	Zinc, expressed as Zn, includes all inorganic and organic zinc compounds, dissolved or bound to particles.
VOC	Volatile organic compounds as defined in Article 3(45) of Directive 2010/75/EU.
Diffuse VOC emissions	Non-channelled VOC emissions which can result from 'area' sources (e.g. tanks) or 'point' sources (e.g. pipe flanges).
Fugitive VOC emissions	Diffuse VOC emissions from 'point' sources.
Flaring	High-temperature oxidation to burn combustible compounds of waste gases from industrial operations with an open flame. Flaring is primarily used for burning off flammable gas for safety reasons or during non-routine operational conditions.

D. Comparison Exercise with BAT

BAT conclusion		STATUS AT INSTALLATION: [ENTER NAME OF OPERATOR] DATE: [ENTER DATE OF ASSESSMENT] Applicability Assessment (describe how the technique applies or not to your installation)	STATE WHETHER IT IS IN PLACE OR STATE SCHEDULE FOR IMPLEMENTATION
1. Environmental management systems			
BAT 1 **Environmental Management System**	In order to improve the overall environmental performance, BAT is to implement and adhere to an environmental management system (EMS) that incorporates all of the following features: i. commitment of the management, including senior management; ii. an environmental policy that includes the continuous improvement of the installation by the management; iii. planning and establishing the necessary procedures, objectives and targets, in conjunction with financial planning and investment; iv. implementation of procedures paying particular attention to: a) structure and responsibility; b) recruitment, training, awareness and competence; c) communication;	Medichem Manufacturing Malta Ltd is a chemical industry and understands that some of its activities may have an impact on the environment and is continuously working to improve its environmental performance. An EMS is in place and certified to ISO 14001:2015 standard. EMS certification is available in Annex C-3 Although Medichem Manufacturing Malta Ltd	In Place

	d) employee involvement; e) documentation; f) effective process control; g) maintenance programmes; h) emergency preparedness and response; i) safeguarding compliance with environmental legislation; v. checking performance and taking corrective action, paying particular attention to: a) monitoring and measurement (see also the Reference Report on Monitoring of emissions to Air and Water from IED installations — ROM); b) corrective and preventive action; c) maintenance of records; d) independent (where practicable) internal or external auditing in order to determine whether or not the EMS conforms to planned arrangements and has been properly implemented and maintained; vi. review of the EMS and its continuing suitability, adequacy and effectiveness by senior management; vii. following the development of cleaner technologies; viii. consideration for the environmental impacts from the eventual decommissioning of the plant at the design stage of a new plant, and throughout its operating life; ix. application of sectoral benchmarking on a regular basis; x. waste management plan (see BAT 13). Specifically for chemical sector activities, BAT is to incorporate the following features in the EMS: xi. on multi-operator installations/sites, establishment of a convention that sets out the roles, responsibilities and coordination of operating procedures of each plant operator in order to enhance the cooperation between the various operators; xii. establishment of inventories of waste water and waste gas streams (see BAT 2). In some cases, the following features are part of the EMS xiii. odour management plan (see BAT 20);	and Combino Pharm Malta Ltd have the same management the operational processes of one is independent from the other. Common processes include the quality control laboratory analysis and the emergency response plan. The inventories on waste water and waste gas are taken into consideration in the EMS as part of environmental aspects of the system.	

	xiv. noise management plan (see BAT 22).		
	Applicability: The scope (e.g. level of detail) and nature of the EMS (e.g. standardised or non-standardised) will generally be related to the nature, scale and complexity of the installation, and the range of environmental impacts it may have.	Applicable	In place
BAT 2 **Inventory of waste water and waste gas streams**	In order to facilitate the reduction of emissions to water and air and the reduction of water usage, BAT is to establish and to maintain an inventory of waste water and waste gas streams, as part of the environmental management system (see BAT 1), that incorporates all of the following features: i. information about the chemical production processes, including: (a) chemical reaction equations, also showing side products; (b) simplified process flow sheets that show the origin of the emissions; (c) descriptions of process-integrated techniques and waste water/waste gas treatment at source including their performances; ii. information, as comprehensive as is reasonably possible, about the characteristics of the waste water streams, such as: (a) average values and variability of flow, pH, temperature, and conductivity; (b) average concentration and load values of relevant pollutants/parameters and their variability (e.g. COD/TOC, nitrogen species, phosphorus, metals, salts, specific organic compounds); (c) data on bioeliminability (e.g. BOD, BOD/COD ratio, Zahn-Wellens test, biological inhibition potential (e.g. nitrification)); iii. information, as comprehensive as is reasonably possible, about the characteristics of the waste gas streams, such as: a. average values and variability of flow and temperature; b. average concentration and load values of relevant pollutants/parameters and their variability (e.g. VOC, CO, NO_X, SO_X, chlorine, hydrogen chloride);	The inventory of waste water and waste gas streams have been identified as follows: Waste Water Streams - Process drain + Floor drain directed to Waste Water Treatment Plant - Final waste water reservoir containing water for batch discharge to public sewer Waste Gas Streams - Boiler exhaust (Particles, CO, NOx) - Vent Scrubber (VOCs) - HVAC exhaust (Particles) Waste waters are normally from cleaning	In place

	c. flammability, lower and higher explosive limits, reactivity; d. presence of other substances that may affect the waste gas treatment system or plant safety (e.g. oxygen, nitrogen, water vapour, dust).	of equipment and floor. The pH, temperature, COD and Chloride characteristics of the waste water stream is measured in-house every time before discharge. Whilst the BOD on a quarterly basis. A full water characterisation is carried out anually. Every quarter the average results obtained is sent to WSC. The analysis are also done anually by WSC to issue the public sewer discharge permit to which we were always compliant. With regards to the waste gas streams the characteristics of the possible pollutatns listed in the IPPC permit are measured every 6 months by the maintenance contractor and anually as requested in the IPPC Permit.	
2. Monitoring			
BAT 3 **Monitoring of key process parameters**	For relevant emissions to water as identified by the inventory of waste water streams (see BAT 2), BAT is to monitor key process parameters (including continuous monitoring of waste water flow, pH and temperature) at key locations (e.g. influent to pre-treatment and influent to final treatment).	Medichem operates a batch discharge process. Temperature, pH, Chlorides and COD are measured prior to each discharge.	In place

<table>
<tr><td></td><td></td><td>Emission limits are as set and agreed with the Water Services Corporation as the stakeholder on waste water.</td><td></td></tr>
<tr><td>BAT 4

Monitoring of emissions to water</td><td>BAT is to monitor emissions to water in accordance with EN standards with at least the minimum frequency given below. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.
<table>
<tr><th>Substance/parameter</th><th>Standard(s)</th><th>Minimum monitoring frequency (1) (2)</th></tr>
<tr><td>Total organic carbon (TOC) (3)</td><td>EN 1484</td><td rowspan="6">Daily</td></tr>
<tr><td>Chemical oxygen demand (COD) (3)</td><td>No EN standard available</td></tr>
<tr><td>Total suspended solids (TSS)</td><td>EN 872</td></tr>
<tr><td>Total nitrogen (TN) (4)</td><td>EN 12260</td></tr>
<tr><td>Total inorganic nitrogen (N_{inorg}) (4)</td><td>Various EN standards available</td></tr>
<tr><td>Total phosphorus (TP)</td><td>Various EN standards available</td></tr>
</table>
<table>
<tr><th colspan="2">Substance/parameter</th><th>Standard(s)</th><th>Minimum monitoring frequency (1) (2)</th></tr>
<tr><td colspan="2">Adsorbable organically bound halogens (AOX)</td><td>EN ISO 9562</td><td rowspan="7">Monthly</td></tr>
<tr><td rowspan="6">Metals</td><td>Cr</td><td rowspan="6">Various EN standards available</td></tr>
<tr><td>Cu</td></tr>
<tr><td>Ni</td></tr>
<tr><td>Pb</td></tr>
<tr><td>Zn</td></tr>
<tr><td>Other relevant, if relevant</td></tr>
<tr><td rowspan="5">Toxicity (5)</td><td>Fish eggs (Danio rerio)</td><td>EN ISO 15088</td><td rowspan="5">To be decided based on a risk assessment, after an initial characterisation</td></tr>
<tr><td>Daphnia (Daphnia magna Straus)</td><td>EN ISO 6341</td></tr>
<tr><td>Luminescent bacteria (Vibrio fischeri)</td><td>EN ISO 11348-1
EN ISO 11348-2 or
EN ISO 11348-3</td></tr>
<tr><td>Duckweed (Lemna minor)</td><td>EN ISO 20079</td></tr>
<tr><td>Algae</td><td>EN ISO 8692
EN ISO 10253
EN ISO 10710</td></tr>
</table>
(1) Monitoring frequencies may be adapted if the data series clearly demonstrate a sufficient stability.
(2) The sampling point is located where the emission leaves the installation.
(3) TOC monitoring and COD monitoring are alternatives. TOC monitoring is the preferred option because it does not rely on the use of very toxic compounds.</td><td>This is not applicable to Medichem as we discharge to the public sewer and not to water</td><td>Not applicable</td></tr>
</table>

<table>
<tr><td></td><td colspan="2">[4]TN and N_{inorg} monitoring are alternatives.
[5] An appropriate combination of these methods can be used.</td><td></td><td></td></tr>
<tr><td>BAT 5

Monitoring of diffuse VOC emissions</td><td colspan="2">BAT is to periodically monitor diffuse VOC emissions to air from relevant sources by using an appropriate combination of the techniques I-III or, where large amounts of VOC are handled, all of the techniques I-III.

i. sniffing methods (e.g. with portable instruments according to EN 15446) associated with correlation curves for key equipment;

ii. optical gas imaging methods;

iii. calculation of emissions based on emissions factors, periodically validated (e.g. once every two years) by measurements.

Where large amounts of VOCs are handled, the screening and quantification of emissions from the installation by periodic campaigns with optical absorption-based techniques, such as Differential absorption light detection and ranging (DIAL) or Solar occultation flux (SOF), is a useful complementary technique to the techniques I to III.

(See also Section 6.2.)</td><td>Diffuse VOC emissions are monitored through a mass balance exercise performed annually as listed in Schedule IV of LN 12 of 3012 (SL549.79).</td><td>In place</td></tr>
<tr><td rowspan="3">BAT 6

Odour emission monitoring</td><td colspan="2">BAT is to periodically monitor odour emissions from relevant sources in accordance with EN standards.</td><td>No monitoring of odour emissions is carried out at Medichem since no odour emission nuisance has been substantiated.</td><td></td></tr>
<tr><td>Description</td><td>Emissions can be monitored by dynamic olfactometry according to EN 13725. Emission monitoring may be complemented by measurement/estimation of odour exposure or estimation of odour impact.</td><td>/</td><td></td></tr>
<tr><td>Applicability</td><td>The applicability is restricted to cases where odour nuisance can be expected or has been substantiated.</td><td>Not applicable</td><td></td></tr>
<tr><td colspan="4">3. Emissions to water</td><td></td></tr>
<tr><td colspan="4">3.1 Water usage and waste water generation</td><td></td></tr>
<tr><td>BAT 7

Reduction of volume and/or pollutant load of waste water streams</td><td colspan="2">In order to reduce the usage of water and the generation of waste water, BAT is to reduce the volume and/or pollutant load of waste water streams, to enhance the reuse of waste water within the production process and to recover and reuse raw materials.</td><td>The production of active pharmaceutical ingredients is governed by GMP regulations which as per GMP requirements only purified or Deionised water complying to strict specifications can be used in the manufacturing of APIs and FDF. Recycled</td><td>In place</td></tr>
</table>

		water could potentially contain microbes, chemicals or other contaminants that would make the water not complaint to these specifications. However solvent raw materials which can be easily distilled off and purified are reused wherever possible in the active pharmaceutical ingredient process to reduce the consumption of raw materials. Measures are taken as part of the Environmental Management System to reduce emissions to water and air, and reduce water usage as much as possible. Such actions are addressed regularly through the Environmental Management Programme (Objectives and Targets). Such actions include, but are not limited to: i. best practice in process design to ensure the use of substances with the least effect on the environment, whenever technically possible and feasible; i. proces improvements to improve process	

			yield and reduce the amount of aqueous waste generated; i. best practice abatement techniques; v. control/reduction of COD through an on-site physical-chemical waste water treatment plant. Process design in itself includes document information with respect to the characteristics of all waste streams. This is a critical step in the R&D process and teams of people are allocated to analyse all processes and come up with the least environmentally damaging solutions, whenever the chemical synthesis process permits.	
3.2. Waste water collection and segregation				
BAT 8 **Segregation of contaminated waste streams**	In order to prevent the contamination of uncontaminated water and to reduce emissions to water, BAT is to segregate uncontaminated waste water streams from waste water streams that require treatment.		The external storage and utilities areas at Medichem are connected to the water treatment plant due to the nature of the chemicals and materials stored. It is not possible to separate uncontaminated rainwater from the contaminated waste water collection system	
	Applicability	The segregation of uncontaminated rainwater may not be applicable in the case of existing waste water collection systems.	Not Applicable	
BAT 9	In order to prevent uncontrolled emissions to water, BAT is to provide an appropriate buffer storage capacity for waste water incurred during other than normal operating conditions based on a risk assessment (taking into		The external storage and utilities areas at Medichem	

<table>
<tr><td rowspan="2">Buffer storage capacity</td><td colspan="2">account e.g. the nature of the pollutant, the effects on further treatment, and the receiving environment), and to take appropriate further measures (e.g. control, treat, reuse).</td><td>are connected to the water treatment plant due to the nature of the chemicals and materials stored. It is not possible to separate uncontaminated rainwater from the contaminated waste water collection system

The water from the production process area is first collected in a sump before being mixed with the other waste water so in case of any emergency this can be collected rather than entering the waste water treatment system.</td><td></td></tr>
<tr><td>Applicability</td><td>The interim storage of contaminated rainwater requires segregation, which may not be applicable in the case of existing waste water collection systems.</td><td>Not applicable</td><td></td></tr>
<tr><td colspan="4">3.3 Waste water treatment</td><td></td></tr>
<tr><td>BAT 10

Integrated waste water management</td><td colspan="2">In order to reduce emissions to water, BAT is to use an integrated waste water management and treatment strategy that includes an appropriate combination of the techniques in the priority order given below.

<table>
<tr><th colspan="2">Technique</th><th>Description</th></tr>
<tr><td>a)</td><td>Process-integrated techniques [(1)]</td><td>Techniques to prevent or reduce the generation of water pollutants.</td></tr>
<tr><td>b)</td><td>Recovery of pollutants at source [(1)]</td><td>Techniques to recover pollutants prior to their discharge to the waste water collection system.</td></tr>
<tr><td>c)</td><td>Waste water pre-treatment [(1)] [(2)]</td><td>Techniques to abate pollutants before the final waste water treatment.

Pre-treatment can be carried out at the source or in combined streams</td></tr>
<tr><td>d)</td><td>Final waste water treatment [(3)]</td><td>Final waste water treatment by, for example, preliminary and primary treatment, biological treatment, nitrogen removal, phosphorus removal and/or final solids removal techniques before discharge to a receiving water body.</td></tr>
</table>

[(1)] These techniques are further described and defined in other BAT conclusions for the chemical industry.
[(2)] See BAT 11.
[(3)] See BAT 12.</td><td>Process design in itself includes document information with respect to the characteristics of all waste streams. This is a critical step in the R&D process and teams of people are allocated to analyse all processes and come up with the least environmentally damaging solutions, whenever the chemical synthesis process permits.

Any waste water which enters the water treatment plant undergo neutralisation and physical treatment before final discharge.</td><td>In place</td></tr>
</table>

	Description	The integrated waste water management and treatment strategy is based on the inventory of waste water streams (see BAT 2).		
	BAT-associated emission levels (BAT-AELs):	see Section 3.4		
BAT 11 **Pre-treatment of waste water**	In order to reduce emissions to water, BAT is to pre-treat waste water that contains pollutants that cannot be dealt with adequately during final waste water treatment by using appropriate techniques. Description: Waste water pre-treatment is carried out as part of an integrated waste water management and treatment strategy (see BAT 10) and is generally necessary to: — protect the final waste water treatment plant (e.g. protection of a biological treatment plant against inhibitory or toxic compounds); — remove compounds that are insufficiently abated during final treatment (e.g. toxic compounds, poorly/non-biodegradable organic compounds, organic compounds that are present in high concentrations, or metals during biological treatment); — remove compounds that are otherwise stripped to air from the collection system or during final treatment (e.g. volatile halogenated organic compounds, benzene); — remove compounds that have other negative effects (e.g. corrosion of equipment; unwanted reaction with other substances; contamination of waste water sludge). In general, pre-treatment is carried out as close as possible to the source in order to avoid dilution, in particular for metals. Sometimes, waste water streams with appropriate characteristics can be segregated and collected in order to undergo a dedicated combined pre-treatment.		Untreatable aqueous wastes are collected during the manufacturing process and are not allowed to reach the waste water treatment plant. Treatable waste water is directed to the waste water treatment plant where it is treated prior to being discharged to the public sewer. As can be expected out of a physical-chemical waste water treatment plant, the following processes take place: - pH correction - Coagulation - Flocculation - Sedimentation - Filtration at high pressure - Sludge formation and separate disposal The chemical characteristics of the waste water discharged to the public sewer are as agreed with the Water Services Corporation as the operator of the receiving municpal waste water treatment plant. Other solvent based waste is always exported for recovery. Heavy Metals are not used in the production of active	In place

<table>
<tr><td></td><td></td><td>pharmaceutical ingredients. Catalyst used in process is sent for recovery.

The annual water analysis of the waste water is always in line with the WSC sewer discharge permit.</td><td></td></tr>
<tr><td>BAT 12

Final waste water treatment techniques</td><td>In order to reduce emissions to water, BAT is to use an appropriate combination of final waste water treatment techniques.

Description: Final waste water treatment is carried out as part of an integrated waste water management and treatment strategy (see BAT 10).

Appropriate final waste water treatment techniques, depending on the pollutant, include:
<table>
<tr><th colspan="2">Technique</th><th>Typical pollutants abated</th><th>Applicability</th></tr>
<tr><td colspan="4">Preliminary and primary treatment</td></tr>
<tr><td>a)</td><td>Equalisation</td><td>All pollutants</td><td rowspan="3">Generally applicable.</td></tr>
<tr><td>b)</td><td>Neutralisation</td><td>Acids, alkalis</td></tr>
<tr><td>c)</td><td>Physical separation, e.g. screens, sieves, grit separators, grease separators or primary settlement tanks</td><td>Suspended solids, oil/grease</td></tr>
<tr><td colspan="4">Biological treatment (secondary treatment), e.x.</td></tr>
<tr><td>d)</td><td>Activated sludge process</td><td rowspan="2">Biodegradable organic compounds</td><td rowspan="2">Generally applicable.</td></tr>
<tr><td>e)</td><td>Membrane bioreactor</td></tr>
<tr><td colspan="4">Nitrogen removal</td></tr>
<tr><td>f)</td><td>Nitrification/denitrification</td><td>Total nitrogen, ammonia</td><td>Nitrification may not be applicable in case of high chloride concentrations (i.e. around 10 g/l) and provided that the reduction of the chloride concentration prior to nitrification would not be justified by the environmental benefits. Not applicable when the final treatment does not include a biological treatment.</td></tr>
<tr><td colspan="4">Phosphorus removal</td></tr>
<tr><td>g)</td><td>Chemical precipitation</td><td>Phosphorus</td><td>Generally applicable</td></tr>
</table></td><td>Waste Water treatment is mainly composed of homogenisation, neutralisation of the water and final solid removal by the use of coagulant and flocculant. No biological treatment is available.

The sludge collected is also treated for the removal of water before disposal.

Tables 1, 2 and 3 are not applicable to Medichem as the waste water is discharged to the public sewer and not to a water body.</td><td>In place</td></tr>
</table>

Final Solids removal			
h)	Coagulation and flocculation	Suspended solids	Generally applicable.
i)	Sedimentation		
J)	Filtration (e.g. sand filtration, microfiltration, ultrafiltration)		
k)	Flotation		

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

3.4. *BAT-associated emission levels for emissions to water*

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

(i) the activities specified in Section 4 of Annex I to Directive 2010/75/EU;

(ii) independently operated waste water treatment plants specified in Section 6.11 of Annex I to Directive 2010/75/EU provided that the main pollutant load originates from activities specified in Section 4 of Annex I to Directive 2010/75/EU;

(iii) The combined treatment of waste water from different origins provided that the main pollutant load originates from activities specified in Section 4 of Annex I to Directive 2010/75/EU.

The BAT-AELs apply at the point where the emission leaves the installation.

Table 1: **BAT-AELs for direct emissions of TOC, COD and TSS to a receiving water body**

Parameter	BAT-AEL (yearly average)	Conditions
Total organic carbon (TOC) (1) (2)	10-33 mg/l (3) (4) (5) (6)	The BAT-AEL applies if the emission exceeds 3,3 t/yr.
Chemical oxygen demand (COD) (1) (2)	30-100 mg/l (3) (4) (5) (6)	The BAT-AEL applies if the emission exceeds 10 t/yr
Total suspended solids (TSS)	5,0-35 mg/l (7) (8)	The BAT-AEL applies if the emission exceeds 3,5 t/yr.

(1) No BAT-AEL applies for Biochemical oxygen demand (BOD). As an indication, the yearly average BOD_5 level in the effluent from a biological waste water treatment plant will generally be ≤ 20 mg/l.
(2) Either the BAT-AEL for TOC or the BAT-AEL for COD applies. TOC is the preferred option because its monitoring does not rely on the use of very toxic compounds.

(3) The lower end of the range is typically achieved when few tributary waste water streams contain organic compounds and/or the waste water mostly contains easily biodegradable organic compounds.
(4) The upper end of the range may be up to 100 mg/l for TOC or up to 300 mg/l for COD, both as yearly averages, if both of the fol- lowing conditions are fulfilled:
— Condition A: Abatement efficiency ≥ 90 % as a yearly average (including both pre-treatment and final treatment).
— Condition B: If a biological treatment is used, at least one of the following criteria is met:
— A low-loaded biological treatment step is used (i.e. ≤ 0,25 kg COD/kg of organic dry matter of sludge). This implies that the BOD5 level in the effluent is ≤ 20 mg/l.
— Nitrification is used.
(5) The upper end of the range may not apply if all of the following conditions are fulfilled:
— Condition A: Abatement efficiency ≥ 95 % as a yearly average (including both pretreatment and final treatment).
— Condition B: same as Condition B in footnote (4).
— Condition C: The influent to the final waste water treatment shows the following characteristics: TOC > 2 g/l (or COD > 6 g/l) as a yearly average and a high proportion of refractory organic compounds.
(6) The upper end of the range may not apply when the main pollutant load originates from the production of methylcellulose.
(7) The lower end of the range is typically achieved when using filtration (e.g. sand filtration, microfiltration, ultrafiltration, membrane bioreactor), while the upper end of the range is typically achieved when using sedimentation only.
(8) This BAT-AEL may not apply when the main pollutant load originates from the production of soda ash via the Solvay process or from the production of titanium dioxide.

***Table 2:* BAT-AELs for direct emissions of nutrients to a receiving water body**

Parameter	BAT-AEL (yearly average)	Conditions
Total nitrogen (TN) (1)	5,0-25 mg/l (2) (3)	The BAT-AEL applies if the emission exceeds 2,5 t/yr
Total inorganic nitrogen (N_{inorg}) (1)	5,0-20 mg/l (2) (3)	The BAT-AEL applies if the emission exceeds 2,0 t/yr.
Total phosphorus (TP)	0,50-3,0 mg/l (4)	The BAT-AEL applies if the emission exceeds 300 kg/yr.

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

***Table 3:* BAT-AELs for direct emission of AOX and metals to a receiving water body**

Parameter	BAT-AEL (yearly average)	Conditions
Adsorbable organically bound halogens (AOX)	0,20-1,0 mg/l (1) (2)	The BAT-AEL applies if the emission exceeds 100 kg/yr.

<table>
<tr>
<td></td>
<td>
<table>
<tr><td>Chromium (expressed as Cr)</td><td>5,0-25 µg/l (3) (4) (5) (6)</td><td>The BAT-AEL applies if the emission exceeds 2,5 kg/yr.</td></tr>
<tr><td>Copper (expressed as Cu)</td><td>5,0-50 µg/l (3) (4) (5) (7)</td><td>The BAT-AEL applies if the emission exceeds 5,0 kg/yr.</td></tr>
<tr><td>Nickel (expressed as Ni)</td><td>5,0-50 µg/l (3) (4) (5)</td><td>The BAT-AEL applies if the emission exceeds 5,0 kg/yr.</td></tr>
<tr><td>Zinc (expressed as Zn)</td><td>20-300 µg/l (3) (4) (5) (8)</td><td>The BAT-AEL applies if the emission exceeds 30 kg/yr</td></tr>
</table>

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

The associated monitoring is in BAT 4.
</td>
<td></td>
<td></td>
</tr>
<tr><td colspan="3">4. Waste</td><td></td></tr>
<tr>
<td>BAT 13

Waste Management Plan</td>
<td>In order to prevent or, where this is not practicable, to reduce the quantity of waste being sent for disposal, BAT is to set up and implement a waste management plan as part of the environmental management system (see BAT 1) that, in order of priority, ensures that waste is prevented, prepared for reuse, recycled or otherwise recovered.</td>
<td>Waste Management is an essential part of Medichem’s EMS as it is one of its significant environmental aspects. An important element of the waste management at Medichem is the waste hierarchy in which the preferred action for waste is always to reduce the amount of waste generated first and foremost.</td>
<td></td>
</tr>
<tr>
<td>BAT 14

Reduction of volume of waste water sludge</td>
<td>In order to reduce the volume of waste water sludge requiring further treatment or disposal, and to reduce its potential environmental impact, BAT is to use one or a combination of the techniques given below.
<table>
<tr><th>Technique</th><th>Description</th><th>Applicability</th></tr>
</table>
</td>
<td>The production of waste water sludge is kept to an absolute minimum through the final stage of the waste</td>
<td>In place</td>
</tr>
</table>

	a) Conditioning	Chemical conditioning (i.e. adding coagulants and/or flocculants) or thermal conditioning (i.e. heating) to improve the conditions during sludge thickening/dewatering.	Not applicable to inorganic sludges. The necessity for conditioning depends on the sludge properties and on the thickening/dewatering equipment used.	water treatment plant, which incorporates a high pressure press filter operating at 200 bar. Water is constantly pushed out at high pressure through a series of mesh filters. The press filter is opened and emptied and the dried filter cake is then sent for disposal.	
	b) Thickening/dewatering	Thickening can be carried out by sedimentation, centrifugation, flotation, gravity belts, or rotary drums. Dewatering can be carried out by belt filter presses or plate filter presses.	Generally applicable.		
	c)Stabilistaion	Sludge stabilisation includes chemical treatment, thermal treatment, aerobic digestion, or anaerobic digestion.	Not applicable to inorganic sludges. Not applicable for short-term handling before final treatment.		
	d) Drying	Sludge is dried by direct or indirect contact with a heat source.	Not applicable to cases where waste heat is not available or cannot be used.		
5. Emissions to air					
5.1. Waste gas collection					
BAT 15 **Treatment of air emissions**	In order to facilitate the recovery of compounds and the reduction of emissions to air, BAT is to enclose the emission sources and to treat the emissions, where possible.			Emissions to air are limited to emissions from HVAC's (particles), vent srucbber (VOCs) and LPG boiler (CO, NOx and particles). HEPA filters are installed at HVAC exhaust. The solvent storage tanks are vented to atmosphere so that there is no pressure build up inside the storage tanks. Each of this event passes through a condenser cooled with chilled water so that any vapours rising from the solvents inside the storage will condensate before exiting into the atmosphere and drain back into the storage tank.	In place
	Applicability	The applicability may be restricted by concerns on operability (access to equipment), safety (avoiding concentrations close to the lower explosive limit) and health (where operator access is required inside the enclosure).			
5.2. Waste gas treatment					

<table>
<tr>
<td>BAT 16

Integrated waste gas management plan</td>
<td>In order to reduce emissions to air, BAT is to use an integrated waste gas management and treatment strategy that includes process-integrated and waste gas treatment techniques.

Description: The integrated waste gas management and treatment strategy is based on the inventory of waste gas streams (see BAT 2) giving priority to process-integrated techniques.</td>
<td>Environmental impacts derived by the processes carried out at Medichem are analysed at the design and development process to ensure that the best available techniques are employed in the design processes so as to make sure that environmental impacts are minimized as reasonable practical.</td>
<td>In place</td>
</tr>
<tr>
<td colspan="3">5.3. Flaring</td>
<td></td>
</tr>
<tr>
<td>BAT 17

Usage of flaring solely for safety reasons</td>
<td>In order to prevent emissions to air from flares, BAT is to use flaring only for safety reasons or non-routine operational conditions (e.g. start-ups, shutdowns) by using one or both of the techniques given below.

<table>
<tr><th colspan="2">Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>a)</td><td>Correct plant design</td><td>This includes the provision of a gas recovery system with sufficient capacity and the use of high-integrity relief valves.</td><td>Generally applicable to new plants. Gas recovery systems may be retro-fitted in existing plants.</td></tr>
<tr><td>b)</td><td>Plant management</td><td>This includes balancing the fuel gas system and using advanced process control.</td><td>Generally applicable.</td></tr>
</table>
</td>
<td>Not applicable – Flaring is not used at the installation</td>
<td></td>
</tr>
<tr>
<td>BAT 18

Flare management</td>
<td>In order to reduce emissions to air from flares when flaring is unavoidable, BAT is to use one or both of the techniques given below.

<table>
<tr><th></th><th>Technique</th><th>Description</th><th>Applicability</th></tr>
<tr><td>a)</td><td>Correct design of flaring devices</td><td>Optimisation of height, pressure, assistance by steam, air or gas, type of flare tips (either enclosed or shielded), etc., aimed to enable smokeless and reliable operation and to ensure the efficient combustion of ex- cess gases.</td><td>Applicable to new flares. In existing plants, applicability may be restricted due to e.g. maintenance time avail- ability during the turnaround of the plant.</td></tr>
</table>
</td>
<td>Not applicable- Flaring is not used at the installation</td>
<td></td>
</tr>
</table>

<table>
<tr><td></td><td>
<table>
<tr><td>b)</td><td>Monitoring and recording as part of flare management</td><td>Continuous monitoring of the gas sent to flaring, measurements of gas flow and estimations of other parameters (e.g. composition, heat con- tent, ratio of assistance, velocity, purge gas flow rate, pollutant emissions (e.g. NOX, CO, hydrocarbons, noise)). The recording of flaring events usually includes the estimated/ measured flare gas composition, the estimated/measured flare gas quantity and the duration of operation. The recording allows for the quantification of emissions and the potential prevention of future flaring events.</td><td>Generally applicable.</td></tr>
</table>
</td><td></td><td></td></tr>
<tr><td colspan="3">5.4 Diffuse VOC emissions</td><td></td></tr>
<tr><td>BAT 19

Mitigation measures to reduce diffuse VOC emission to air</td><td>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.
<table>
<tr><th colspan="2">Technique</th><th>Applicability</th></tr>
<tr><td colspan="3">Techniques related to plant design</td></tr>
<tr><td>a)</td><td>Limit the number of potential emissions sources</td><td rowspan="4">Applicability may be restricted in the case of existing plants due to operability requirements.</td></tr>
<tr><td>b)</td><td>Maximise process-inherent containment features</td></tr>
<tr><td>c)</td><td>Select high-integrity equipment (see the description in Section 6.2)</td></tr>
<tr><td>d)</td><td>Facilitate maintenance activities by ensuring access to potentially leaky equipment</td></tr>
<tr><td colspan="3">Techniques related to plant/equipment constructions, assembly and commissioning</td></tr>
<tr><td>e)</td><td>Ensure well-defined and comprehensive procedures for plant/equipment construction and assembly. This includes using the designed gasket stress for flanged joint assembly (see the description in Section 6.2)</td><td rowspan="2">Generally applicable.</td></tr>
<tr><td>f)</td><td>Ensure robust plant/equipment commissioning and handover procedures in line with the design requirements</td></tr>
<tr><td colspan="3">Techniques related to plant operation</td></tr>
<tr><td>g)</td><td>Ensure good maintenance and timely replacement of equipment</td><td rowspan="3">Generally applicable.</td></tr>
<tr><td>h)</td><td>Use a risk-based leak detection and repair (LDAR) programme (see the description in Section 6.2)</td></tr>
<tr><td>i)</td><td>As far as it is reasonable, prevent diffuse VOC emissions, collect them at source, and treat them</td></tr>
</table>
The associated monitoring is in BAT 5.</td><td>Diffuse VOC emissions may only be present from the storage facility in the external warehouse.

All equipment inside the plant is installed as per design requirement and periodically maintained and requalified every 5 years.

With regards to prevention of VOCs emissions, the techniques related to plant operation are applicable in view that scheduled preventive maintenance is in place for plant equipment. VOC emissions from plant all pass through scrubber before release.

Tanks for storage of fresh solvent and solvent based waste are also in place. These tanks are vented to atmosphere so that there is no pressure build up inside the storage tanks. Each of this event passes through a condenser cooled with chilled water so that any vapours rising from the solvents inside the storage</td><td></td></tr>
</table>

<table>
<tr><td></td><td colspan="2"></td><td>will condensate before exiting into the atmosphere and drain back into the storage tank</td><td></td></tr>
<tr><td colspan="4">5.5. Odour emissions</td><td></td></tr>
<tr><td rowspan="2">BAT 20

Odour Management Plan</td><td colspan="2">In order to prevent or, where that is not practicable, to reduce odour emissions, BAT is to set up, implement and regularly review an odour management plan, as part of the environmental management system (see BAT 1), that includes all of the following elements:

i. a protocol containing appropriate actions and timelines;

ii. a protocol for conducting odour monitoring;

iii. a protocol for response to identified odour incidents;

iv. an odour prevention and reduction programme designed to identify the source(s); to measure/estimate odour exposure; to characterise the contributions of the sources; and to implement prevention and/or reduction measures.

The associated monitoring is in BAT 6.</td><td>Not applicable since no odour nuisance has ever been substantiated.</td><td></td></tr>
<tr><td>Applicability</td><td>The applicability is restricted to cases where odour nuisance can be expected or has been substantiated</td><td></td><td></td></tr>
<tr><td>BAT 21

Mitigation measures for the reduction of odours from waste water collection/treatment and from sludge treatment</td><td colspan="2">In order to prevent or, where that is not practicable, to reduce odour emissions from waste water collection and treatment and from sludge treatment, 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>Minimise residence times</td><td>Minimise the residence time of waste water and sludge in collection and storage systems, in particular under anaerobic conditions.</td><td>Applicability may be restricted in the case of existing collection and storage systems.</td></tr>
<tr><td>b)</td><td>Chemical treatment</td><td>Use chemicals to destroy or to reduce the formation of odorous compounds (e.g. oxidation or precipitation of hydrogen sulphide).</td><td>Generally applicable.</td></tr>
<tr><td>c)</td><td>Optimise aerobic treatment</td><td>This can include:
(i) controlling the oxygen content;
(ii) frequent maintenance of the aeration system;
(iii) use of pure oxygen;
(iv) Removal of scum in tanks.</td><td>Generally applicable.</td></tr>
<tr><td>d)</td><td>Enclosure</td><td>Cover or enclose facilities for collecting and treating waste water and sludge to collect the odorous waste gas for further treatment.</td><td>Generally applicable.</td></tr>
<tr><td>e)</td><td>End-of-pipe treatment</td><td>This can include:
(i) biological treatment;
(ii) Thermal oxidation.</td><td>Biological treatment is only applicable to compounds that are easily soluble in water and readily bioeliminable.</td></tr>
</table></td><td>Applicable techniques to reduce odours from waste water treatment is to reduce as much as possible storage residence times. In addition an agitator at both the homogenization tank and final water reservoir is present to aerate the wate and reduce anaerobic conditions.</td><td>In place</td></tr>
</table>

<table>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">5.6. Noise emissions</td><td></td></tr>
<tr><td rowspan="2">BAT 22

Noise Management Plan</td><td colspan="2">In order to prevent or, where that is not practicable, to reduce noise emissions, BAT is to set up and implement a noise management plan, as part of the environmental management system (see BAT 1), that includes all of the following elements:

(i) a protocol containing appropriate actions and timelines;

(ii) a protocol for conducting noise monitoring;

(iii) a protocol for response to identified noise incidents;

(iv) a noise prevention and reduction programme designed to identify the source(s), to measure/estimate noise exposure, to characterise the contributions of the sources and to implement prevention and/or reduction measures.</td><td>A comprehensive noise monitoring exercise was carried out in 2016 (Reference: En-Sure Ltd, 2016. IP 002/05 – Noise Monitoring Study at Medichem Manufacturing (Malta) Ltd, Hal Far Industrial Estate, Hal Far. Noise Monitoring Study (Version number: 1) San Gwann, March, 2016; v+15+Appendices), and was submitted to ERA as part of the Annual Environmental Report of 2017 (basis year 2016).

The study showed that noise emissions from the installation are at times much less than those present in the surrounding environment.</td><td></td></tr>
<tr><td>Applicability</td><td>The applicability is restricted to cases where noise nuisance can be expected or has been substantiated.</td><td></td><td></td></tr>
<tr><td>BAT 23

Mitigations of Noise Emissions</td><td colspan="2">In order to prevent or, where that is not practicable, to reduce noise emissions, BAT is to use one or a combination of the techniques given below.

<table>
<tr><th colspan="2">Techniques</th><th>Description</th><th>Applicability</th></tr>
<tr><td>a)</td><td>Appropriate location of equipment and buildings</td><td>Increasing the distance between the emitter and the receiver and using buildings as noise screens.</td><td>For existing plants, the relocation of equipment may be restricted by a lack of space or excessive costs.</td></tr>
<tr><td>b)</td><td>Operational measures</td><td>This includes:
i. improved inspection and maintenance of equipment;
ii. closing of doors and windows of enclosed areas, if possible;</td><td>Generally applicable.</td></tr>
</table>
</td><td>A comprehensive noise monitoring exercise was carried out in 2016 (Reference: En-Sure Ltd, 2016. IP 002/05 – Noise Monitoring Study at Medichem Manufacturing (Malta) Ltd, Hal Far Industrial Estate, Hal Far. Noise Monitoring Study (Version number: 1) San Gwann, March, 2016;</td><td></td></tr>
</table>

			iii. equipment operation by experienced staff; iv. avoidance of noisy activities at night, if possible; v. provisions for noise control during maintenance activities.		v+15+Appendices), and was submitted to ERA as part of the Annual Environmental Report of 2017 (basis year 2016). The study showed that noise emissions from the installation are at times much less than those present in the surrounding environment.	
	c)	Low-noise equipment	This includes low-noise compressors, pumps and flares.	Applicable only when the equipment is new or replaced.		
	d)	Noise-control equipment	This includes: (i) noise-reducers; (ii) equipment insulation; (iii) enclosure of noisy equipment; (iv) soundproofing of buildings.	Applicability may be restricted due to space requirements (for existing plants), health, and safety issues.		
	e)	Noise abatement	Inserting obstacles between emitters and receivers (e.g. protection walls, embankments and buildings).	Applicable only to existing plants; since the design of new plants should make this technique unnecessary. For existing plants, the insertion of obstacles may be restricted by a lack of space.		

6. Descriptions of techniques	
6.1. *Waste water treatment*	
Technique	***Description***
Activated sludge process	The biological oxidation of dissolved organic substances with oxygen using the metabolism of microorganisms. In the presence of dissolved oxygen (injected as air or pure oxygen) the organic components are mineralised into carbon dioxide and water or are transformed into other metabolites and biomass (i.e. the activated sludge). The microorganisms are maintained in suspension in the waste water and the whole mixture is mechanically aerated. The activated sludge mixture is sent to a separation facility from which the sludge is recycled to the aeration tank.
Nitrification/denitrification	A two-step process that is typically incorporated into biological waste water treatment plants. The first step is the aerobic nitrification where microorganisms oxidise ammonium (NH_4^+) to the intermediate nitrite (NO_2^-), which is then further oxidised to nitrate (NO_3^-). In the subsequent anoxic denitrification step, microorganisms chemically reduce nitrate to nitrogen gas.
Chemical precipitation	The conversion of dissolved pollutants into an insoluble compound by adding chemi-cal precipitants. The solid precipitates formed are subsequently separated by sedimen-tation, air flotation or filtration. If necessary, this may be followed by microfiltration or ultra filtration. Multivalent metal ions (e.g. calcium, aluminium, iron) are used for phosphorus precipitation.
Coagulation and flocculation	Coagulation and flocculation are used to separate suspended solids from waste water and are often carried out in successive steps. Coagulation is carried out by adding coagulants with charges opposite to those of the suspended solids. Flocculation is carried out by adding polymers, so that collisions of microfloc particles cause them to bond to produce larger flocs.
Equalisation	Balancing of flows and pollutant loads at the inlet of the final waste water treatment by using central tanks. Equalisation may be decentralised or carried out using other management techniques.
Filtration	The separation of solids from waste water by passing them through a porous medium e.g. sand filtration, microfiltration and ultra-filtration.
Flotation	The separation of solid or liquid particles from waste water by attaching them to fine gas bubbles, usually air. The buoyant particles accumulate at the water surface and are collected with skimmers.
Membrane bioreactor	A combination of activated sludge treatment and membrane filtration. Two variants are used: a) an external recirculation loop between the activated sludge tank and the membrane module; and b) immersion of the membrane module into the aerated activated sludge tank, where the effluent is filtered through a hollow fibre membrane, the biomass remaining in the tank (this variant is less energy-consuming and results in more compact plants).
Neutralisation	The adjustment of the pH of waste water to a neutral level (approximately 7) by the addition of chemicals. Sodium hydroxide (NaOH) or calcium hydroxide ($Ca(OH)_2$) is generally used to increase the pH; whereas, sulphuric acid (H_2SO_4), hydrochloric acid (HCl) or carbon dioxide (CO_2) is generally used to decrease the pH. The precipitation of some substances may occur during neutralisation.
Sedimentation	The separation of suspended particles and suspended material by gravitational settling.

6.2. *Diffuse VOC emissions*	
Technique	**Description**
High-integrity equipment	High-integrity equipment includes: — valves with double packing seals; — magnetically driven pumps/compressors/agitators; — pumps/compressors/agitators fitted with mechanical seals instead of packing; — high-integrity gaskets (such as spiral wound, ring joints) for critical applications; — corrosion-resistant equipment.
Leak detection and repair (LDAR) programme	A structured approach to reduce fugitive VOC emissions by detection and subsequent repair or replacement of leaking components. Currently, sniffing (described by EN 15446) and optical gas imaging methods are available for the identification of leaks.

	Sniffing method: The first step is the detection using hand-held VOC analysers measuring the concentration adjacent to the equipment (e.g. by using flame ionisation or photo-ionisation). The second step consists of bagging the component to carry out a direct measurement at the source of emission. This second step is sometimes replaced by mathematical correlation curves derived from statistical results obtained from a large number of previous measurements made on similar components. **Optical gas imaging methods**: Optical imaging uses small lightweight hand-held cameras which enable the visualisation of gas leaks in real time, so that they appear as 'smoke' on a video recorder together with the normal image of the component concerned, to easily and rapidly locate significant VOC leaks. Active systems produce an image with a back-scattered infrared laser light reflected on the component and its surroundings. Passive systems are based on the natural infrared radiation of the equipment and its surroundings
Thermal oxidation	The oxidation of combustible gases and odorants in a waste gas stream by heating the mixture of contaminants with air or oxygen to above its auto-ignition point in a combustion chamber and maintaining it at a high temperature long enough to complete its combustion to carbon dioxide and water. Thermal oxidation is also referred to as 'incineration', 'thermal incineration' or 'oxidative combustion'.
Using the designed gasket stress for flanged joint assembly	This includes: (i) obtaining a certified high quality gasket, e.g. according to EN 13555; (ii) calculating the highest possible bolt load, e.g. according to EN 1591-1; (iii) obtaining a qualified flange-assembling equipment; (iv) supervision of the bolt tightening by a qualified fitter.
VOC diffuse emissions monitoring	Sniffing and optical gas imaging methods are described under leak detection and repair programme. Full screening and quantification of emissions from the installation can be undertaken with an appropriate combination of complementary methods, e.g. Solar occultation flux (SOF) or Differential absorption LIDAR (DIAL) campaigns. These results can be used for trend evaluation in time, cross-checking and updating/validation of the on- going LDAR programme. **Solar occultation flux (SOF)**: The technique is based on the recording and spectrometric Fourier Transform analysis of a broadband infra-red or ultraviolet/visible sunlight spectra along a given geographical itinerary, crossing the wind direction and cutting through VOC plumes. **Differential absorption LIDAR (DIAL)**: This is a laser-based technique using differential absorption LIDAR (light detection and ranging), which is the optical analogue of radio wave-based RADAR. The technique relies on the back-scattering of laser beam pulses by atmospheric aerosols, and the analysis of spectral properties of the returned light collected with a telescope.