Sterling Chemical Malta Ltd

BEST AVAILABLE TECHNOLOGIES

PROJECT DESCRIPTION

ANNEX B.2.2-A3

Annex I: Comparison of the processes at Facility with the BREF for Manufacture of Organic Fine Chemicals (published August 2006).

Part 1. Prevention and minimisation of environmental impact

1.1 Prevention of environmental impact

Aspect of BAT	BAT	Status at Installation
Integration of environmental, health and safety considerations into process development	The likelihood of successful prevention and minimisation of the environmental impact of a process increases if environmental, health and safety issues are considered early in the process development chain. This is even more the case where production processes require validation procedures under other regulations, such as cGMP or approval by the European Medicine Evaluation Agency (EMEA), the United States Food and Drug Administration (FDA) or other applicable medicine approval authorities in the case of API production. In such cases, retrofitting of a process would cause long and costly revalidation processes. The aim is to design out environmental issues and to provide an auditable trail for the assessment and consideration of environmental issues. However, often a compromise has to be found or one aspect has to be favoured over another. Examples for alternative synthesis and reaction conditions are given in Section 4.1.4. In reality, management and treatment of a wide variety of unavoidable waste streams remain crucial tasks on a multipurpose site	In order to answer to this delicate issue, all the company know-how, resulting from 30 years of work in the chemical-pharmaceutical industry has been transferred. Furthermore, from 3 years ago the Italian head office is equipped with an environmental, health and safety management system which completes and enhances the quality management system, written in compliance with the GMP regulations and approved by FDA, AIFA (Italian Medicines Agency), and by the Medicine Authority that recently certified the plant as respectful of the API Good Manufacturing international standards. The HSE management system is ISO 14001 certified (as far as the environment) and OH SAS 18001 certified (as far as health and safety). This system has already been implemented in Malta for the Research and Development laboratory and the pilot-plant; furthermore all choices concerning the project, plant, machinery and suppliers strictly follow what is required by the procedures and operative instructions. In order to certify the system for the Maltese plant, both procedures and the plant must be

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	(see next Section "Management and treatment of waste streams").	operative at least from 6 months.
	BAT is to provide an auditable trail for the integration of environmental, health and safety considerations into process development (see BREF Section 4.1.2). BAT is to develop new processes as follows (see BREF Section 4.1.1): a) to improve process design to maximise the incorporation of all the input materials used into the final product (see, e.g. BREF Sections 4.1.4.3 and 4.1.4.8) b) to use substances that possess little or no toxicity to human health and the environment. Substances should be chosen in order to minimise the potential for accidents, releases, explosions and fires (e.g for solvent selection, see BREF Section 4.1.3). c) to avoid the use of auxiliary substances (e.g. solvents, separation agents, etc. see e.g. BREF Section 4.1.4.2) d) to minimise energy requirements in recognition of the associated environmental and economic impacts. Reactions at ambient temperatures and pressures	All raw materials used are chosen by carefully studying the impact that they could have in terms of environment, health and safety. For example, all materials that can be used in ATEX areas have been chosen for the plant. Reactors are made of AISI stainless steel and all materials are CE certified. In fact, according to the management procedure in force, each new piece of equipment or machinery must be checked by the HSE office in order to ensure the best solution (for example ATEX or CE certifications, closed systems whose security is guaranteed by the producer, or emergency and warning levels for the environment and guarantees of the maximum energy efficiency). Even those raw materials that are part of the chemical synthesis need to be authorized, and some of them cannot be admitted, such as the carcinogenic materials or those that could lead to deformations for newborn babies. Some raw materials will be recovered and re-used in the same process. For example, solvents such as acetone, methanol, dichloromethane and toluene could be reused in other phases such as the plant cleaning, re-distillation or a recrystallization of the product. Check all procedures and operative instructions attached to the main document (Annex B.2.1-A2). However, the

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	should be preferred e) to use renewable feedstock rather than depleting, wherever technically and economically practicable f) to avoid unnecessary derivatisation (e.g. blocking or protection groups) g) to apply catalytic reagents, which are typically superior to stoichiometric reagents (see, e.g. BREF Sections 4.1.4.4 and 4.1.4.5).	Research and Development department is constantly working with the Production department for improving yields and finding better solutions to minimize costs and the consumption of energy and hazardous substances. The purpose is to reduce the amount of waste produced by recovering the waste that can be reused. As far as the plant, the energy saving (which is a very important issue for the Company), is performed with thermal insulated pipes and
Process safety and prevention of runaway reactions	Safety assessment is introduced in this document as it can help to prevent accidents with potentially significant environmental impacts. However, this subject could not be entirely dealt with in this document. The field of process safety is much wider than presented here. Section BREF 4.1.6.3 contains a list of references for additional information.	The company developed a risk assessment so as to highlight the possible security risks that could arise during the production process. Furthermore, a Risk assessment which include the HAZOP analysis on the plant and the activity has been written (it is related to the IPPC permit too).
Process safety and prevention of runaway reactions **Safety assessment**	BAT is to carry out a structured safety assessment for normal operation and to take into account effects due to deviations of the chemical process and deviations in the operation of the plant (see BREF Section 4.1.6). In order to ensure that a process can be controlled adequately, BAT is to apply one or a combination of the following techniques (without ranking, see BREF Section 4.1.6.1):	1. In order to ensure safety conditions during operations within the plant, the following safety measures have been taken: 1. All operations to be carried out are listed in detail in a Production Record which shows all the sensitive parameters (temperature, pressure, vapor, time), all machinery and all fixed or mobile mechanical equipment that can be used. Such Production Record is endorsed by the environment and safety office. In addition, the

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	• organisational measures • concepts involving control engineering techniques • reaction stoppers (e.g. neutralisation, quenching) • emergency cooling • pressure resistant construction • pressure relief.	Quality and Safety management system establishes all procedures and gives useful suggestions on the workers safety. Every morning an operator is charged with checking that all utilities are correctly working (cooling tower, nitrogen inerting system, LPG tanks connections, scrubber, etc.) Through the software it is possible to monitor the utilities and the parameters, such as pressure and temperature of fluids and the reaction mass, the inerting capacity of the system, before and after use by using nitrogen. inertizzare il sistema prima e dopo l'uso attraverso l'impiego di azoto 2. Nil 3. Nil 4. They are built in compliance with PED regulation and all certified; 5. In case of an uncontrolled rising of pressure inside, a security system based on the rupture of the disk will start functioning. Such system will channel the gas in a collecting tank, connected to the abatement system, and then will release it in the air. If the pressure rises within the jacket (that is the internal coil that encloses the reactor to ensure the temperatures needed are reached) there is a safety valve for discharging the liquid or vapor present at that moment..

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Process safety and prevention of runaway reactions **Handling and storage of hazardous substances**	Handling and storage of hazardous substances require precautions to limit the risks. On sites where toxic substances are handled, operators need sufficient and adequate knowledge to work safely in normal operation and to react adequately when deviations from normal operations occur. BAT is to establish and implement procedures and technical measures to limit risks from the handling and storage of hazardous substances (for an example, see BREF Section 4.2.30). BAT is to provide sufficient and adequate training for operators who handle hazardous substances (for an example, see BREF Section 4.2.29).	Incompatible chemicals will be stored in different places so as to avoid any contact, as required in the management system procedures. All operators will be provided with the appropriate personal protective equipment that changes depending on the toxicity or danger of the substance being handled. Many operations in the plant will be performed in a closed circuit (for example, loading solvents inside the reactors or weighing them), so pouring operations will not occur as well as any contact with the environment. All substances will be handled under a fume hood so as to suck VOCs and dust towards the abatement system installed.

1.2 Minimisation of environmental impact

Aspect of BAT	BAT	Status at Installation
Plant design	The design of a plant is not easily changed, so for existing plants a step-by-step retrofitting is required. For example, the possibility of consequently using gravity flow depends on the production building actually available (five floors required) and may not be possible in many cases.	The plant has been designed so as to minimize the possible emissions of hazardous substances, such as VOCs and dust, to the environment. All production processes that require a contact with the environment have been minimized. For example, reactors, centrifuges and mobile filters are

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	BAT is to design new plants in such a way that emissions are minimised by applying techniques including the following (see BREF Sections 4.2.1, 4.2.3, 4.2.14, 4.2.15, 4.2.21): a) using closed and sealed equipment b) closing the production building and ventilating it mechanically c) using inert gas blanketing for process equipment where VOCs are handled d) connecting reactors to one or more condensers for solvent recovery e) connecting condensers to the recovery/abatement system f) using gravity flow instead of pumps (pumps can be an important source of fugitive emissions) g) enabling the segregation and selective treatment of waste water streams h) enabling a high degree of automation by application of a modern process control system in order to ensure a stable and efficient operation.	mutually connected through fixed or mobile pipes in order to ensure a way for the reaction mass or the single product/raw material with no interruptions. The pumps will only be used when loading liquid raw materials into reactors, any possible leakage due to an operator's error or to not-sealed flanges, is blocked since the operators must always turn on the local extraction system. Such system is made up of mobile hoods with movable pipes that allow you to suck the escaping pollutants by channeling them to the abatement system consisting of a scrubbers and an activated-carbon filter. All operations must be carried out when the machinery is off, (also in compliance with the quality standards required by GMP), in this way, in case of dispersion over the mobile extraction fans, the ventilation system would hold them. All operations, including the drying phase, are preceded and followed by the inertisation of the installation typically performed through nitrogen. The inertisation of reactors, dryers and pipes is an effective system for preventing any potentially explosive atmosphere from being generated. It consists in diluting the combustive agent (the oxygen in air) with inert gases such as nitrogen, argon, carbon dioxide. The use of inert gases (in particular nitrogen) within plants where combustible products are used ensures safety conditions and complies with the Italian regulation in force. However, the percentage of oxygen will be less than 5%. Each reactor is equipped with a shell-and-

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		tube heat exchanger which is intended to cool a large amount of the solvents collected in round-bottom flasks and subsequently separated. Vapors of those solvents that cannot be condensed at that temperature are channeled to the pollutant abatement system (scrubber + activated carbon filter). A system for processing the mass will be implemented too. It takes advantage of the gravity by allowing the passage between the various parts of the plant (reactors, distillation and receiving flasks) with no interruptions in the plant structure: the mass will not come in contact with pumps, flanges or joints which often represent the weak points of a system since they could lead to leakages and emissions of VOCs. With regard to the flow of waste or wastewater resulting from the operations, some of them are recovered, reprocessed, analyzed and then reused in the plant while other are selected right from the start depending on their characteristics and then stored separately.
Ground protection and water retention options	BAT is to design, build, operate and maintain facilities, where substances (usually liquids) which represent a potential risk of contamination of ground and groundwater are handled, in such a way that spill potential is minimised. Facilities have to be sealed, stable and sufficiently resistant against possible mechanical, thermal or chemical stress (see BREF Section 4.2.27).	In order to protect soil and groundwater, the company has taken the following preventative measures (they are described in detail in the main document "project description" of the IPPC permit): 1. Indoor areas are paved with a specific floor resistant to the most aggressive chemical agents since the base is made of industrial quartz and covered with protective resin resistant to solvents such as acetone,

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	BAT is to enable leakages to be quickly and reliably recognised (see BREF Section 4.2.27). BAT is to provide sufficient retention volumes to safely retain spills and leaking substances in order to enable treatment or disposal (see BREF Section 4.2.27). BAT is to provide sufficient retention volume to safely retain fire fighting water and contaminated surface water (see BREF Section 4.2.28). BAT is to apply all the following techniques (see also BREF Section 4.2.27): • carrying out loading and unloading only in designated areas protected against leakage run-off • storing and collecting materials awaiting disposal in designated areas protected against leakage run-off • fitting all pump sumps or other treatment plant chambers from which spillage might occur with high liquid level alarms or regularly supervising pump sumps by personnel instead • establishing programmes for testing and inspecting tanks and pipelines including flanges and valves • providing spill control equipment, such as containment booms and suitable absorbent material	methanol, ethanol, etc. Furthermore, the slope of the floor allows conveying any possible spilled fluid towards the channel drain connected to an underground collection tank, generally used for cleaning the plant. Such tank is made of reinforced concrete and covered with a water-repellent sheath and a resistant resin. According to the procedures established by the management system, it is necessary to check every two years the real waterproof feature of the tank. In order to avoid the tank from being too much full and the leakage of washing water on the surface, a level switch has been installed. It warns you when the underground tank is too much full through an alarm. In addition, in order to allow a quiet outflow of polluted water, the pipe will be cleaned and inerted every year. Routine maintenance works will be carried out when checking the waterproof feature of the tank. Such maintenance services will allow a reconstruction of the sheath and its resin. 2. Goods loading and unloading operations are a delicate stage, for this reason, different operative procedures and instructions on how to use the forklift have been designed. In order to protect the sewer and permeable areas, in stage I and II the loading/unloading will be performed in the External

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	• testing and demonstrating the integrity of bunds • equipping tanks with overfill prevention.	Flammable Warehouse equipped with sloping flooring which allows you to collect any liquid spilled from tanks (IBC) and drums. In stage III the loading area will be away from manholes. If it is not possible, the operators will be required to cover the manholes with waterproof carpets or coatings resistant to acids, bases and fuels. Furthermore, a spill-kit is provided and shown in the main document of this permit. In those areas where raw materials are moved and handled, a spill-kit will be available. Such kit will allow the operator to take immediate action to stop the liquid outflow. Then the liquid will be absorbed by using inert material, collected and disposed of as a polluted waste. 3. All goods, regardless of their danger level, must be stored in permeable areas always equipped with a fixed or mobile containment basin. Each containment basin can collect the 30% of the entire volume of raw material stored therein. All bunds will be periodically tested in order to check their integrity. All storage areas are covered, so raw materials will be protected from the atmospheric agents and the possible spillage cannot be channeled outside the company by the rain. All retention basins will be checked and periodically monitored by maintenance operators.

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		4. The maintenance program submitted with the documentation establishes all the periodic checks to be done on more important equipment and those tolls that will come in direct contact with raw materials.
Minimisation of VOC emissions **Enclosure of sources**	An example is the separation of solid products or intermediates from solvents in closed systems. This is realised consequently by the application of filter dryers or by keeping the system closed when discharging the wet filter cake for subsequent operations (see BREF Section 4.2.19). BAT is to contain and enclose sources and to close any openings in order to minimise uncontrolled emissions (see BREF Section 4.2.14).	With regard to the type of process carried out in the plant, two critical phases have been detected: 1. The passage of the reaction mass (including solvents) between a reactor and another one or between a reactor and a centrifuge or vice versa. In this case a closed system is used, so there will be two pipes for connecting the receptacles. In the final reactor, the liquid is sucked by the vacuum created with a pump (if you do not exploit gravity) while the return piping (the pipe in which the liquid does not pass) suck all vapors that will be conveyed to the abatement system (condenser + scrubber + activated carbon filter). 2. The transition for the physical separation between solid and liquid is achieved by connecting the last reactor with a filter. All filters used will be closed-type filters by following the system described for the reactor, but the collecting panel of the product will be cleaned under the exhaust hood and only after

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		wastewater has been removed. The liquid does not come in contact with the environment.
Minimisation of VOC emissions **Drying in closed circuits**	BAT is to carry out drying by using closed circuits, including condensers for solvent recovery (see BREF Section 4.2.14).	Drying operations are performed in aseptic areas (clean room), so once the product has been filtered is placed on trays within a static dryer until it is completely dry. In this case the liquid, solvent or water sucked is channeled through a vacuum unit to the abatement system. No VOCs or powders emissions occur because the room is controlled and supported with an abatement system consisting of very efficient HEPA pre-filters and filters.
Minimisation of VOC emissions **Equipment cleaning using solvents**	Often, the cleaning of equipment (e.g. vessels) is finished with a final rinse with solvent. The equipment is kept closed and residual solvent is removed by applying vacuum and/or by slightly heating and removing vapours after the emptying of the vessel (see BREF Section 4.2.13). BAT is to keep equipment closed for rinsing and cleaning with solvents (see BREF Section 4.2.14).	The cleaning of the reactor is performed as described in the left column, but the vapors sucked are always conveyed to the abatement systems. Once operations have been completed, the container is inerted by using nitrogen.
Minimisation of VOC emissions **Recirculation of process vents**	BAT is to use recirculation of process vapours where purity requirements allow this (see BREF Section 4.2.14).	In order to further minimize the possibility of emissions, the amount of solvent used in the cleaning phase is strictly controlled during the planning phase. In this way it is possible to reduce costs.
Minimisation of exhaust gas	At a given temperature (e.g. set by a condenser), the decisive parameter to control the mass flow of an exhaust gas is the	The collection system of the vapors sucked during all operations within the plant does not have openings.

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volume flows and loads **Closure of openings**	volume flow. BAT is to close any unnecessary openings in order to prevent air being sucked to the gas collection system via the process equipment (see BREF Sections 4.2.14 and 4.3.5.17).	
Minimisation of exhaust gas volume flows and loads **Testing the airtightness of process equipment**	This is carried out by closing and sealing all openings until the equipment holds a vacuum or a pressure (e.g. a vacuum of about 100 mbar for at least 30 minutes). BAT is to ensure the airtightness of process equipment, especially of vessels (see BREF Section 4.2.16).	The check of the sealing feature and the ability to generate vacuum inside the equipment and, in particular, inside the reactors is: 1. Certified by the vacuum units manufacturers 2. Kept and performed according to the plan and the plan attached 3. Visually verifiable through barometric indicators which measure and show the pressure inside the reactors
Minimisation of exhaust gas volume flows and loads **Inertisation**	Testing airtightness of the equipment is carried out regularly and enables the application of shock inertisation instead of continuous inertisation. Still, continuous inertisation has to be accepted due to safety requirements, e.g. where processes generate O_2 or where processes require further loading of material after inertisation. BAT is to apply shock inertisation instead of continuous inertisation (see BREF Section 4.2.17).	Inertisation is performed before and after loading/unloading the reaction mass.
Minimisation of	Exhaust gas volume flows from distillations can be minimised	Each reactor is equipped with a shell-and-tube heat

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exhaust gas volume flows and loads **Minimisation of exhaust gas volume flows from distillations**	to almost zero if the layout of the condenser allows sufficient heat removal. BAT is to minimise the exhaust gas volume flows from distillations by optimising the layout of the condenser (see BREF Section 4.2.20).	exchanger that allows reducing the exhaust gas by condensing vapors and collecting them in receiving flasks. Then, the flow passes through an activated carbon filter, and arrives to the scrubber which completely removes the last VOCs left.
Minimisation of exhaust gas volume flows and loads **Liquid additions into vessels**	Liquid addition to a vessel is possible as top feed or as bottom feed or with dip-leg. In the case of an organic liquid, the organic load in the displaced gas is about 10 to 100 times higher if added via top feed. If both solids and an organic liquid are added to the vessel, the solids can be used as a dynamic lid in the case of bottom feeding the liquid: BAT is to carry out liquid addition to vessels as bottom feed or with dip-leg, unless reaction chemistry and/or safety considerations make it impractical (see BREF Sections 4.2.15, 4.2.18). In such cases, the addition of liquid as top feed with a pipe directed to the wall reduces splashing and hence, the organic load in the displaced gas. If both solids and an organic liquid are added to a vessel, BAT is to use solids as a blanket in circumstances where the density difference promotes the reduction of the organic load in the displaced gas, unless reaction chemistry and/or safety considerations make it impractical (see BREF Section 4.2.18).	Liquid raw materials are loaded through a dip-leg.

Aspect of BAT	BAT	Status at Installation
Minimisation of exhaust gas volume flows and loads **Minimisation of peak emission concentrations**	A characteristic aspect of batch processes is the variation of pollutant load and volume flow in exhaust gases. Such variations represent a challenge for the operation of recovery or abatement techniques and result frequently in undesirable emission concentration peaks potentially representing a higher environmental impact: BAT is to minimise the accumulation of peak loads and flows and related emission concentration peaks by, e.g. a) optimisation of the production matrix (see BREF Section 4.3.5.17) b) application of smoothing filters (see BREF Section 4.3.5.16 and also Section 4.3.5.13).	The quality of the vapors sucked is closely related to what enters the plant, while the abatement system efficiency is closely related to the cleanliness of filters or the scrubber. According to the planning, also carbons present in the filters as well as the scrubber water must be replaced. However, cleaning must be performed at least twice a week.
Minimisation of volume and load of waste water streams **Mother liquors with high salt content**	The separation of products or intermediates from aqueous solutions frequently creates highly loaded aqueous mother liquors. Especially where the product is obtained by salting out or bulk neutralisation, a work-up of such mother liquors is often hindered by the high salt content. Alternative separation of products or intermediates can increase yields or even the product quality, but the technical applicability of alternative separation techniques needs to be assessed for each case individually. For examples, see BREF Sections 4.2.4, 4.2.25 and 4.2.26.	During the separation between the liquid waste phase and the solid phase of the product it is possible that a certain amount of product remains in the liquid phase or that salt could be generated. In order to recover the product or allow a further separation in terms of waste, proceed with the "solvent-based process". In particular, the "mother liquors" are loaded into a reactor, the mass is concentrated under vacuum and up to the volume pick, the temperature is kept between 0 and 5°C. Left to settle for few hours and proceed to a further filtration. Then the solid left must be analyzed

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	BAT is to avoid mother liquors with high salt content or to enable the work-up of mother liquors by the application of alternative separation techniques (see BREF Section 4.2.24), e.g. a) membrane processes a) solvent-based processes b) reactive extraction c) or to omit intermediate isolation.	and classified as "recovered product" or "waste-derived filtration residue."
Minimisation of volume and load of waste water streams **Countercurrent product washing**	As a polishing step, organic products are often washed with an aqueous phase in order to remove impurities. High efficiencies in combination with low water consumption (and low waste water generation) can be achieved with countercurrent washing. However, the degree of optimisation of the washing process depends on the production level and regularity. With small amounts, experimental production runs and rare production campaigns, countercurrent product washing is not applicable. BAT is to apply countercurrent product washing where the production scale justifies the introduction of the technique (see BREF Section 4.2.22).	Not applicable. With small amounts, experimental production runs and rare production campaigns, countercurrent product washing is not applicable
Minimisation of volume and load	Water-free vacuum generation is realised by using, e.g. dry running pumps, liquid ring pumps using solvents as the ring	Not applicable, Sterling Chemical Malta Ltd only uses dry-type pumps for generate vacuum.

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of waste water streams **Water-free vacuum generation**	medium or closed cycle liquid ring pumps. However, where the applicability of these techniques is restricted (see cross-references below), the use of steam injectors or water ring pumps is justified. BAT is to apply water-free vacuum generation (see BREF Sections 4.2.5, 4.2.6 and 4.2.7).	
Minimisation of volume and load of waste water streams **Determination of the completion of reactions**	The precise determination of a chemical process completion minimises the potential load in waste water streams caused by a batch process. For batch processes, BAT is to establish clear procedures for the determination of the desired end point of the reaction (for an example, see BREF Section 4.2.23).	A processing is never the same as another one. The end of the reaction changes depending on the different starting conditions initially imposed, such as the amount of raw materials used. However, the Production records available in the plant show all the parameters to be followed for optimally performing the synthesis. In particular, the Production Records indicates the execution time of a single operation step by step. These times are dictated by a twenty-year experience in the field of the fine organic synthesis.
Minimisation of volume and load of waste water streams **Indirect cooling**	Indirect cooling is not applicable for processes which require the addition of water or ice to enable safe temperature control, temperature jumps or temperature shock. Direct cooling can also be required to control “run away” situations (see BREF Section 4.1.6.2) or where there are concerns about blocking heat-exchangers. BAT is to apply indirect cooling (see BREF Section 4.2.9).	Not applicable for Sterling process.
Minimisation of	Production plant cleaning procedures can be optimised to	In nearly every cleaning operation of the reactors and

Aspect of BAT	BAT	Status at Installation
volume and load of waste water streams **Cleaning**	reduce the resulting waste water loads. In particular, the introduction of an additional cleaning step (pre-rinsing) enables the separation of large portions of solvents from wash-waters. Where different materials are frequently transported in pipes, the use of pigging technology represents another option to reduce product losses within cleaning procedures (see BREF Section 4.2.8). BAT is to apply a pre-rinsing step prior to rinsing/cleaning of equipment to minimise organic loads in wash-waters (see BREF Section 4.2.12).	centrifuges a prewash is carried out by using a solvent such as, acetone, dimethylformamide, toluene, dichloromethane or methanol. Such solvent, in addition to clean the equipment, can be reused for subsequent production processes. Once cleaning has been performed, about 1/3 of water (compared to the volumetric capacity of the container) must be added, so as to contain the waste. The water used will be contained and much cleaner, and at the same time you will have the chance to send the waste for recovery (R13-classification).
Minimisation of energy consumption	On an OFC site, a wide variety of processes/operations involve cooling and heating, heat-exchange or the use of temperature profiles. An obvious example to optimise heat consumption is the use of residual heat as energy input to another process, for example in the case of energetically coupled distillations. As another example, Section 4.2.10 gives the basic concept of the Pinch methodology which has been applied successfully on an OFC site operating batch processes with 30 reactors and over 300 products achieving cost savings and quick paybacks. BAT is to assess the options and to optimise the energy consumption (for examples, see BREF Sections 4.2.11 and 4.2.20).	Sterling has the steam generator with condensate recovery whose heat is reused also for the feeding of the stoves in the laboratories.

Part 2. Management and treatment of waste streams

Aspect of BAT	BAT	Status at Installation
Introduction	Management and treatment of a wide variety of unavoidable waste streams are crucial tasks on a multipurpose site. However, as an alternative to the investment of recovery/abatement techniques, a modernisation of the process should always be assessed as an option in order to prevent or minimise waste stream volumes or loads, close cycles or enable on-site or off-site re-use (see BAT in the previous Section "Prevention and minimisation of environmental impact", and for examples see BREF Sections 4.1.4.2 and 4.1.4.3). The operational mode and frequent product change on a multipurpose site naturally favour flexible recovery/abatement solutions, e.g. modular concepts (see BREF Section 4.3.5.17) or techniques fulfilling several tasks efficiently and simultaneously (for examples see BREF Sections 4.2.1 and 4.3.5.7). In addition, external treatment should always be considered as an option, including solutions such as joint pre-treatment/treatment platforms for waste water streams as shown in BREF Section 4.3.7.4.	Sterling Chemical Malta Ltd has a small production site available, so today a treatment system for wastewater is not feasible. Furthermore, as far as the economic aspect and the volumes produced, it would not be convenient at all and it would represent a weight for the company competitiveness, instead of a resource. See the technical-economic analyses performed and shown in Annex B9 attached at the main document of the IPPC permit..

2.1 Mass balances and process waste stream analysis

Aspect of BAT	BAT	Status at Installation
Introduction	Mass balances are important tools for understanding a multipurpose production and the development of priorities for improvement strategies. The management of waste streams is based on the knowledge of the properties of the occurring waste stream and the monitoring of the results of the treatment of waste streams, including the final emission data.	Now, the mass balance technique has been introduced in Italy, together with the study of the COD that allows a further diversification of the waste streams. As far as Malta, this situation is being planned at Stage II when there will be a larger amount of waste.
Mass balances	BAT is to establish mass balances for VOCs (including CHCs), TOC or COD, AOX or EOX and heavy metals on a yearly basis (see BREF Sections 4.3.1.4, 4.3.1.5 and 4.3.1.6).	See as above
Waste stream analysis	BAT is to carry out a detailed waste stream analysis in order to identify the origin of the waste stream and a basic data set to enable management and suitable treatment of exhaust gases, waste water streams and solid residues (see BREF Section 4.3.1.1).	The study on the amount of waste produced by a process is carried out during the planning phase by production supervisors. This allows you to properly manage outgoing waste, by storing it for the shortest time possible within the company. The chemical analyses that allow a further diversification will not be carried out (except for the COD) since they are not economically convenient due to the amount of waste and the cost to be paid for purchasing analytical equipment
Assessment of waste water	BAT is to assess at least the parameters given in Figure 1 for waste water streams, unless the parameter can be seen as	See as above

Aspect of BAT	BAT	Status at Installation
streams	irrelevant from a scientific point of view (see BREF Section 4.3.1.2).	
Monitoring of emissions to air	Monitoring of waste gas emissions should reflect the operational mode of the production processes (batch, semi-continuous or continuous) and should also take into account the emission of individual substances, especially if substances with ecotoxicological potential are released. Therefore, emission profiles should be recorded instead of levels derived from short sampling periods. Emission data should be related to the operations responsible. For emissions to air, BAT is to monitor the emission profile which reflects the operational mode of the production process (see BREF Section 4.3.1.8). In the case of a non-oxidative abatement/recovery system, BAT is to apply a continuous monitoring system (e.g. FID), where exhaust gases from various processes are treated in a central recovery/abatement system (see BREF Section 4.3.1.8). BAT is to individually monitor substances with ecotoxicological potential if such substances are released (see BREF Section 4.3.1.8).	Sterling, in addition to observe all monitoring measures required by the IPPC permit, is willing to achieve, for each emission point present in the company, an annually-repeatable temporal profile that identifies in 24 hours, the entire synthesis step which is potentially more eco-toxic. In case a raw material is different from the production standards, the waste resulting from such processing can be disposed of separately, upon instructions by the HSE office.

Aspect of BAT	BAT	Status at Installation
Assessment of individual volume flows	The key to the understanding of the waste gas emission situation and the basis of improvement strategies is the knowledge of the individual contribution of processes and operations to the volume flow to recovery and abatement systems. BAT is to assess individual exhaust gas volume flows from process equipment to recovery/abatement systems (see BREF Section 4.3.1.7).	Not applicable at the moment because the company is an start up phase with new chemical synthesis, could be a measure to improve future

Figure 1:

Parameter	
Volume per batch	Standard
Batches per year	
Volume per day	
Volume per year	
COD or TOC	
BOD_5	
pH	
Bioeliminability	
Biological inhibition, including nitrification	
AOX	Where it is expected
CHCs	
Solvents	
Heavy metals	
Total N	
Total P	
Chloride	
Bromide	
SO_4^{2-}	
Residual toxicity	

Table 5.1: Parameters for the assessment of waste water streams

2.2 Re-use of solvents

Aspect of BAT	BAT	Status at Installation
Solvents re-use	BAT is to re-use solvents as far as purity requirements (e.g. requirements according to cGMP) allow, by: a) using the solvent from previous batches of a production campaign for future batches as far as purity requirements allow (see Section 4.3.4) b) collecting spent solvents for on-site or off-site purification and re-use (for an example, see Section 4.3.3) c) collecting spent solvents for on-site or off-site utilisation of the calorific value (see Section 4.3.5.7).	Many solvents are reused in the production process or for cleaning reactors and centrifuges. In both cases, they will be used only upon approval by the quality control laboratory in order to certify their chemical properties according to the international GMP guidelines.

2.3 Treatment of exhaust gases

Aspect of BAT	BAT	Status at Installation
Selection of VOC recovery/abatem	The selection of VOC treatment techniques is a crucial task on a multipurpose site. Since the volume flows show a wide variation on a multipurpose site, the key parameter	The trap-system of VOCs coming from the production plant are the following: 1. Cryogenic condensation through heat exchanger;

Aspect of BAT	BAT	Status at Installation
ent techniques and achievable emission levels	for the selection of techniques are average mass flows from emission point sources in kg/hour. One or a combination of techniques can be applied as a recovery/abatement system for a whole site, an individual production building, or an individual process. This depends on the particular situation and affects the number of point sources.	2. An activated carbon filter; 3. Wet scrubber For emissions coming from the laboratories, the system provides HEPA filter EU13 and activated carbon filters. For prevede HEPA filter EU13, e filtri a carboni attivi. Per la camera di pesatura HEPA filter H14 e filtro a carboni attivi, per lo steam generator e la caldaia il sistema di trattamento è compreso nella tecnologia dell'impianto e sfrutta il meccanismo dell'ossidazione termica attraverso una maggiore residenza dei fumi con il doppio anello di circolazione consentendo la trasformazione di inquinanti in prodotti innocui.
Selection of VOC recovery/abatement techniques and achievable emission levels **Selection of VOC and recovery abatement techniques**	BAT is to select VOC recovery and abatement techniques according to the flow scheme in Figure 2.	The exhaust gases from each reactor pass through a heat exchanger so as to condense the VOC
Selection of VOC recovery/abatement techniques and achievable emission levels	Non-oxidative recovery/abatement techniques are operated efficiently after minimisation of volume flows (see BREF Section 5.1.2.4) and the achieved concentration levels should be related to the corresponding volume flow without dilution by, e.g. volume flows from building or room ventilation.	Not applicable the volume flow is not dilution from room ventilation or building ventilation

Aspect of BAT	BAT	Status at Installation
Non-oxidative VOC recovery and abatement techniques	BAT is to reduce emissions to the levels given in Figure 3 where non-oxidative VOC recovery or abatement techniques are applied (see BREF Sections 4.3.5.6, 4.3.5.11, 4.3.5.14, 4.3.5.17, 4.3.5.18).	
Selection of VOC recovery/abatement techniques and achievable emission levels **VOC abatement by thermal oxidation/ incineration and catalytic oxidation**	Thermal oxidation/incineration and catalytic oxidation are proven techniques for destroying VOCs with highest efficiency but show considerable cross-media effects. In direct comparison, catalytic oxidation consumes less energy and creates less NO_X and hence is preferred where technically possible. Thermal oxidation is advantageous where support fuel can be replaced by organic liquid waste (e.g. waste solvents which are technically/economically available on-site and non-recoverable) or where autothermal operation can be enabled by stripping of organic compounds from waste water streams (see BREF Section 4.3.5.9 and BAT in Part 4, Section "Removal of solvents from waste water streams"). Where exhaust gases also contain high loads of other pollutants besides VOCs, thermal oxidation can enable, e.g. the recovery of marketable HCl (see BREF Section 4.3.5.2) or, if the thermal oxidiser is equipped with a $DeNO_X$ unit or is designed as two stage combustion, the efficient abatement of NO_X (see BREF Section 4.3.5.7). Thermal oxidation/incineration and catalytic oxidation can also be a	The thermal oxidation principle is applied by the steam generator used for heating and monitoring the temperature of the plant. The two fire-tubes allow holding flue gases produced by combustion within the boiler for a longer time before being released into the atmosphere. In this way pollutants such as VOCs, NOx and SOx turns into secondary products with a reduced environmental impact through the completion of the following reaction: V.O.C. + O2 + Ignition energy CO2 + H2O + heat The reaction must be carried out under suitable conditions of temperature, turbulence and residence time in a combustion chamber. The energy required to ignite the reaction, as well as the heat generated, can be recovered through suitable regenerative thermal oxidizers (regenerative thermal oxidation) that are not available at the moment, since the plant has a too little energy consumption to justify this type of project.

Aspect of BAT	BAT	Status at Installation
	suitable technique to reduce odour emissions. BAT is to reduce VOC emissions to the levels given in Figure 4 where thermal oxidation/incineration or catalytic oxidation are applied (see BREF Sections 4.3.5.7, 4.3.5.8, 4.3.5.18).	
Recovery/ abatement of NO_X **NOX from thermal oxidation/ incineration or catalytic oxidation**	For thermal oxidation/incineration or catalytic oxidation, BAT is to achieve the NO_X emission levels given in Figure 6 and, where necessary, to apply a De NO_X system (e.g. SCR or SNCR) or two stage combustion to achieve such levels (see BREF Sections 4.3.5.7 and 4.3.5.19).	Not applicable. Sterling uses the scrubber to trap NOx for NOx for NOx from the production line.
Recovery/ abatement of NO_X **NO_X from thermal oxidation/ incineration or catalytic oxidation**	Where NO_X is absorbed from strong NO_X streams (about 1000 ppm and higher) a 55 % HNO_3 can be obtained for on-site or off-site re-use. Often, exhaust gases containing NO_X from chemical processes also contain VOCs and can be treated in a thermal oxidiser/incinerator, e.g. equipped with a $DeNO_X$ unit or built as a two stage combustion (where already available on-site). For exhaust gases from chemical production processes, BAT is to achieve the NO_X emission levels given in Figure 6 and, where necessary to apply treatment techniques such as scrubbing or scrubber cascades with scrubber media such as H_2O and/or H_2O_2 to achieve such levels (see	Not applicable. Sterling uses the scrubber to trap NOx for NOx for NOx from the production line.

Aspect of BAT	BAT	Status at Installation
	BREF Section 4.3.5.1).	
Recovery/ abatement of NO_X **Recovery/abatement of HCl, Cl_2 and HBr/Br_2**	HCl is removed from exhaust gases with one or more scrubbers using scrubbing media such as H_2O or NaOH (see BREF Section 4.3.5.3). HCl can be efficiently recovered from exhaust gases with high HCl concentrations, if the production volume justifies the investment costs for the required equipment. This can be expected where production lines are dedicated to a larger volume product or to a range of similar products. For an example, see BREF Section 4.3.5.2. Where HCl recovery is not preceded by VOC removal, potential organic contaminants (AOX) have to be considered in the recovered HCl. Similarly, Cl_2 requires additional measures if present in the exhaust gas. HBr and Br_2 are recovered/removed under similar conditions from exhaust gases (see BREF Section 4.3.5.4). BAT is to achieve HCl emission levels of 0.2 – 7.5 mg/m^3 or 0.001 – 0.08 kg/hour and, where necessary, to apply of one or more scrubbers using scrubbing media such as H_2O or NaOH in order to achieve such levels (see BREF Section 4.3.5.3). BAT is to achieve Cl_2 emission levels of 0.1 – 1 mg/m^3 and, where necessary, to apply techniques such as absorption of the excess chlorine (see BREF Section	The scrubber also allows trapping the HCl.

Aspect of BAT	BAT	Status at Installation
	4.3.5.5) and/or scrubbing with scrubbing media such as $NaHSO_3$ in order to achieve such levels (see BREF Section 4.3.5.2). BAT is to achieve HBr emission levels <1 mg/m^3 and, where necessary, to apply scrubbing with scrubbing media such as H_2O or NaOH in order to achieve such levels (see BREF Sections 1.1.1, 4.3.5.4).	
NH_3 emission levels **Removal of NH_3 from exhaust gases**	BAT is to achieve NH_3 emission levels of 0.1 – 10 mg/m^3 or 0.001 – 0.1 kg/hour and, where necessary, to apply scrubbing with scrubbing media such as H_2O or acid in order to achieve such levels (see BREF Section 4.3.5.20).	Not applicable. The ammonia will be use in laboratory only, and will use the Platinum-catalysed oxidation
NH_3 emission levels **NH_3 slip from DeNOx**	BAT is to achieve NH_3 slip levels from SCR or SNCR of <2 mg/m^3 or <0.02 kg/hour (see BREF Section 4.3.5.7).	Not applicable The ammonia will be use in laboratory only, and will use the Platinum-catalysed oxidation
Removal of SO_X from exhaust gases	BAT is to achieve SO_X emission levels of 1 – 15 mg/m^3 or 0.001 – 0.1 kg/hour and, where necessary, to apply scrubbing with scrubbing media such as H_2O or NaOH in order to achieve such levels (see BREF Section 4.3.5.21).	Sterling uses the scrubber to trap SOx.
Removal of particulates from exhaust gases	Particulates are removed from various exhaust gases. The choice of recovery/abatement systems depends strongly on the particulate properties.	The scrubber is an abatement system which entails using a liquid (usually water or an aqueous solution containing an additive, such as soda to be used only if ammonia is present in the production) for separating powders, gases and vapors

Aspect of BAT	BAT	Status at Installation
	BAT is to achieve particulate emission levels of 0.05 – 5 mg/m^3 or 0.001 – 0.1 kg/hour and, where necessary, to apply techniques such as bag filters, fabric filters, cyclones, scrubbing, or wet electrostatic precipitation (WESP) in order to achieve such levels (see BREF Section 4.3.5.22).	from the air. The abatement is an impact between the sprayed-abatement liquid, powders and pollutants in the air. For this particular purpose, the air is conveyed at a low speed through a vertical or horizontal duct (wet scrubber), by passing through a system of fixed or mobile bodies sprayed by jets of water. Such jets are supplied by a pump connected to a collection tank. A demister is installed on the top of the tower to remove water drops entrained in the air flow. In this way treated air is released into the atmosphere. The SCRUBBER always uses the same abatement liquid, which after washing, falls in the tank. In this phase, all abated air pollutants are accumulated and left to settle (in case of powders). Then they are disposed of in the form of sludge or suspension. The system is continuously working, with no interruptions except for periodic maintenance services. The abatement performed with this type of treatment provides high yields with low management costs. It is suitable for all types of pollutant, provided that it can be wetted or it can react with water-soluble additives.
Removal of free cyanides from exhaust gases	Due to their toxicity, cyanides are removed from rich and lean exhaust gases by scrubbing. BAT is to remove free cyanides from exhaust gases, and to achieve a waste gas emission level of 1 mg/m^3 or 3 g/hour as HCN (see BREF Section 4.3.6.2).	Not applicable since exhaust gases do not contain HCN.

Figure 2:

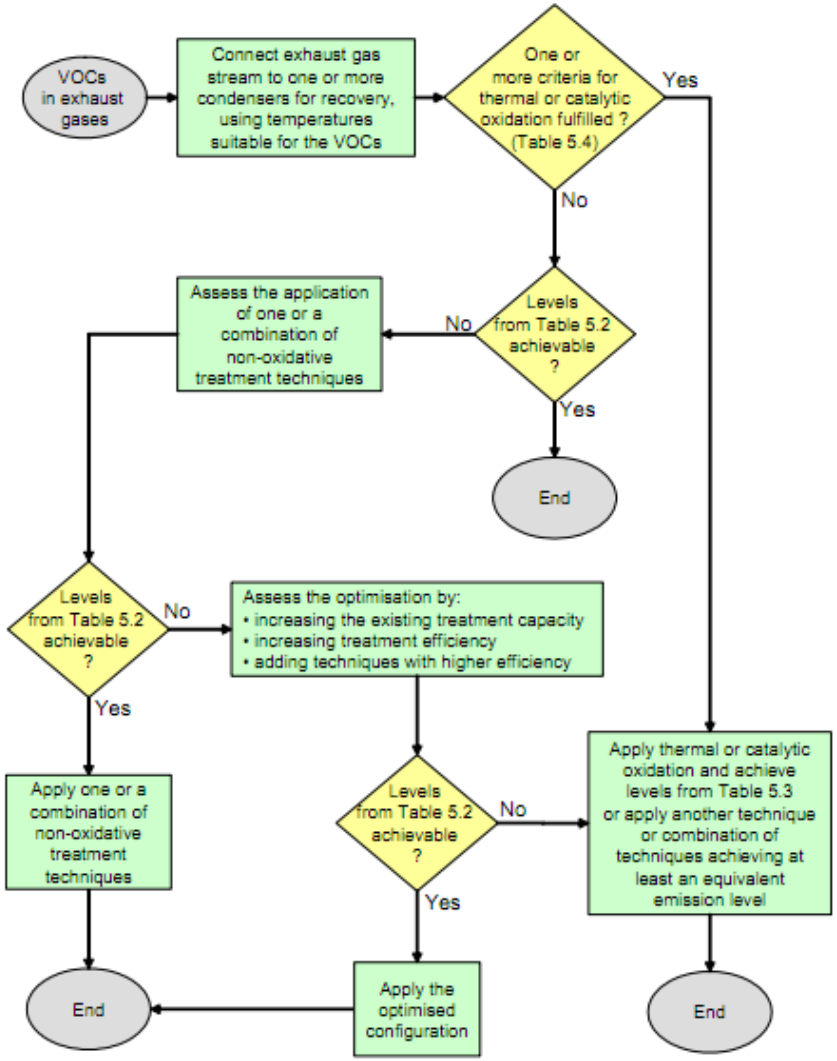

Figure 5.1: BAT for the selection of VOC recovery/abatement techniques

Figure 3:

Parameter	Average emission level from point sources*
Total organic C	0.1 kg C/hour or 20 mg C/m^3**

* The averaging time relates to the emission profile (see Sections 5.2.1.1.4 and 4.3.1.8), the levels relate to dry gas and Nm^3

** The concentration level relates to volume flows without dilution by, e.g. volume flows from room or building ventilation

Table 5.2: BAT associated VOC emission levels for non-oxidative recovery/abatement techniques

Figure 4:

Thermal oxidation/incineration or catalytic oxidation	**Average mass flow** **kg C/hour**		**Average concentration** **mg C/m^3**
Total organic C	<0.05	or	<5
The averaging time relates to the emission profile (see Section 5.2.1.1.4), levels relate to dry gas and Nm^3			

Table 5.3: BAT associated emission levels for total organic C for thermal oxidation/incineration or catalytic oxidation

Figure 5:

	Selection criteria
a	the exhaust gas contains very toxic, carcinogenic or cmr category 1 or 2 substances, or
b	autothermal operation is possible in normal operation, or
c	overall reduction of primary energy consumption is possible in the installation (e.g. secondary heat option)

Table 5.4: Selection criteria for catalytic and thermal oxidation/incineration

Figure 6:

Source	Average mass flow kg/hour*		Average concentration mg/m³*	Comment
Chemical production processes, e.g. nitration, recovery of spent acids	0.03 – 1.7	or	7 – 220**	The lower end of the range relates to low inputs to the scrubbing system and scrubbing with H_2O. With high input levels, the lower end of the range is not achievable even with H_2O_2 as the scrubbing medium
Thermal oxidation/incineration, catalytic oxidation	0.1 – 0.3		13 – 50***	
Thermal oxidation/incineration, catalytic oxidation, input of nitrogenous organic compounds			25 – 150***	Lower range with SCR, upper range with SNCR

* NO_X expressed as NO_2, the averaging time relates to the emission profile (see Section 5.2.1.1.4)
** Levels relate to dry gas and Nm^3
*** Levels relate to dry gas and Nm^3

Table 5.5: BAT associated NO_X emission levels

2.4 Management and treatment of waste water streams

Aspect of BAT	BAT	Status at Installation
Typical waste water streams for segregation, pre-treatment or disposal	Some types of waste water streams are typical candidates for segregation and selective pre-treatment or disposal due to their characteristic properties.	No pre-treatment is required for liquid waste, except for the recovery of the product in mother liquors since the cost of pre-treatment system is excessive compared to the cost-effectiveness of a waste disposal. Furthermore, it is not possible to build a pre-treatment system for some waste due to a matter of space available within the production plant of Sterling Chemical Malta Ltd.
Typical waste water streams for segregation, pre-treatment or disposal **Mother liquors from halogenation and sulphochlorination**	BAT is to segregate and pretreat or dispose of mother liquors from halogenations and sulphochlorinations (see BREF Sections 4.3.2.5, 4.3.2.10).	Not applicable Sterling not produce the mother liquors from sulphochlorinations and for halogenations Sterling will send the mother liquors at company for recovery and use and not for dispose.
Typical waste water streams for segregation, pre-treatment or disposal **Waste water streams containing biologically active substances**	Examples are, e.g. waste water streams from the production of biocides/plant health products or wash-waters from product washing after the nitration of aromates, typically containing (nitro-) phenols. BAT is to pretreat waste water streams containing biologically active substances at levels which could pose a risk either to a subsequent waste water treatment or to the receiving environment after discharge (see BREF Sections 4.3.2.6, 4.3.7.5, 4.3.7.9, 4.3.8.13 and 4.3.8.18).	Not applicable since the waste produced do not contain biologically-active substances.

Aspect of BAT	BAT	Status at Installation
Typical waste water streams for segregation, pre-treatment or disposal **Spent acids from sulphonations or nitrations**	Spent acids from sulphonations or nitrations can usually be recovered. Where recovery is not possible, e.g. due to a high salt content (see also BAT in Part 1 Section "Mother liquors with high salt content" of this document), pre-treatment can be necessary according to the BAT given in Part 2 Section "Treatment of waste water streams with relevant refractory organic load" of this document. An example is the extraction of mother liquors from nitrations after phase separation (see BREF Section 4.3.2.6). BAT is to segregate and collect separately spent acids, e.g. from sulphonations or nitrations for on-site or off-site recovery or to apply BAT given in Part 2 next section "Treatment of waste water streams with relevant refractory organic load" of this document (see BREF Sections 4.3.2.6, 4.3.2.8).	Not applicable see above as
Treatment of waste water streams with relevant refractory organic load	The refractory organic load of a waste water stream passes through the biological WWTP more or less unchanged and requires pre-treatment prior to biological treatment (see BREF Section 4.3.7.10). Pre-treatment techniques include oxidative techniques (e.g. see BREF Section 4.3.7.2) and non-destructive techniques (e.g. see BREF Section 4.3.7.1) and alternatively the disposal option (incineration). Two main strategies are	Not applicable in according to the analysis performed by Water Service Corporation the waste water from sterling does not have a Relevant refractory organic loading

Aspect of BAT	BAT	Status at Installation
	available for pre-treatment: elimination of refractory loadings or enhancing the biodegradability of such loadings (compare BREF Sections 4.3.7.6 and 4.3.7.12). However, as an alternative to the investment of pre-treatment techniques a modernisation of the process should always be assessed as an option in order to prevent or minimise the refractory load of a waste water stream. The main criterion for this is the bioeliminability. If the actual production spectrum causes poorly bioeliminable organic loadings in most of the waste water streams (e.g. manufacture of dyes, optical brighteners, aromatic intermediates), the refractory load is introduced as selection criterion in order to set priorities. Bioeliminabilities and, hence, the refractory organic load are related to the assessment of the inherent bioeliminability, e.g. by Zahn-Wellens test (see BREF Section 4.3.1.3). Instead of the 80 % from inherent bioeliminability testing, for screening purposes, a BOD5/COD ratio of 0.6 can be used. For examples of waste water streams from different unit processes, see BREF Section 4.3.2. The development of pre-treatment strategies for refractory loads is not viable in cases of experimental production runs and rare batch production.	
Treatment of waste water streams with	For the purposes of pre-treatment, BAT is to classify organic loading as follows:	Not applicable in according to the analysis performed by Water Service Corporation the waste water from sterling does not have a Relevant refractory organic loading

Aspect of BAT	BAT	Status at Installation
relevant refractory organic load **Relevant refractory organic loading**	Refractory organic loading is not relevant if the waste water stream shows a bioeliminability of greater than about 80 – 90 % (see BREF Sections 4.3.7.6, 4.3.7.7, 4.3.7.8). In cases with lower bioeliminability, the refractory organic loading is not relevant if it is lower than the range of about 7.5 – 40 kg TOC per batch or per day (see BREF Sections 4.3.7.10, 4.3.7.12 and 4.3.7.13).	
Treatment of waste water streams with relevant refractory organic load **Segregation and pretreatment**	BAT is to segregate and pretreat waste water streams containing relevant refractory organic loadings according to the criteria given in previous Section "Relevant refractory organic loading".	Not applicable in according to the analysis performed by Water Service Corporation the waste water from sterling does not have a Relevant refractory organic loading
Treatment of waste water streams with relevant refractory organic load **Overall COD elimination**	For the segregated waste water streams carrying a relevant refractory organic load according to Section "Relevant refractory organic loading". BAT is to achieve overall COD elimination rates for the combination of pre-treatment and biological treatment of >95 % (see BREF Section 4.3.8.9).	See as above
Removal of solvents from waste water	Because of the volumes used, solvents are often a big environmental impact of a process. Hence, recovery and re-use of solvents, or at least the	Not applicable. For the mother liquors with Code 070703* Sterling will send to Italian **Company** for recovery and reuse. Sterling does not have available space for a waste

Aspect of BAT	BAT	Status at Installation
streams	utilisation of the calorific value, is an important task. Recovery of solvents from waste water streams for re-use is always viable if: Costs for biological treatment + purchase costs for fresh solvents > Costs for recovery + purification Recovery of solvents from waste water streams in order to use the calorific value is environmentally advantageous always if the energy balance (comparison of biological WWTP on one side and stripping/distillation/thermal oxidation on the other side) shows that overall natural fuel can be substituted. As a result for many solvents, a target of 1 g/l in waste water streams is used. The target is higher for cheap solvents (e.g. for methanol, ethanol 10 – 15 g/l) and for solvents which require higher efforts to be purified (for orientation, see BREF Section 4.3.7.18). Rapidly degradable solvents can also represent a necessary C-source for a biological WWTP (e.g. see BREF Section 4.3.8.8). Combinations of techniques such as stripping/incineration can represent an efficient and viable alternative to treatment in the biological WWTP and can also alter the economic/energetic balance in favour of thermal oxidation/incineration as the main exhaust gas abatement system (see BREF Section 4.3.5.9). Besides the economic or energetic balance, the removal of solvents from waste	treatment site and prefer to send this to specialized companies

Aspect of BAT	BAT	Status at Installation
	water streams can also be required in order to protect downstream pre-treatment facilities, such as activated carbon adsorption. For halogenated solvents, apply BAT in next Section "Removal of halogenated compounds from waste water streams" of this document, for poorly bioeliminable solvents, apply BAT in previous Section "Treatment of waste water streams with relevant refractory organic load" of this document. BAT is to recover solvents from waste water streams for on-site or off-site re-use, using techniques such as stripping, distillation/rectification, extraction or combinations of such techniques, where the costs for biological treatment and purchase of fresh solvents are higher than the costs for recovery and purification (see BREF Section 4.3.7.18). BAT is to recover solvents from waste water streams in order to use the calorific value if the energy balance shows that overall natural fuel can be substituted (see BREF Section 4.3.5.7).	
Removal of halogenated compounds from waste water streams	Purgeable chlorinated hydrocarbons (CHCs) show ecotoxicological potential and are being substituted as solvents where technically possible. Where CHCs are still in use, all efforts are undertaken to remove such compounds from waste water streams.	Not applicable, the Sterling waste water that collected into the public sewer does not contain the CHCs. For the mother liquors with Code 070703* Sterling will send to Italian Company for recovery and reuse.

Aspect of BAT	BAT	Status at Installation
Removal of purgeable chlorinated hydrocarbons	BAT is to remove purgeable CHCs from waste water streams, e.g. by stripping, rectification or extraction and to achieve sum concentrations <1 mg/l in the outlet from pre-treatment or to achieve sum concentrations of <0.1 mg/l in the inlet to the on-site biological WWTP or in the inlet to the municipal sewerage system (see BREF Sections 4.3.7.18, 4.3.7.19, 4.3.7.20).	
Removal of halogenated compounds from waste water streams **Pre-treatment of waste water streams containing AOX**	[1]BAT is to pretreat waste water streams with significant AOX loads and to achieve the AOX levels given in Figure 7 in the inlet to the on-site biological WWTP or in the inlet to the municipal sewerage system (see BREF Section 4.3.7.14).	Not applicable. In the waste water inlet to the municipal sewerage system there aren't adsorbable organic halogens
Pre-treatment of waste water streams containing heavy metals	The main factor to actively influence the emission level of heavy metals is the segregation and selective pre-treatment of waste water streams from processes where heavy metals are used deliberately. For examples and applied pre-treatment techniques, see BREF Sections 4.2.25, 4.3.2.4, 4.3.7.3, 4.3.7.21. If equivalent removal levels can be demonstrated in comparison with the combination of pre-treatment and biological waste water treatment, heavy metals can be eliminated from the total effluent using only the biological waste water treatment process, provided that	Not applicable, The Sterling waste water does not contain heavy metal.

Aspect of BAT	BAT	Status at Installation
	the biological treatment is carried out on-site and the treatment sludge is incinerated. BAT is to pretreat waste water streams containing significant levels of heavy metals or heavy metal compounds from processes where they are used deliberately and to achieve the heavy metal concentrations given in Figure 8 in the inlet to the on-site biological WWTP or in the inlet to the municipal sewerage system (see BREF Section 4.3.7.22).	
Destruction of free cyanides	Due to their toxicity, cyanides are removed from rich and lean waste water streams, e.g. by pH adjustment and oxidative destruction with H_2O_2 (for other techniques, see BREF Section 4.3.6.2 under Applicability). Depending on the individual case, it may be also possible to enable safe degradation of cyanides in a biological WWTP (see BREF Section 4.3.6.2 under Applicability). The use of NaOCl for pre-treatment is not considered as BAT due to the potential for formation of AOX. Reconditioning of different cyanide loaded streams can enable re-use and substitution of raw materials. Cyanides occurring in waste water streams together with high COD loads can be pre-treated oxidatively by techniques such as wet oxidation with O_2 under alkaline conditions. In such cases, cyanide levels <1 mg/l are achievable in the treated waste water stream (see BREF	Not applicable, Sterling does not use cyanides

Aspect of BAT	BAT	Status at Installation
	Section 4.3.7.4). BAT is to recondition waste water streams containing free cyanides in order to substitute raw materials where technically possible (see BREF Section 4.3.6.2). BAT is to: a) pretreat waste water streams containing significant loads of cyanides and to achieve a cyanide level of 1 mg/l or lower in the treated waste water stream (see BREF Section 4.3.6.2) or to b) enable safe degradation in a biological WWTP (see BREF Section 4.3.6.2 under Applicability).	
Biological waste water treatment	After the application of BAT given in previous Sections "Typical waste water streams for segregation, pretreatment or disposal", "Treatment of waste water streams with relevant refractory organic load", "Removal of solvents from waste water streams", "Removal of halogenated compounds from waste water streams" and "Pre-treatment of waste water streams containing heavy metals" of this document (management and treatment of waste water streams), BAT is to treat effluents containing a relevant organic load, such as waste water streams from production processes, rinsing and cleaning water, in a biological	Not applicable. The mother liquids of Sterling do not contain heavy metals

Aspect of BAT	BAT	Status at Installation
	WWTP (see BREF Sections 4.3.8.6 and 4.3.8.10).	
Biological waste water treatment **On-site and joint treatment**	Biological waste water treatment is carried out on-site or as joint treatment with other industrial waste waters or together with municipal waste water. Joint treatment can have advantages and disadvantages (see BREF Section 4.3.8.4) and the biological treatment of a complex effluent from an OFC site requires a high level of communication between production and WWTP. An important aspect is the protection of the biological treatment from variations of the input properties, e.g. load or toxicity (see BREF Sections 4.3.7.5, 4.3.8.4, 4.3.8.6, 4.3.8.7). Where stable operation cannot be ensured, retrofitting to a more reliable setup is required (see BREF Sections 4.3.8.3, 4.3.8.8). This retrofitting may include the change-over from joint treatment with municipal waste water to on-site treatment. BAT is to ensure that the elimination in a joint waste water treatment is overall not poorer than in the case of on-site treatment. This is realised by regular degradability/ bioeliminability testing (see BREF Section 4.3.8.5).	Not applicable. The volumes of waste generated by Sterling does not justify such a large investment. Furthermore, the available spaces of Sterling does not allow to provide for a treatment system
Biological waste water treatment **Elimination rates and emission levels**	For biological waste water treatment, COD elimination rates of 93 – 97 % are typically achievable as a yearly average. It is important that a COD elimination rate cannot be understood as a standalone parameter, but is influenced by	Not applicable. In accordance with the findings made by the WSC COD and BOD5 of waste water from Sterling are manageable and not large they require a treatment system

Aspect of BAT	BAT	Status at Installation
	the production spectrum (e.g. production of dyes/pigments, optical brighteners, aromatic intermediates which create refractory loadings in most of the waste water streams on a site), the degree of solvent removal (see BREF Section 4.3.7.18) and the degree of pre-treatment of refractory organic loadings (see BREF Sections 4.3.8.7 and 4.3.8.10). Depending on the individual situation, retrofitting of the biological WWTP is required in order to adjust, e.g. treatment capacity or buffer volume or the application of a nitrification/denitrification or a chemical/mechanical stage (e.g. see BREF Section 4.3.8.8).[2] BAT is to take full advantage of the biological degradation potential of the total effluent and to achieve BOD elimination rates above 99 % and yearly average BOD emission levels of 1 – 18 mg/l. The levels relate to the effluent after biological treatment without dilution, e.g. by mixing with cooling water (see BREF Section 4.3.8.11). BAT is to achieve the emission levels given in Figure 9.	
Monitoring of the total effluent	Regular monitoring of the total effluent, including performance of the biological WWTP enables the operator of a multipurpose plant to identify problems arising from product changes, individual production campaigns or even individual production batches and to indicate that measures	Sterling regularly monitors its effluents

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	to solve such problems lead to results (for an example, see BREF Section 4.3.8.8). Monitoring of refractory loads, AOX, and heavy metals show if pre-treatment strategies were successful (for an example, see BREF Sections 4.3.7.14 and 4.3.7.22). The monitoring frequencies should reflect the operational mode of the production and the frequency of product changes as well as the ratio of buffer volume and residence time in the biological WWTP. For an example concerning monitoring frequencies, see Table 4.86 in Section 4.3.8.21 in the BREF document. BAT is to regularly monitor the total effluent to and from the biological WWTP measuring at least the parameters given in Figure 1 (see BREF Section 4.3.8.21). Not available	
Monitoring of the total effluent **Biomonitoring**	Where substances with ecotoxicological potential are handled or produced with or without intention (e.g. production of active pharmaceutical ingredients, biocides, plant health products), biomonitoring is a tool to identify residual acute toxicity in the total effluent instead of tracking an uncertain and possibly wide range of individual substances. Biomonitoring also represents an option to identify inherent problems on a production site which are possibly not as visible as fluctuations in other monitoring data. The biomonitoring frequencies should reflect them	Not applicable Sterling can also make a monthly monitoring according to the raw materials that will be used in production

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	operational mode of the production and the frequency of product changes. Where biomonitoring shows that residual toxicity is a concern, the causes of such toxicity should be identified in order to develop and implement measures. BAT is to carry out regular biomonitoring of the total effluent after the biological WWTP where substances with ecotoxicological potential are handled or produced with or without intention (for examples, see BREF Sections 4.3.8.18 and 4.3.8.19).	
Monitoring of the total effluent **Online toxicity monitoring**	Where residual toxicity is identified as a concern (e.g. where fluctuations of the performance of the biological WWTP can be related to critical production campaigns), online biomonitoring in combination with online TOC measurement is a tool to identify critical situations early and to enable the operator to react. BAT is to apply online toxicity monitoring in combination with online TOC measurement if residual acute toxicity is identified as a concern, for examples see BREF Sections 4.3.8.7 and 4.3.8.20.	Not applicable. There is no connection between the sewage system and toxic raw materials.

[1] In some Member States, AOX is a well established screening parameter for the assessment of halogenated organic compounds in aqueous solutions. In other Member States, AOX as a parameter is just being established and step-by-step implementation will be necessary in many cases. The main factor to actively influence the emission level of AOX is the segregation and selective pretreatment of waste water streams from processes with AOX relevance. For examples and applied techniques, see BREF Sections 4.3.7.15, 4.3.7.16, 4.3.7.17, 4.3.7.23.

[2] In some Member States, AOX is a well established screening parameter for the assessment of halogenated organic compounds in an aqueous solution. In other Member States, AOX as a parameter is just being established and step-by-step implementation will be necessary in many cases. The main factor to actively influence the heavy metal emission levels is the segregation and selective pre-treatment of waste water streams (see BREF Section 4.3.7.22).

Figure 7:

Parameter	Yearly average levels	Unit	Comment
AOX	0.5 – 8.5	mg/l	The upper range relates to cases where halogenated compounds are processed in numerous processes and the corresponding waste water streams are pretreated and/or where the AOX is very bioeliminable.

Table 5.6: BAT associated AOX levels in the inlet to the on-site biological WWTP or in the inlet to the municipal sewerage system

Figure 8:

Parameter	Yearly average levels	Unit	Comment
Cu	0.03 – 0.4	mg/l	The upper ranges result from the deliberate use of heavy metals or heavy metal compounds in numerous processes and the pretreatment of waste water streams from such use.
Cr	0.04 – 0.3		
Ni	0.03 – 0.3		
Zn	0.1 – 0.5		

Table 5.7: BAT associated levels for heavy metals in the inlet to the on-site biological WWTP or in the inlet to the municipal sewerage system

Figure 9:

	Yearly averages*		
Parameter	**Level**	**Unit**	**Comment**
COD	12 – 250	mg/l	see Section 4.3.8.10
Total P	0.2 – 1.5		The upper range results from the production of mainly compounds containing phosphorus (see Sections 4.3.7.24, 4.3.8.16, 4.3.8.17)
Inorganic N	2 – 20		The upper range results from production of mainly organic compounds containing nitrogen or from, e.g. fermentation processes (see Sections 4.3.2.11 and 4.3.8.14)
AOX	0.1 – 1.7		The upper range results from numerous AOX relevant productions and pretreatment of waste water streams with significant AOX loads (see Sections 4.3.8.12, 5.2.4.4.2).
Cu	0.007 – 0.1		The upper ranges result from the deliberate use of heavy metals or heavy metal compounds in numerous processes and the pretreatment of waste water streams from such use (see Sections 4.3.7.22, 4.3.8.1, 5.2.4.5).
Cr	0.004 – 0.05		
Ni	0.01 – 0.05		
Zn	– 0.1		
Suspended solids	10 – 20		See Section 4.3.8.7
LID_F	1 – 2	Dilution factor	Toxicity is also expressed as aquatic toxicity (EC_{50} levels), see also Sections 4.3.8.7, 4.3.8.13, 4.3.8.18
LID_D	2 – 4		
LID_A	1 – 8		
LID_L	3 – 16		
LID_{EU}	1.5		

* The levels relate to the effluent after biological treatment without dilution, e.g. by mixing with cooling water

Table 5.8: BAT for emissions from the biological WWTP

Part 3. Environmental management

Aspect of BAT	BAT	Status at Installation
Environmental management techniques	A number of environmental management techniques are determined as BAT. 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. BAT is to implement and adhere to an Environmental Management System (EMS) that incorporates, as appropriate to individual circumstances, the following features: (see BREF Chapter 4) • definition of an environmental policy for the installation by top management (commitment of the top management is regarded as a precondition for a successful application of other features of the EMS) • planning and establishing the necessary procedures • implementation of the procedures, paying particular attention to - structure and responsibility - training, awareness and competence - communication	Sterling Chemical Malta is progressively implementing an integrated management system on environment, health and safety issues, by applying what has already been implemented in Italy into the Maltese plant. All procedures and operative instructions in force in Malta are attached to the main document of the IPPC permit. More procedures will be attached during the evolution of the plant and according to what the Maltese competent authorities stated. The system will be certified six months after the activation of the plant. This is required by the regulation ISO14001 in order to check the effectiveness of the procedures and operative instructions implemented.

Aspect of BAT	BAT	Status at Installation
	- employee involvement - documentation - efficient process control - maintenance programme - emergency preparedness and response - safeguarding compliance with environmental legislation • checking performance and taking corrective action, paying particular attention to - monitoring and measurement (see also the Reference document on Monitoring of Emissions) - corrective and preventive action - maintenance of records - independent (where practicable) internal auditing in order to determine whether or not the environmental management system conforms to planned arrangements and has been properly implemented and maintained. • review by top management. Three further features, which can complement the above stepwise, are considered as supporting measures. However,	

Aspect of BAT	BAT	Status at Installation
	their absence is generally not inconsistent with BAT. These three additional steps are: • having the management system and audit procedure examined and validated by an accredited certification body or an external EMS verifier • preparation and publication (and possibly external validation) of a regular environmental statement describing all the significant environmental aspects of the installation, allowing for year-by-year comparison against environmental objectives and targets as well as with sector benchmarks as appropriate • implementation and adherence to an internationally accepted voluntary system such as EMAS and EN ISO 14001:1996. This voluntary step could give higher credibility to the EMS. In particular EMAS, which embodies all the above-mentioned features, gives higher credibility. However, non-standardised systems can in principle be equally effective provided that they are properly designed and implemented.	
Waste water and waste gas	BREF for common waste water & waste gas treatment systems in the chemical sector (published 2003/2009)	This BREF is not applicable for Sterling process. The waste produced, particularly those actually treatable are not in an

Aspect of BAT	BAT	Status at Installation
treatment		amount such as to bring a real benefit to the environment. It is stated, as proof of this, an extract of the research commissioned by Sterling in order to assess the actual social, environmental and economical convenience feasibility on applying a system of treatment of waste water. Also note how the size of the treatment plant are incompatible with the space available for Sterling
Industrial cooling system	BREF for Industrial cooling systems (published 2001)	The Industrial cooling systems adopted by Sterling follows the BREF instructions. In particular: The chillers are designed for outdoor installation. These units are air-cooled, equipped with modular finned core condensers, axial fans, multiple scroll compressors connected in parallel (tandem or trio) serving 2, independent refrigerant circuits, independent aeraulic condensing sections, and plate evaporators. These solutions make it possible to enhance energy efficiency at low loads, which account for the largest portion of the working life of an air conditioning unit, thereby maximising seasonal performance indices. The units are administrated by a microprocessor controller that provides fully independent management of all the main functions. One of the processor tasks is to modulate the flow of water depending on the need of the current process. This saves considerable energy as provided in Section 4.3.2 and Table 4.3 of BAT for industrial cooling systems. Furthermore, the application of pumps with inverter

Aspect of BAT	BAT	Status at Installation
		technology allows to manage and modulate the flow to the real needs of the process. In the chillers used for the industrial process there will be the hermetic compressors employed to offer a series of benefits, including: reduced pressure drops on the suction side thanks to the absence of valves, significant resistance to possible liquid pressure shocks, high compression efficiency, long working life with zero maintenance requirements, and very low levels of vibration and noise emissions. Each compressor is equipped with a check valve on the discharge line that prevents possible liquid reverse flow. To reduce the corrosion, pipelines in galvanized steel as suggested in Table 4.6 of the BAT are applied and to reduce the possibility of water stagnation in the pipelines its speed is greater than 0.8 m/s as suggested for the Condensers and the heat exchangers always in table 4.6. In addition, the temperatures always set below 60° C enables a reduction in the risk of rupture of the pipes. The modest size of the cooling tower exclude the possibility of the formation of large plumes such as to cause visual pollution. To avoid corrosive phenomena there will be used chemical additives such as glycol and anticorrosive and to operate with pH comprised between 7 and 8. The liquid used it will be periodically replaced to ensure the efficiency of the system and it will be used during the winter. It is also excluded the discharge into the public sewer. The liquid is

Aspect of BAT	BAT	Status at Installation
		collected in tanks, it will be analyzed by the internal laboratory if still reflects the characteristics of pH it will be reused in the system otherwise disposed of as waste as CER code 070701*. This ensures another important aspect mentioned in the BREF to point 3.4.6