### BAT conclusions specific to mechanical biological treatment (MBT)

Mechanical-biological waste treatment (MBT technology) is a material-specific process. Mixed (residual) waste is separated into various fractions, each of which is treated and, if possible, recycled in a way that is customised to its properties. The core elements of MBT are mechanical or physical separation technologies and the biological treatment of biodegradable waste components unless they are diverted to recycling (e.g. paper). Most MBT plants divide their input into a fine fraction for biological treatment and a coarse high-calorific fraction that undergoes extended mechanical treatment. Mechanical-biological stabilisation plants (MBS) deviate from this concept as their entire input or the mechanically separated, high-calorific fraction undergoes biological drying.

## Types of mechanical-biological waste treatment

Mechanical-biological waste treatment plants are grouped into the following types based upon the main technology used in the biological stage:

* aerobic treatment (output from the biological stage is consigned to landfill)
* aerobic mechanical-biological stabilisation or drying (MBS) to produce refuse-derived fuel (output from the biological stage is mainly used to make refuse-derived fuel).
* dry digestion (anaerobic)
* wet digestion (anaerobic)

**The following mechanical treatment occurs:**

* Functions of mechanical treatment
* Shredding and homogenisation
* Sorting coarse and fine fractions
* Separating FE and NF metals
* Processing the high-calorific fraction
* Ejection of impurities and recyclables using sensors
* Wet mechanical sorting technologies

### Functions of mechanical treatment

Mechanical processing prepares waste for subsequent treatment. The degree of processing is determined mainly by the application for the high-calorific coarse fraction and the biological treatment process for the fine fraction.

### Shredding and homogenisation

In the first stage of mechanical processing, waste is prepared for subsequent treatment, pre-shredded to the necessary size and thereby also homogenised for the first time. The shredding process also opens containers and bags etc, and increases the surface area of the waste components, improving the breakdown of degradable organic elements for biological treatment.

The decision whether to pre-shred material depends upon the waste’s properties. The machinery used in this phase varies in terms of its shredding effect and depends on the type of waste to be treated. Plants frequently use breaking (e.g. single or multi-shaft breakers), cutting (rotary shear or cutting mill) or shearing (screw mill) machinery. One alternative is high-pressure compactors, which combine shredding and sorting of fractions that will undergo biological treatment.

### Sorting coarse and fine fractions

The sorting of high-calorific coarse waste fractions and the fine fraction destined for biological treatment is largely performed using screening (drum, vibrating and star screens) with screen cuts between 40 mm and 150 mm. Air-classifiers are occasionally used as well. A few plants also utilise ballistic separators.

### Separating FE and NF metals

Magnets remove ferrous metals; non-ferrous (NF) metals are extracted using eddy current separation systems.

### Processing the high-calorific fraction

The resulting high-calorific fraction must undergo additional processing prior to energy recovery, if necessary, depending on the customer’s specifications. Apart from additional shredding, other steps include further removal of metals and other impurities, such as rocks or other inert, non-combustible materials.

### Ejection of impurities and recyclables using sensors

A few plants also utilise sensor-based sorting technologies (optical NIR sensors) in order to remove PVC, for instance, from the high-calorific fraction. The PVC's high chlorine level would lower fuel quality. A few sensor-based sorting solutions remove paper and wood from the fine fraction.

### Wet mechanical sorting technologies

Wet digestion plants use pulpers after the dry mechanical stage to homogenise substrate and better bring it into suspension through defibration. The pulper can eject both non-digestible floating solids and inert suspended solids, but this step may also be performed in other stages (e.g. the grit chamber). The pulper is followed by other wet sorting stages to remove floating and suspended solids (the grit chamber). Hydrocyclones are also used for this purpose.

The objective is to remove impurities, such as leftover metal, glass, sand, rocks and gravel, through sedimentation and plastic through a floating action to the aqueous phase. The degradable organic fraction that will be sent for anaerobic biological treatment is left.

#### Overview of MBT steps

The typical process stages of an MBT operation with the principal functions of each step are listed below:

* Feedstock acceptance and storage:
* To formally accept waste
* To provide adequate capacity for the feedstock
* To prevent fugitive emissions
* To blend feedstock’s and balance conditions in the waste to optimise treatment
* Mechanical treatment of feedstock prior to biological treatment steps:
* To eject and/or process (e.g. shredding) impurities
* To screen out a fine fraction with a high level of degradable organic components for biological treatment
* To sort, shred or customise high-calorific waste fractions for energy recovery (in the MBT plant’s main stream before or after biological treatment)
* To eject heavy fractions
* To separate groups of materials for recycling (e.g. metals)
* To break down and homogenise waste components for biological treatment
* To customise high-calorific output material
* Biological treatment steps:
* To prepare organic material for its end use or disposal.
* Storage:
* To store MBT outputs ready for use or prior to disposal.

#### Principal techniques applied to MBT steps

|  |  |
| --- | --- |
| **Specific techniques include:** | **Process Step to which technique is applicable:** |
| Rotary Shredders  Rotating drum shredders  Rotary shears or cutting mills  Screw mills  Single or multiple-shaft breakers  Ball mills  Bag splitters | Waste preparation |
| Conveyor systems  Trommels and screens (drum, vibrating and star screens)  Manual separation (hand sorting)  Magnetic separation  Eddy current separation  Air classification  Ballistic separation  Optical separation | Mechanical separation |
| Biodrying  Indoor composting  Outdoor composting  Biostabilisation | Biological treatment: Aerobic |
| Anaerobic digestion (wet or dry) | Biological treatment: Anaerobic |
| Heat treatment – autoclaving;  Heat treatment – continuous heat treatment | Heat treatment |

**XX. In order to improve the environmental performance of MBT composting installations, BAT is to use the construction and design techniques below.**

|  |  |  |
| --- | --- | --- |
| **Techniques** | **Description** | **Applicability** |
| Waste reception and storage area design | * The reception area is appropriately sized to accommodate the expected volume of waste, a dedicated area for off-loading and inspections of input material loads, a dedicated quarantine area for unacceptable or rejected loads and any area allocated to pre-treatment * Where the waste reception area is required to be in an enclosed building it includes a building ventilation system and an emission abatement system that maintains the building under negative air pressure in order to minimise fugitive odour, bioaerosol, and dust release from the building. * The reception area is designed to facilitate cleaning including drainage to allow discharge of wash waters into gullies and to a sump for use within the process or to be discharged into sewers. * All reception areas have an impermeable surface with self-contained drainage, to prevent any spillage entering the storage systems or escaping off-site. The design should prevent the contamination of clean surface water. | Applicable to indoor composting |
| Vessel or enclosed building design | * The vessel or enclosed treatment space should is designed with sufficient capacity for waste to be treated within the retention time of the treatment process or the relevant treatment step. * The process should be fully enclosed with an air abatement system. * Treatment areas have engineered impermeable surfaces with kerbed areas to allow collection of runoff and leachate. * Run off and leachate (dirty water) is collected in an engineered system, collected in a sump or lagoon and where possible kept separate from clean roof or yard water. * Air extraction should be designed and maintained to move and handle the volume of air to provide a clear working environment | Applicable to indoor composting |
| Pre-treatment and post-treatment areas design | * All treatment areas have engineered impermeable surfaces with kerbed areas to allow collection of runoff and leachate as defined in section * Run off and leachate (dirty water) are collected in an engineered system and collected in a sump or lagoon. * A maintenance schedule is included in the management system. Repair should be initiated within the time frame specified in the plant’s management system. | Applicable to indoor composting |
| Waste storage | * Waste is stored under appropriate conditions in the quarantine area to avoid putrefaction, odour generation, the attraction of vermin and any other nuisance or objectionable condition. * The operator ensures that incoming waste is stored in a manner to prevent nuisance from odour, dust vermin birds etc. * Where required by the Regulator or relevant Competent Authority, the waste storage occur inside an appropriate building. | Generally applicable |

**XX. In order to improve the environmental performance of composting installations, BAT is to use the management techniques below for waste acceptance and characterisation.**

|  |  |  |
| --- | --- | --- |
| **Techniques** | **Description** | **Applicability** |
| Waste pre-acceptance procedures | * Waste is only accepted at the facility if suitable for processing. The plant operator establishes and maintains detailed written procedures for the acceptance and handling of wastes. These procedures provide for the pre-clearance and characterisation of waste types proposed to be accepted at the facility. * Some waste streams not already well characterised may require feedstock characterisation by sampling and testing, composition analysis or visual assessment to be conducted as part of establishing a supply contract. * Some waste streams may require periodic verification of the initial characterisation. | Generally applicable |
| Waste acceptance procedures | * Waste is accepted at the facility from known customers or new customers subject to pre-acceptance procedures. * The operator should have clear and unambiguous criteria for the rejection of wastes or any actions to be taken to remove or reduce physical contaminants or any other unsuitable content prior to processing, together with a written procedure for tracking and reporting non-conformance. * Waste arriving at the facility are certified (as to source), weighed, documented and directed to the Waste reception area. The quality and quantity of feedstock arriving at the installation is recorded at the weighbridge. Each load of waste arriving at the Waste reception facility is inspected upon tipping within this facility. Only after such inspections the waste is processed for recovery. If the inspection indicates that the wastes fail to meet the acceptance criteria, then such loads are stored in a dedicated quarantine area and dealt with appropriately. | Generally applicable |
| Increase the retention time in the anaerobic digestion processes | Involves allowing the digestate to spend more time under degradation conditions | Applicable for AD, but also be achieved with general process improvements and monitoring |

#### General management system of operational process with a view to enhance environmental performances

**XX. In order to improve the environmental performance of composting installations, BAT is to adhere to an environmental management system to include the following features:**

|  |  |  |
| --- | --- | --- |
| **Techniques** | **Description** | **Applicability** |
| Operations and maintenance procedures | Effective operational and maintenance systems are in use for all aspects of the process especially where failure could impact on the environment, in particular there should be:   * control of operations that may have an adverse impact on the environment * a defined procedure for identifying, reviewing and prioritising items of plant for which a preventative maintenance regime is necessary * documented procedures for monitoring emissions or impacts * a preventative maintenance programme covering all plant, whose failure could lead to impact on the environment, including regular inspection of major ‘non-productive’ items such as tanks, pipe work, retaining walls, bunds, ducts and filters. The maintenance system includes auditing of performance against requirements arising from the above and reporting the result of audits to top management. * Maintenance schedules are included in the management system. Repair should be initiated within the time frame specified in the plant’s management system. | Generally applicable |
| Competence and training procedures | * The plant employs a suitable qualified and experienced facility manager who is designated as the person in charge. The facility manager or a nominated, suitably qualified and experienced deputy is present on the facility at all times during its operation. * The plant ensures that personnel who performs specific tasks is qualified on the basis of appropriate education, training and experience as required and aware of the requirements of the permit/licence. In addition, the facility manager and his/her deputy successfully complete a recognised specific training course relevant to the management of the facility. * Training systems, covering the following items, should be in place for all relevant staff which cover: * awareness of the regulatory implications of the permit/licence and how this impacts their work responsibilities and activities; * awareness of all potential environmental effects from operation under normal and abnormal or extreme circumstances (e.g. extreme weather, plant failure, emergency) * awareness of the need to report deviation from the permit/license * prevention of accidental emissions and action to be taken when accidental emissions occur * reporting and accountability procedures within the management structure of the facility. | Generally applicable |
| Accidents / incidents procedures | An accident plan is in place which:   * identifies the likelihood and consequence of accidents and emergency * identifies actions to prevent accidents and mitigate any consequences   The accident management plan considers and has procedures for dealing with events which effect the day to day operation of the facility e.g. risks and impact of flooding and fires. | Generally applicable |
| Environmental Management Systems | A written management system is in place which provides the framework for the plant to deal with immediate and long-term environmental impact of its products, services and processes.  A management system needs consider the location, waste types treated, size of your site, and complexity of your process.  The operation of formal environmental management systems (EMSs) is equally accepted as non-certified systems. The level of information and control should be proportional to the risk each activity may have to the environment or on process control. | Generally applicable |

#### Biological treatment process monitoring

**XX. In order to ensure stable process operation and optimisation and to minimise operational difficulties, BAT is to have a suitable monitoring system, both manual and instrumental. Parameters monitored may include, but are not limited to, the following:**

|  |  |
| --- | --- |
| **Parameter** | **Parameter, Unit, Measurement frequency and Critical limits** |
| Indoor composting | See section ### |
| Outdoor composting | See section ### |
| Biodrying | See section ### |
| Biostabilisation | See section ### |
| Anaerobic digestion | See section ### |

#### Emissions to water

**XX. In order to reduce or prevent emissions to water, BAT is to use the following techniques.**

|  |  |  |
| --- | --- | --- |
| **Operational techniques** | **Description** | **Applicability** |
| Procedures to manage discharge of leachate and/or contaminated storm water to surface water | Unless otherwise agreed by the Regulator or relevant Competent Authority, no leachate and/or contaminated storm water is  discharged to surface water drains and courses. | Applicable to biological treatments |
| Procedures to manage direct or indirect emissions to groundwater | Unless otherwise agreed by the Regulator or relevant Competent Authority, no leachate and/or contaminated storm water is  discharged directly or indirectly to groundwater. | Applicable to biological treatments |
| Procedures to manage discharge of compost leachate and/or contaminated storm water to sewers or for treatment at sewage treatment work off-site | Where effluent is treated off-site at a sewage treatment works:   * action plans are appropriate to prevent direct discharge of the waste-waters in the event of sewer bypass, (via storm/emergency overflows or at intermediate sewage pumping stations) for example, knowing when bypass is occurring, rescheduling activities such as cleaning or even shutting down when bypass is occurring. * a suitable monitoring programme is in place for emissions to sewer. * the operator conducts visual checks on the effluent management system and maintain a log. * the operator has in place procedures to ensure that the effluent specification is suitable for the on-site effluent treatment system or discharge criteria * measures are in place to isolate effluent where samples indicate a breach of specification. Incidents of this nature are recorded in the effluent log. | Applicable to biological treatments |
| Closed loop cooling systems | Wherever possible, closed loop cooling systems are used and procedures in place to ensure blow down from abatement systems is minimised | Applicable to biological treatments |
| Leachate management | Leachate is managed via a sealed drainage system that collects and separately contains it from non-contaminated surface water at the facility. All systems are fitted with high level alarms and a record of inspection of levels kept on site.  Prevention of excessive leachate as a priority through design is needed, diverting rainfall from stored feedstock, active composting and product maturation areas where possible*.* The amounts collected can be minimised by providing separate drainage for clean roof water and clean yard water*.* Clean and dirty drainage are clearly identified. | Applicable to biological treatments |
| **Management techniques** | **Description** | **Applicability** |
| Re-use of leachate or process water | Where possible reuse of leachate or other water helps maintaining moisture content in the active composting phase. Leachate from unsanitised waste is not applied to sanitised wastes.  Digestate has to be circulated to maintain the microbiological population in the digestor to the extent that no inhibiting effects (e.g. NH3) may occur. Good digestate and water management reduces the amount of waste water. | Applicable to biological treatments |

#### Emissions to air – odours, bioaerosols, dust, point source emissions (e.g. ammonia from biofilter)

The AD process itself is enclosed and air emissions and odour are unlikely to occur except during transfer to and from the digester as well as separation and pretreatment of biowaste as well as open tanks. However emissions related to the delivery of waste and mechanical treatment may cause emissions of odours and dust as well as the post composting of the digestate may cause a significant odour problem if not properly treated.

**XX. In order to operate low-emission composting installations, BAT is to have the following techniques.**

|  |  |  |
| --- | --- | --- |
| **Process step** | **Operational Techniques** | **Applicability** |
| Reception area | * Reception in an open or enclosed area * Ensure that gates to halls and bunkers open quickly during reception; operate gate air curtain system when gates open. Tip feedstock into open bunkers, reception area and pits quickly. | Applicable to MBT |
| Interim storage | * When storage is enclosed, capture, discharge and treat exhaust air and wastewater | Applicable to MBT |
| Processing | * When pre-treatment is carried out in an enclosed area, capture, discharge and treat exhaust air. | Applicable to MBT |
| Intensive or main decomposition (enclosed) | * Control active aeration system to ensure sufficient air is supplied to the composting material | Applicable to composting |
| Exhaust air capture and encapsulation | * Have a control programme for all aeration and ventilation systems that encompasses all operating statuses in the entire plant and in individual parts or units. Instructions for malfunction. * Effectively control hall gates and doors (e.g. automatic closing, remote operation from the wheel-loader etc.). * Ensure a vacuum in parts of the installation where air is extracted (prevent fugitive gas emissions) | Applicable to composting |
| Final product storage | * Operators ensure that sufficient provision has been made for storage prior to distribution to compost recipients. Storage provision may have to take into account situations where the land-bank may be unavailable for prolonged periods, for example, where the land is waterlogged or frozen. | Applicable to composting |
| **Process step** | **Management Techniques** | **Applicability** |
| Reception area | * Review the admissibility and suitability of compost feedstock * Clean the reception and tipping area on a regular basis | Applicable to composting |
| Interim storage | * Identify substrate suitable for open-air storage and move it to the respective interim store. | Applicable to composting |
| Batch formation  Indoor or outdoor? | * Produce the feedstock blend while ensuring adequate levels of structurally stable substances (wood chips, screenings etc.), favourable water levels, favourable C:N ratio, adequate air pore volume. * Form batches while respecting the underlying design and ballast loads to guarantee adequate air pore volume. | Applicable to composting |
| Intensive or main decomposition  (enclosed) | * Control active aeration system to ensure sufficient air is supplied to the composting material * Irrigate composting material in the case of insufficient moisture content (but do not waterlog). | Applicable to composting |
| Post-treatment | * If drum screens are used: * wet material (> 35% water) => Reduced screening capability, low screening yield, high screen overflow. * dry material (< 35% water) => Good screening capability, good screening yield; significant dust emissions possibly associated with microbe emissions as water levels decrease (< 20%). | Applicable to composting |
| Final product storage | * Do not overly agitate product with very compact layers. | Applicable to composting |
| Precipitation of sulphur | Chemical precipitation of sulphur inside of the digestor by air injection or use of metal-ions. Alternatively or additionally the produced biogas can be cleaned from sulphur and siloxane with activated carbon filtration | Applicable biogas with high sulphur concentrations |

**XX. In order to reduce or prevent odour and dust emissions, including dust emissions from the facility and bioaerosols emissions, BAT is to use the following techniques.**

|  |  |  |
| --- | --- | --- |
| **Techniques** | **Description** | **Applicability** |
| Odour management plan/system | An odour management system is in place including measures aimed at minimising, or where possible preventing, odour emissions. Features include (but are not limited to:   * Composting process is optimised by controlling parameters listed in 1.1.1.5 * Where odour-generating activities take place in the open, (or potentially odorous materials are stored outside), a high level of management control and use of best practice to prevent odours is expected. * Where possible processing activities that are high risk of producing odour during unfavourable meteorological conditions such as turning, screening and shredding are avoided. | Applicable to biological treatments |
| Dust management plan | In dry weather, site roads and any other areas used by vehicles are sprayed with water as and when required to minimise airborne dust nuisance.  Other measures include:   * Covering of skips to and from site and in storage. * Where dust creation is unavoidable, use of sprays, binders, stockpile management techniques, windbreaks etc. are employed based on risk assessment * Wheel and road cleaning (avoiding transfer of pollution to water and wind blown particulate) * Closed conveyors, pneumatic or screw conveying (noting the higher energy needs). Filters on the conveyors to clean the transport air prior to release * Regular housekeeping | Applicable to biological treatments |
| Identification of activities that could potentially generate bioaerosols | A full and complete identification of activities that could potentially generate bioaerosols is carried out. | Applicable to biological treatments |
| Avoidance of activities generating bioaerosols | Where possible, particulate and bioaerosols forming activities, such as turning, screening and shredding in unfavourable meteorological conditions are avoided. Activity ceases if wind direction is toward the sensitive receptor | Applicable to biological treatments |
| Composting process control and optimisation | Process monitoring and control measures are in place to correct excessive temperatures and moisture and to control evaporation, in order to minimise surface emissions off wastes. | Applicable to biological treatments |
| Scrubber and biofilter and design and optimisation | Scrubbers and biofilters are designed, commissioned and monitored to ensure optimum performance, i.e. operating at correct pH, ensuring adequate chemical wash replenishment and replacement and pressure drop monitoring. | Applicable to biological treatments |
| Recording of weather data | Weather data are recorded or obtained from national weather agency | Applicable to biological treatments |
| Use of misting devices | Misting and atomising units at the boundary or operationally placed. If used will be fully operational and maintained. | Applicable to biological treatments |

**XX. In order to prevent, or where it is not practicable, to reduce emissions to air from indoor composting, BAT is to use one or a combination of the following abatement systems.**

|  |  |  |
| --- | --- | --- |
| **Techniques** | **Description** | **Applicability** |
| Biofilter |  | Applicable to biological treatments |
| Wet scrubber |  | Applicable to biological treatments |
| Activated carbon |  | Applicable to biological treatments |
| Bioscrubber |  | Applicable to biological treatments |
| Ozone treatment |  | Applicable to biological treatments |
| Acidic scrubber |  | Applicable to biological treatments |
| Regenerative thermal oxidisers | Flameless oxidation technique that involves a heated bed of ceramic material and whose function is to reduce greenhouse gas emissions (e.g. methane) and to dispose of other organic substances that have an impact on the environment and human health | Applicable to MBT |
| [other] |  |  |

**XX. In order to prevent, or where it is not practicable, to reduce emissions to air from indoor composting, BAT is to use one or a combination of the following types of containment.**

|  |  |  |
| --- | --- | --- |
| **Techniques** | **Description** | **Applicability** |
| Tunnels |  | Applicable to biological treatments |
| Rotating Drums |  | Applicable to biological treatments |
| Enclosed halls |  | Applicable to biological treatments |
| Silos |  | Applicable to biological treatments |
| Agitated bays |  | Applicable to biological treatments |
| [others] |  | Applicable to biological treatments |

**XX. In order to reduce or prevent litter, BAT is to use the following techniques.**

|  |  |  |
| --- | --- | --- |
| **Techniques** | **Description** | **Applicability** |
| Management procedures for litter control | All loose litter or other waste, placed on or in the vicinity of the facility, other than in accordance with the requirements of the permit/licence, is removed in a timely manner, subject to the agreement of the landowners. | Generally applicable |

**XX. In order to reduce or prevent the presence of pests/ vermin, BAT is to follow any or a combination of the following techniques:**

|  |  |  |
| --- | --- | --- |
| **Techniques** | **Description** | **Applicability** |
| Management procedures for pests/vermin control | The operator has documented procedures in place to ensure pests/vermin are controlled. These include inspections at the facility and its immediate surrounds for nuisances caused by vermin, birds, and flies. The operator maintains a record of all nuisance inspections. | Generally applicable |

#### Noise and vibrations

**XX. In order to reduce or prevent noise and vibration, BAT is to follow any or a combination of the following techniques:**

|  |  |  |
| --- | --- | --- |
| **Techniques** | **Description** | **Applicability** |
| Noise survey and management plan | The plant carries out a noise survey of the site operations. The survey programme identifies: the main sources of noise and including infrequent sources); the nearest noise sensitive locations and relevant environmental surveys which have been undertaken; and the proposed techniques and measures for the control of noise. | Generally applicable |
| Measures for the control of noise, including maintenance | The operator employs basic good practice measures for the control of noise, including adequate maintenance of any parts of plant or equipment whose deterioration may give rise to increases in noise (for example, bearings, air handling plant, the building fabric, and specific noise attenuation kit associated with plant or machinery). | Generally applicable |

#### Resource and energy efficiency (waste and materials use, water consumption etc.)

**XX. In order to use energy efficiently and to reduce raw materials and chemicals consumption, BAT is to follow any or a combination of the following techniques:**

|  |  |  |
| --- | --- | --- |
| **Techniques** | **Description** | **Applicability** |
| Energy efficiency audit | The plant carries out an audit of the energy efficiency of the site within one year of the date of commencement of the plant activity. The energy efficiency audit is repeated at intervals as required by the Regulator. The audit identifies all practicable opportunities for energy use reduction and efficiency and the recommendations of the audit will be incorporated into the plant management system targets. | Generally applicable |
| Water recycling and reuse | The plant identifies opportunities for reduction in the quantity of water used on site including recycling and reuse initiatives, wherever possible. Reductions in water usage shall be incorporated into the plant management system targets.  Optimise the water reuse, taking into account the legal requirements (odour minimsation), technical requirements (need of water for optimised aerobic degradation) and sanitisation requirements (non recontamination of compost). | Generally applicable |
| Assessment of efficiency of use of raw materials | The plant undertakes an assessment of the efficiency of use of raw materials in all processes, having particular regard to the reduction in waste generated. The assessment takes account of best international practice for this type of activity. Where improvements are identified, these are incorporated into the plant management system targets. | Generally applicable |

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