Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU)

Changes to legislation: There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)

ANNEX

BAT CONCLUSIONS FOR THE PRODUCTION OF PULP, PAPER AND BOARD

SCOPE

These BAT conclusions concern the activities specified in Sections 6.1.(a) and 6.1.(b) of Annex I to Directive 2010/75/EU, i.e. the integrated and non-integrated production in industrial installations of:

(a) pulp from timber or other fibrous materials;

(b) paper or cardboard with a production capacity exceeding 20 tonnes per day.

In particular, these BAT conclusions cover the following processes and activities:

(i) chemical pulping:

  (a) kraft (sulphate) pulping process

  (b) sulphite pulping process

(ii) mechanical and chemimechanical pulping

(iii) processing paper for recycling with and without deinking

(iv) papermaking and related processes

(v) all recovery boilers and lime kilns operated in pulp and paper mills

These BAT conclusions do not address the following activities:

(i) production of pulp from non-wood fibrous raw material (e.g. yearly plant pulp);

(ii) stationary internal combustion engines;

(iii) combustion plants for steam and power generation other than recovery boilers;

(iv) dryers with internal burners for paper machines and coaters.

Other reference documents which are relevant for the activities covered by these BAT conclusions are the following:

Reference documents	Activity
Industrial Cooling Systems (ICS)	Industrial cooling systems, e.g. cooling towers, plate heat exchangers
Economics and Cross-Media Effects (ECM)	Economics and cross-media effects of techniques
Emissions from Storage (EFS)	Emissions from tanks, pipework and stored chemicals
Energy Efficiency (ENE)	General energy efficiency
Large Combustion Plants (LCP)	Generation of steam and electricity in pulp and paper mills by combustion plants
General Principles of Monitoring (MON)	Emissions monitoring
Waste Incineration (WI)	On-site incineration and co-incineration of waste

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Waste Treatments Industries (WT)	Preparation of waste as fuels

GENERAL CONSIDERATIONS

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

Unless otherwise stated, the BAT conclusions are generally applicable.

EMISSION LEVELS ASSOCIATED WITH BAT

Where emission levels associated with the best available techniques (BAT-AELs) are given for the same averaging period in different units (e.g. as concentration and specific load values (that is per tonne of net production)), those different ways of expressing BAT-AELs are to be seen as equivalent alternatives.

For integrated and multi-product pulp and paper mills, the BAT-AELs defined for the individual processes (pulping, papermaking) and/or products need to be combined according to a mixing rule based on their additive shares of discharge.

AVERAGING PERIODS FOR EMISSIONS TO WATER

Unless stated otherwise, the averaging periods associated with the BAT-AELs for emissions to water are defined as follows.

Daily average	Average over a sampling period of 24 hours taken as a flow-proportional composite sample[a] or, provided that sufficient flow stability is demonstrated, from a time-proportional sample[a]
Yearly average	Average of all daily averages taken within a year, weighted according to the daily production, and expressed as mass of emitted substances per unit of mass of products/materials generated or processed

a In special cases, there may be a need to apply a different sampling procedure (e.g. grab sampling)

REFERENCE CONDITIONS FOR EMISSIONS TO AIR

The BAT-AELs for emissions to air refer to standard conditions: dry gas, temperature of 273,15 K, and pressure of 101,3 kPa. Where BAT-AELs are given as concentration values, the reference O_2 level (% by volume) is indicated.

Conversion to reference oxygen concentration

The formula for calculating the emissions concentration at a reference oxygen level is shown below.

$$E_R = \frac{21-O_R}{21-O_M} \times E_M$$

where:

E_R (mg/Nm^3)	:	emissions concentration referred to the reference oxygen level O_R
O_R (vol %)	:	reference oxygen level

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E_M (mg/Nm^3)	:	measured emissions concentration referred to the measured oxygen level O_M
O_M (vol %)	:	measured oxygen level.

AVERAGING PERIODS FOR EMISSIONS TO AIR

Unless stated otherwise, the averaging periods associated with the BAT-AELs for emissions to air are defined as follows.

Daily average	Average over a period of 24 hours based on valid hourly averages from continuous measurement
Average over the sampling period	Average value of three consecutive measurements of at least 30 minutes each
Yearly average	In the case of continuous measurement: average of all valid hourly averages. In the case of periodic measurements: average of all 'averages over the sampling period' obtained during one year.

DEFINITIONS

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

Term used	Definition
New plant	A plant first permitted on the site of the installation following the publication of these BAT conclusions or a complete replacement of a plant on the existing foundations of the installation following the publication of these BAT conclusions.
Existing plant	A plant which is not a new plant.
Major refurbishment	A major change in design or technology of a plant/abatement system and with major adjustments or replacements of the process units and associated equipment.
New dust abatement system	A dust abatement system first operated on the site of the installation following the publication of these BAT conclusions.
Existing dust abatement system	A dust abatement system which is not a new dust abatement system.
Non-condensable odorous gases (NCG)	Non-condensable odorous gases, referring to malodorous gases of kraft pulping.
Concentrated non-condensable odorous gases (CNCG)	Concentrated non-condensable odorous gases (or 'strong odorous gases'): TRS-containing gases from cooking, evaporation and from stripping of condensates.

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Strong odorous gases	Concentrated non-condensable odorous gases (CNCG).
Weak odorous gases	Diluted non-condensable odorous gases: TRS-containing gases which are not strong odorous gases (e.g. gases coming from tanks, washing filters, chip bins, lime mud filters, drying machines).
Residual weak gases	Weak gases that are emitted in ways other than through a recovery boiler, a lime kiln or a TRS-burner.
Continuous measurement	Measurements using an automated measuring system (AMS) permanently installed on site.
Periodic measurement	Determination of a measurand (particular quantity subject to measurement) at specified time intervals using manual or automated methods.
Diffuse emissions	Emissions arising from a direct (non-channelled) contact of volatile substances or dust with the environment under normal operating conditions.
Integrated production	Both pulp and paper/board are produced at the same site. The pulp is normally not dried before paper/board manufacture.
Non-integrated production	Either (a) production of market pulp (for sale) in mills that do not operate paper machines, or (b) production of paper/board using only pulp produced in other plants (market pulp).
Net production	(i) For paper mills: the unpacked, saleable production after the last slitter winder, i.e. before converting. (ii) For off-line coaters: production after coating. (iii) For tissue mills: saleable production after the tissue machine before any rewinding processes and excluding any core. (iv) For market pulp mills: production after packing (ADt). (v) For integrated mills: Net pulp, production refers to the production after packing (ADt) plus the pulp transferred to the paper mill (pulp calculated at 90 % dryness, i.e. air dry). Net paper production: same as (i)

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Speciality paper mill	A mill producing numerous paper and board grades for special purposes (industrial and/or non-industrial) that are characterised by particular properties, relatively small end use market or niche applications that are often especially designed for a particular customer or end-user group. Examples of speciality papers include cigarette papers, filter papers, metallised paper, thermal paper, self-copy paper, sticking labels, cast coated paper, as well as gypsum liners and special papers for waxing, insulating, roofing, asphalting, and other specific applications or treatments. All of these grades fall outside of the standard paper categories.
Hardwood	Group of wood species including e.g. aspen, beech, birch and eucalyptus. The term hardwood is used as opposite to softwood.
Softwood	Wood from conifers including e.g. pine and spruce. The term softwood is used as opposite to hardwood.
Causticising	Process in the lime cycle in which hydroxide (white liquor) is regenerated by the reaction $Ca(OH)_2 + CO_3^{2-} \rightarrow CaCO_3 (s) + 2 OH^-$

ACRONYMS

Term used	Definition
ADt	Air Dry tonnes (of pulp) expressed as 90 % dryness.
AOX	Adsorbable organic halides measured according to the EN ISO: 9562 standard method for waste waters.
BOD	Biochemical oxygen demand. The quantity of dissolved oxygen required by microorganisms to decompose organic matter in waste water.
CMP	Chemimechanical pulp.
CTMP	Chemithermomechanical pulp.
COD	Chemical oxygen demand; the amount of chemically oxidisable organic matter in waste water (normally referring to analysis with dichromate oxidation).
DS	Dry solids, expressed as weight %.

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DTPA	Diethlyene triamine pentaacetic acid (complexing/chelating agent used in peroxide bleaching).
ECF	Elemental Chlorine Free.
EDTA	Ethylene diamine tetraacetic acid (complexing/chelating agent).
H_2S	Hydrogen sulphide.
LWC	Light weight coated paper.
NO_X	The sum of nitrogen oxide (NO) and nitrogen dioxide (NO_2), expressed as NO_2.
NSSC	Neutral sulphite semi chemical.
RCF	Recycled fibres.
SO_2	Sulphur dioxide.
TCF	Totally Chlorine Free.
Total nitrogen (Tot-N)	Total nitrogen (Tot-N) given as N, includes organic nitrogen, free ammonia and ammonium (NH_4^+-N), nitrites (NO_2-N) and nitrates (NO_3-N).
Total phosphorus (Tot-P)	Total phosphorus (Tot-P) given as P, includes dissolved phosphorus plus any insoluble phosphorus carried over into the effluent in the form of precipitates or within microbes.
TMP	Thermomechanical pulp.
TOC	Total organic carbon.
TRS	Total reduced sulphur. The sum of the following reduced malodorous sulphur compounds generated in the pulping process: hydrogen sulphide, methyl mercaptan, dimethylsulphide and dimethyldisulphide, expressed as sulphur.
TSS	Total suspended solids (in waste water). Suspended solids consist of small fibre fragments, fillers, fines, non-settled biomass (agglomeration of microorganisms) and other small particles.
VOC	Volatile organic compounds as defined in Article 3(45) of Directive 2010/75/EU.

1.1. GENERAL BAT CONCLUSIONS FOR THE PULP AND PAPER INDUSTRY

The process specific BAT conclusions included in Sections 1.2 to 1.6 apply, in addition to the general BAT conclusions mentioned in this section.

Changes to legislation: *There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)*

1.1.1. Environmental management system

BAT 1. In order to improve the overall environmental performance of plants for the production of pulp, paper and board, BAT is to implement and adhere to an environmental management system (EMS) that incorporates all of the following features:

(a) commitment of the management, including senior management;

(b) definition of an environmental policy that includes the continuous improvement of the installation by the management;

(c) planning and establishing the necessary procedures, objectives and targets, in conjunction with financial planning and investment;

(d) implementation of procedures paying particular attention to:

- (i) structure and responsibility
- (ii) training, awareness and competence
- (iii) communication
- (iv) employee involvement
- (v) documentation
- (vi) efficient process control
- (vii) maintenance programmes
- (viii) emergency preparedness and response
- (ix) safeguarding compliance with environmental legislation;

(e) checking performance and taking corrective action, paying particular attention to:

- (i) monitoring and measurement (see also the Reference Document on the General Principles of Monitoring)
- (ii) corrective and preventive action
- (iii) maintenance of records
- (iv) independent (where practicable) internal and external auditing in order to determine whether or not the EMS conforms to planned arrangements and has been properly implemented and maintained;

(f) review of the EMS and its continuing suitability, adequacy and effectiveness by senior management;

(g) following the development of cleaner technologies;

(h) consideration for the environmental impacts from the eventual decommissioning of the installation at the stage of designing a new plant, and throughout its operating life;

(i) application of sectoral benchmarking on a regular basis.

Applicability

***Changes to legislation:** There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/ EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)*

The scope (e.g. level of details) 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.

1.1.2. Materials management and good housekeeping

BAT 2. BAT is to apply the principles of good housekeeping for minimising the environmental impact of the production process by using a combination of the techniques given below.

	Technique
a	Careful selection and control of chemicals and additives
b	Input-output analysis with a chemical inventory, including quantities and toxicological properties
c	Minimise the use of chemicals to the minimum level required by the quality specifications of the final product
d	Avoid the use of harmful substances (e.g. nonylphenol ethoxylate-containing dispersion or cleaning agents or surfactants) and substitution by less harmful alternatives
e	Minimise the input of substances into the soil by leakage, aerial deposition and the inappropriate storage of raw materials, products or residues
f	Establish a spill management programme and extend the containment of relevant sources, thus preventing the contamination of soil and groundwater
g	Proper design of the piping and storage systems to keep the surfaces clean and to reduce the need for washing and cleaning

BAT 3. In order to reduce the release of not readily biodegradable organic chelating agents such as EDTA or DTPA from peroxide bleaching, BAT is to use a combination of the techniques given below.

	Technique	Applicability
a	Determination of quantity of chelating agents released to the environment through periodic measurements	Not applicable for mills that do not use chelating agents
b	Process optimisation to reduce consumption and emission of not readily	Not applicable for plants that eliminate 70 % or more of EDTA/DTPA in their waste

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	biodegradable chelating agents	water treatment plant or process
c	Preferential use of biodegradable or eliminable chelating agents, gradually phasing out non-degradable products	Applicability depends on the availability of appropriate substitutes (biodegradable agents meeting e.g. brightness requirements of pulp)

1.1.3. **Water and waste water management**

BAT 4. In order to reduce the generation and the pollution load of waste water from wood storage and preparation, BAT is to use a combination of the techniques given below.

	Technique	Applicability
a	Dry debarking (description see Section 1.7.2.1)	Restricted applicability when high purity and brightness is required with TCF bleaching
b	Handling of wood logs in such a way as to avoid the contamination of bark and wood with sand and stones	Generally applicable
c	Paving of the wood yard area and particularly the surfaces used for the storage of chips	Applicability may be restricted due to the size of the wood yard and storage area
d	Controlling the flow of sprinkling water and minimising surface run-off water from the wood yard	Generally applicable
e	Collecting of contaminated run-off water from the wood yard and separating out suspended solids effluent before biological treatment	Applicability may be restricted by the degree of contamination of run-off water (low concentration) and/or the size of the waste water treatment plant (large volumes)

The BAT-associated effluent flow from dry debarking is 0,5 – 2,5 m^3/ADt.

BAT 5. In order to reduce fresh water use and generation of waste water, BAT is to close the water system to the degree technically feasible in line with the pulp and paper grade manufactured by using a combination of the techniques given below.

	Technique	Applicability
a	Monitoring and optimising water usage	Generally applicable

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b	Evaluation of water recirculation options	
c	Balancing the degree of closure of water circuits and potential drawbacks; adding additional equipment if necessary	
d	Separation of less contaminated sealing water from pumps for vacuum generation and reuse	
e	Separation of clean cooling water from contaminated process water and reuse	
f	Reusing process water to substitute for fresh water (water recirculation and closing of water loops)	Applicable to new plants and major refurbishments. Applicability may be limited due to water quality and/or product quality requirements or due to technical constraints (such as precipitation/ incrustation in water system) or increase odour nuisance
g	In-line treatment of (parts of) process water to improve water quality to allow for recirculation or reuse	Generally applicable

The BAT-associated waste water flow at the point of discharge after waste water treatment as yearly averages are:

Sector	BAT-associated waste water flow
Bleached kraft	25 – 50 m^3/ADt
Unbleached kraft	15 – 40 m^3/ADt
Bleached sulphite paper grade pulp	25 – 50 m^3/ADt
Magnefite pulp	45 – 70 m^3/ADt
Dissolving pulp	40 – 60 m^3/ADt
NSSC pulp	11 – 20 m^3/ADt
Mechanical pulp	9 – 16 m^3/t
CTMP and CMP	9 – 16 m^3/ADt
RCF paper mills without deinking	1,5 – 10 m^3/t (the higher end of the range is mainly associated with folding boxboard production)

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RCF paper mills with deinking	8 – 15 m^3/t
RCF-based tissue paper mills with deinking	10 – 25 m^3/t
Non-integrated paper mills	3,5 – 20 m^3/t

1.1.4. **Energy consumption and efficiency**

BAT 6. In order to reduce fuel and energy consumption in pulp and paper mills, BAT is to use technique (a) and a combination of the other techniques given below.

	Technique	Applicability
a	Use an energy management system that includes all of the following features: (i) Assessment of the mill's overall energy consumption and production (ii) Locating, quantifying and optimising the potentials for energy recovery (iii) Monitoring and safeguarding the optimised situation for energy consumption	Generally applicable
b	Recover energy by incinerating those wastes and residues from the production of pulp and paper that have high organic content and calorific value, taking into account BAT 12	Only applicable if the recycling or reuse of wastes and residues from the production of pulp and paper with a high organic content and high calorific value is not possible
c	Cover the steam and power demand of the production processes as far as possible by the cogeneration of heat and power (CHP)	Applicable for all new plants and for major refurbishments of the energy plant. Applicability in existing plants may be limited due to the mill layout and available space
d	Use excess heat for the drying of biomass and sludge, to heat boiler feedwater and process water, to heat buildings, etc.	Applicability of this technique may be limited in cases where the heat sources and locations are far apart
e	Use thermo compressors	Applicable to both new and existing plants for all grades

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		of paper and for coating machines, as long as medium pressure steam is available
f	Insulate steam and condensate pipe fittings	Generally applicable
g	Use energy efficient vacuum systems for dewatering	
h	Use high efficiency electrical motors, pumps and agitators	
i	Use frequency inverters for fans, compressors and pumps	
j	Match steam pressure levels with actual pressure needs	

Description

Technique (c): Simultaneous generation of heat and electrical and/or mechanical energy in a single process, referred to as a combined heat and power plant (CHP). CHP plants in the pulp and paper industry normally apply steam turbines and/or gas turbines. The economic viability (achievable savings and payback time) will depend mainly on the cost of electricity and fuels.

1.1.5. **Emissions of odour**

With regard to the emissions of malodorous sulphur-containing gases from kraft and sulphite pulp mills, see the process-specific BAT given in Sections 1.2.2 and 1.3.2.

BAT 7. In order to prevent and reduce the emission of odorous compounds originating from the waste water system, BAT is to use a combination of the techniques given below.

	Technique
I. Applicable for odours related to water systems closure	
a	Design paper mill processes, stock and water storage tanks, pipes and chests in such a way as to avoid prolonged retention times, dead zones or areas with poor mixing in water circuits and related units, in order to avoid uncontrolled deposits and the decay and decomposition of organic and biological matter.
b	Use biocides, dispersants or of oxidising agents (e.g. catalytic disinfection with hydrogen peroxide) to control odour and decaying bacteria growth.
c	Install internal treatment processes (‘kidneys’) to reduce the concentrations of organic matter and consequently possible odour problems in the white water system.
II. Applicable for odours related to waste water treatment and sludge handling, in order to avoid conditions where waste water or sludge becomes anaerobic	

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a	Implement closed sewer systems with controlled vents, using chemicals in some cases to reduce the formation of and to oxidise hydrogen sulphide in sewer systems.
b	Avoid over-aeration in equalisation basins but maintain sufficient mixing.
c	Ensure sufficient aeration capacity and mixing properties in aeration tanks; revise the aeration system regularly.
d	Guarantee proper operation of secondary clarifier sludge collection and return sludge pumping
e	Limit the retention time of sludge in sludge storages by sending the sludge continuously to the dewatering units.
f	Avoid the storage of waste water in the spill basin longer than is necessary; keep the spill basin empty.
g	If sludge dryers are used, treatment of thermal sludge dryer vent gases by scrubbing and/or bio filtration (such as compost filters).
h	Avoid air cooling towers for untreated water effluent by applying plate heat exchangers.

1.1.6. Monitoring of key process parameters and of emissions to water and air

BAT 8. BAT is to monitor the key process parameters according to the table given below.

I. Monitoring key process parameters relevant for emissions to air	
Parameter	**Monitoring frequency**
Pressure, temperature, oxygen, CO and water vapour content in flue-gas for combustion processes	Continuous
II. Monitoring key process parameters relevant for emissions to water	
Parameter	**Monitoring frequency**
Water flow, temperature and pH	Continuous
P and N content in biomass, sludge volume index, excess ammonia and ortho-phosphate in the effluent, and microscopy checks of the biomass	Periodic
Volume flow and CH_4 content of biogas produced in anaerobic waste water treatment	Continuous
H_2S and CO_2 contents of biogas produced in anaerobic waste water treatment	Periodic

BAT 9. BAT is to carry out the monitoring and measurement of emissions to air, as indicated below, on a regular basis with the frequency indicated and according to EN standards. If EN standards are not available, BAT is to use ISO, national or other international standards which ensure the provision of data of an equivalent scientific quality.

	Parameter	**Monitoring frequency**	**Emission source**	**Monitoring associated with**
a	NO_x and SO_2	Continuous	Recovery boiler	BAT 21 BAT 22 BAT 36 BAT 37
		Periodic or continuous	Lime kiln	BAT 24 BAT 26
		Periodic or continuous	Dedicated TRS burner	BAT 28 BAT 29
b	Dust	Periodic or continuous	Recovery boiler (kraft) and lime kiln	BAT 23 BAT 27
		Periodic	Recovery boiler (sulphite)	BAT 37
c	TRS (including H_2S)	Continuous	Recovery boiler	BAT 21
		Periodic or continuous	Lime kiln and dedicated TRS burner	BAT 24 BAT 25 BAT 28
		Periodic	Diffuse emissions from different sources (e.g. the fibre line, tanks, chip bins, etc.) and residual weak gases	BAT 11 BAT 20
d	NH_3	Periodic	Recovery boiler equipped with SNCR	BAT 36

BAT 10. BAT is to carry out the monitoring of emissions to water, as indicated below, with the indicated frequency and according to EN standards. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.

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	Parameter	**Monitoring frequency**	**Monitoring associated with**
a	Chemical oxygen demand (COD) or Total organic carbon (TOC)[a]	Daily[bc]	BAT 19 BAT 33 BAT 40 BAT 45 BAT 50
b	BOD_5 or BOD_7	Weekly (once a week)	
c	Total suspended solids (TSS)	Daily[bc]	
d	Total nitrogen	Weekly (once a week)[b]	
e	Total phosphorus	Weekly (once a week)[b]	
f	EDTA, DTPA[d]	Monthly (once a month)	
g	AOX (according to EN ISO 9562:2004)[e]	Monthly (once a month)	BAT 19: bleached kraft
		Once every two months	BAT 33: except TCF and NSSC mills BAT 40: except CTMP and CMP mills BAT 45 BAT 50
h	Relevant metals (e.g. Zn, Cu, Cd, Pb, Ni)	Once a year	

a There is a trend to replace COD by TOC for economic and environmental reasons. If TOC is already measured as a key process parameter, there is no need to measure COD; however, a correlation between the two parameters should be established for the specific emission source and waste water treatment step.

b Rapid test methods can also be used. The results of rapid tests should be checked regularly (e.g. monthly) against EN standards or, if EN standards are not available, against ISO, national or other international standards which ensure the provision of data of an equivalent scientific quality.

c For mills operating less than seven days a week, the monitoring frequency for COD and TSS may be reduced to cover the days the mill is in operation or to extend the sampling period to 48 or 72 hours.

d Applicable where EDTA or DTPA (chelating agents) are used in the process.

e Not applicable to plants that provide evidence that no AOX is generated or added via chemical additives and raw materials.

BAT 11. BAT is to regularly monitor and assess diffuse total reduced sulphur emissions from relevant sources.

Description

The assessment of diffuse total reduced sulphur emissions can be done by periodic measurement and assessment of diffuse emissions that are emitted from different sources (e.g. the fibre line, tanks, chip bins etc.) by direct measurements.

1.1.7. **Waste management**

Changes to legislation: There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)

BAT 12. In order to reduce the quantities of wastes sent for disposal, BAT is to implement a waste assessment (including waste inventories) and management system, so as to facilitate waste reuse, or failing that, waste recycling, or failing that, 'other recovery', including a combination of the techniques given below.

	Technique	Description	Applicability
a	Separate collection of different waste fractions (including separation and classification of hazardous waste)	See Section 1.7.3	Generally applicable
b	Merging of suitable fractions of residues to obtain mixtures that can be better utilised		Generally applicable
c	Pretreatment of process residues before reuse or recycling		Generally applicable
d	Material recovery and recycling of process residues on site		Generally applicable
e	Energy recovery on- or off-site from wastes with high organic content		For off-site utilisation, the applicability depends on the availability of a third party
f	External material utilisation		Depending on the availability of a third party
g	Pretreatment of waste before disposal		Generally applicable

1.1.8. **Emissions to water**

Further information on waste water treatment in pulp and paper mills and process-specific BAT-AELs are given in Sections 1.2 to 1.6.

BAT 13. In order to reduce nutrient (nitrogen and phosphorus) emissions into receiving waters, BAT is to substitute chemical additives with high nitrogen and phosphorus contents by additives containing low nitrogen and phosphorus contents.

Applicability

Applicable if the nitrogen in the chemical additives is not bioavailable (i.e. it cannot serve as nutrient in biological treatment) or if the nutrient balance is in surplus.

Changes to legislation: There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)

BAT 14. In order to reduce emissions of pollutants into receiving waters, BAT is to use all of the techniques given below.

	Technique	Description
a	Primary (physico-chemical) treatment	See Section 1.7.2.2
b	Secondary (biological) treatment[a]	

a Not applicable to plants where the biological load of waste water after the primary treatment is very low, e.g. some paper mills producing speciality paper.

BAT 15. When further removal of organic substances, nitrogen or phosphorus is needed, BAT is to use tertiary treatment as described in Section 1.7.2.2.

BAT 16. In order to reduce emissions of pollutants into receiving waters from biological waste water treatment plants, BAT is to use all of the techniques given below.

	Technique
a	Proper design and operation of the biological treatment plant
b	Regularly controlling the active biomass
c	Adjustment of nutrition supply (nitrogen and phosphorus) to the actual need of the active biomass

1.1.9. **Emissions of noise**

BAT 17. In order to reduce the emissions of noise from pulp and paper manufacturing, BAT is to use a combination of the techniques given below.

	Technique	Description	Applicability
a	Noise-reduction programme	A noise-reduction programme includes identification of sources and affected areas, calculations and measurements of noise levels in order to rank sources according to noise levels, and identification of the most cost effective combination of techniques, their implementation and monitoring.	Generally applicable.

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b	Strategic planning of the location of equipment, units and buildings	Noise levels can be reduced by increasing the distance between the emitter and the receiver and by using buildings as noise screens.	Generally applicable to new plants. In the case of existing plants, the relocation of equipment and production units may be restricted by the lack of space or by excessive costs.
c	Operational and management techniques in buildings containing noisy equipment	This includes: — improved inspection and maintenance of equipment to prevent failures — closing of doors and windows of covered areas — equipment operation by experienced staff — avoidance of noisy activities during night-time — provisions for noise control during maintenance activities	Generally applicable.
d	Enclosing noisy equipment and units	Enclosure of noisy equipment, such as wood handling, hydraulic units, and compressors in separate structures, such as buildings or soundproofed cabinets, where internal-external lining is made of impact-absorbent material.	

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e	Use of low-noise equipment and noise-reducers on equipment and ducts.		
f	Vibration insulation	Vibration insulation of machinery and decoupled arrangement of noise sources and potentially resonant components.	
g	Soundproofing of buildings	This potentially includes use of: — sound-absorbing materials in walls and ceilings — sound-isolating doors — double-glazed windows	
h	Noise abatement	Noise propagation can be reduced by inserting barriers between emitters and receivers. Appropriate barriers include protection walls, embankments and buildings. Suitable noise abatement techniques include fitting silencers and attenuators to noisy equipment such as steam releases and dryer vents.	Generally applicable to new plants. In the case of existing plants, the insertion of obstacles may be restricted by the lack of space.
i	Use of larger wood-handling machines to reduce lifting and transport times and noise from logs falling onto log piles or the feed table.		Generally applicable.
j	Improved ways of working, e.g. releasing logs from a lower height onto the log piles or the feed table; immediate feedback of the level of noise for the workers.		

1.1.10. **Decommissioning**

Changes to legislation: There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)

BAT 18. In order to prevent pollution risks when decommissioning a plant, BAT is to use the general techniques given below.

	Technique
a	Ensure that underground tanks and piping are either avoided in the design phase or that their location is well known and documented.
b	Establish instructions for emptying process equipment, vessels and piping.
c	Ensure a clean closure when the facility is shut down, e.g. to clean up and rehabilitate the site. Natural soil functions should be safeguarded, if feasible.
d	Use a monitoring programme, especially relative to groundwater, in order to detect possible future impacts on site or in neighbouring areas.
e	Develop and maintain a site closure or cessation scheme, based on risk analysis, that includes a transparent organisation of the shutdown work, taking into account relevant local specific conditions.

1.2. BAT CONCLUSIONS FOR KRAFT PULPING PROCESS

For integrated kraft pulp and paper mills, the process-specific BAT conclusions for papermaking given in Section 1.6 apply, in addition to the BAT conclusions in this section.

1.2.1. **Waste water and emissions to water**

BAT 19. In order to reduce emissions of pollutants into receiving waters from the whole mill, BAT is to use TCF or modern ECF bleaching (see description in Section 1.7.2.1), and a suitable combination of the techniques specified in BAT 13, BAT 14, BAT 15 and BAT 16 and of the techniques given below.

	Technique	Description	Applicability
a	Modified cooking before bleaching	See Section 1.7.2.1	Generally applicable
b	Oxygen delignification before bleaching		
c	Closed brown stock screening and efficient brown stock washing		
d	Partial process water recycling in the bleach plant		Water recycling may be limited due

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			to incrustation in bleaching
e	Effective spill monitoring and containment with a suitable recovery system		Generally applicable
f	Maintaining sufficient black liquor evaporation and recovery boiler capacity to cope with peak loads		Generally applicable
g	Stripping the contaminated (foul) condensates and reusing the condensates in the process		

BAT-associated emission levels

See Table 1 and Table 2. These BAT-associated emission levels are not applicable to dissolving kraft pulp mills.

The reference waste water flow for kraft mills is set out in BAT 5.

TABLE 1

BAT-associated emission levels for the direct waste water discharge to receiving waters from a bleached kraft pulp mill

Parameter	**Yearly averagekg/ADt**[a]
Chemical oxygen demand (COD)	7 – 20
Total suspended solids (TSS)	0,3 – 1,5
Total nitrogen	0,05 – 0,25[b]
Total phosphorus	0,01 – 0,03[b] Eucalyptus: 0,02 – 0,11 kg/ADt[c]
Adsorbable organically bound halogens (AOX)[de]	0 – 0,2

a The BAT-AEL ranges refer to market pulp production and the pulp production part of integrated mills (emissions from papermaking are not included).

b A compact biological waste water treatment plant can result in slightly higher emission levels.

c The upper end of the range refers to mills using eucalyptus from regions with higher levels of phosphorus (e.g. Iberian eucalyptus).

d Applicable for mills using chlorine containing bleaching chemicals.

e For mills producing pulp with high strength, stiffness and high purity properties (e.g. for liquid packaging board and LWC), emissions level of AOX up to 0,25 kg/ADt may occur.

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TABLE 2

BAT-associated emission levels for the direct waste water discharge to receiving waters from an unbleached kraft pulp mill

Parameter	Yearly averagekg/ADt[a]
Chemical oxygen demand (COD)	2,5 – 8
Total suspended solids (TSS)	0,3 – 1,0
Total nitrogen	0,1 – 0,2[b]
Total phosphorus	0,01 – 0,02[b]

a The BAT-AEL ranges refer to market pulp production and the pulp production part of integrated mills (emissions from papermaking are not included).

b A compact biological waste water treatment plant can result in slightly higher emission levels.

The BOD concentration in the treated effluents is expected to be low (around 25 mg/l as a 24-hour composite sample).

1.2.2. **Emissions to air**

1.2.2.1. *Reduction of emissions in strong and weak odorous gases*

BAT 20. In order to reduce odour emissions and total reduced sulphur emissions due to strong and weak odorous gases, BAT is to prevent diffuse emissions by capturing all process-based sulphur containing off-gases, including all vents with sulphur-containing emissions, by applying all of the techniques given below.

	Technique	Description
a	Collection systems for strong and weak odorous gases, comprising the following features: — covers, suction hoods, ducts, and extraction system with sufficient capacity; — continuous leak detection system; — safety measures and equipment.	
b	Incineration of strong and weak non-condensable gases	Incineration can be carried out using: — recovery boiler — lime kiln[a] — dedicated TRS burner equipped with wet scrubbers for SO_x removal; or — power boiler[b] To ensure the constant availability of incineration for odorous strong gases, back-up systems are installed.

a The SO_x emission levels of the lime kiln increase significantly when strong non-condensable gases (NCG) are fed to the kiln and no alkaline scrubber is used.

b Applicable for the treatment of weak odorous gases.

c Applicable for the treatment of strong odorous gases.

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		Lime kilns can serve as back-up for recovery boilers; further back-up equipment are flares and package boiler
c	Recording unavailability of the incineration system and any resulting emissions[c]	

a The SO_x emission levels of the lime kiln increase significantly when strong non-condensable gases (NCG) are fed to the kiln and no alkaline scrubber is used.

b Applicable for the treatment of weak odorous gases.

c Applicable for the treatment of strong odorous gases.

Applicability

Generally applicable for new plants and for major refurbishments of existing plants. The installation of necessary equipment may be difficult for existing plants due to layout and space restrictions. The applicability of incineration might be limited for safety reasons, and in this case wet scrubbers could be used.

BAT-associated emission level of total reduced sulphur (TRS) in residual weak gases emitted is 0,05 – 0,2 kg S/ADt.

1.2.2.2. *Reduction of emissions from a recovery boiler*
SO_2 and TRS emissions

BAT 21. In order to reduce SO_2 and TRS emissions from a recovery boiler, BAT is to use a combination of the techniques given below.

	Technique	Description
a	Increasing the dry solids (DS) content of black liquor	The black liquor can be concentrated by an evaporation process before burning
b	Optimised firing	Firing conditions can be improved e.g. by good mixing of air and fuel, control of furnace load etc.
c	Wet scrubber	See Section 1.7.1.3

BAT-associated emission levels

See Table 3.

TABLE 3

BAT-associated emission levels for SO_2 and TRS emissions from a recovery boiler

Changes to legislation: There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)

Parameter		**Daily average[ab] mg/ Nm^3 at 6 % O_2**	**Yearly average[a] mg/ Nm^3 at 6 % O_2**	**Yearly average[a] kg S/ ADt**
SO_2	DS < 75 %	10 – 70	5 – 50	—
	DS 75 – 83 %[c]	10 – 50	5 – 25	—
Total reduced sulphur (TRS)		1 – 10[d]	1 – 5	—
Gaseous S (TRS-S + SO_2-S)	DS < 75 %	—	—	0,03 – 0,17
	DS 75 – 83 %[c]			0,03 – 0,13

a Increasing the DS content of the black liquor results in lower SO_2 emissions and higher NO_x emissions. Due to this, a recovery boiler with low emission levels for SO_2, may be on the higher end of the range for NO_x and vice versa.

b BAT-AELs do not cover periods during which the recovery boiler is run on a DS content much lower than the normal DS content due to shut down or maintenance of the black liquor concentration plant.

c If a recovery boiler were to burn black liquor with a DS > 83 %, then SO_2 and gaseous S emission levels should be reconsidered on a case-by-case basis.

d The range is applicable without the incineration of odorous strong gases.

DS = dry solid content of the black liquor.

NO_x emissions

BAT 22. In order to reduce NO_x emissions from a recovery boiler, BAT is to use an optimised firing system including all of the features given below.

	Technique
a	Computerised combustion control
b	Good mixing of fuel and air
c	Staged air feed systems, e.g. by using different air registers and air inlet ports

Applicability

Technique (c)is applicable to new recovery boilers and in the case of a major refurbishment of recovery boilers, as this technique requires considerable changes to the air feed systems and the furnace.

BAT-associated emission levels

See Table 4.

TABLE 4

BAT-associated emission levels for NO_x emissions from a recovery boiler

Changes to legislation: *There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)*

Parameter		**Yearly average[a] mg/Nm^3 at 6 % O_2**	**Yearly average[a] kg NO_x/ADt**
NO_x	Softwood	120 – 200[b]	DS < 75 %: 0,8 – 1,4 DS 75 – 83 %[c]: 1,0 – 1,6
	Hardwood	120 – 200[b]	DS < 75 %: 0,8 – 1,4 DS 75 – 83 %[c]: 1,0 – 1,7

a Increasing the DS content of the black liquor results in lower SO_2 emissions and higher NO_x emissions. Due to this, a recovery boiler with low emission levels for SO_2, may be on the higher end of the range for NO_x and vice versa.

b The actual NO_x emission level of a recovery boiler depends on the DS content and the nitrogen content of the black liquor, and the amount and combination of NCG and other nitrogen containing flows (e.g. dissolving tank vent gas, methanol separated from the condensate, biosludge) burnt. The higher the DS content, the nitrogen content in the black liquor, and the amount of NCG and other nitrogen containing flows burnt, the closer the emissions will be to the upper end of the BAT-AEL range.

c If a recovery boiler were to burn black liquor with a DS > 83 %, then NO_x emission levels should be reconsidered on a case-by-case basis.

DS = dry solid content of black liquor.

Dust emissions

BAT 23. In order to reduce dust emissions from a recovery boiler, BAT is to use an electrostatic precipitator (ESP) or a combination of ESP and wet scrubber.

Description

SeeSection 1.7.1.1.

BAT-associated emission levels

See Table 5.

TABLE 5

BAT-associated emission levels for dust emissions from a recovery boiler

Parameter	**Dust abatement system**	**Yearly averagemg/ Nm^3 at 6 % O_2**	**Yearly averagekg dust/ADt**
Dust	New or major refurbishment	10 – 25	0,02 – 0,20
	Existing	10 – 40[a]	0,02 — 0,3[a]

a For an existing recovery boiler equipped with an ESP approaching the end of its operational life, emission levels may increase over time up to 50 mg/Nm^3 (corresponding to 0,4 kg/ADt).

1.2.2.3. *Reduction of emissions from a lime kiln*

SO_2 emissions

BAT 24. In order to reduce SO_2 emissions from a lime kiln, BAT is to apply one or a combination of the techniques given below.

	Technique	**Description**

Changes to legislation: There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)

a	Fuel selection/low sulphur fuel	See Section 1.7.1.3
b	Limit incineration of sulphur-containing odorous strong gases in the lime kiln	
c	Control of Na_2S content in lime mud feed	
d	Alkaline scrubber	

BAT-associated emission levels

See Table 6.

TABLE 6

BAT-associated emission levels for SO_2 and sulphur emissions from a lime kiln

Parameter[a]	Yearly averagemg SO_2/Nm^3 at 6 % O_2	Yearly averagekg S/ADt
SO_2 when strong gases are not burnt in the lime kiln	5 – 70	—
SO_2 when strong gases are burnt in the lime kiln	55 – 120	—
Gaseous S (TRS-S + SO_2-S) when strong gases are not burnt in the lime kiln	—	0,005 – 0,07
Gaseous S (TRS-S + SO_2-S) when strong gases are burnt in the lime kiln	—	0,055 – 0,12

a ‘strong gases’ includes methanol and turpentine

TRS emissions

BAT 25. In order to reduce TRS emissions from a lime kiln, BAT is to apply one or a combination of the techniques given below.

	Technique	Description
a	Control of the excess oxygen	See Section 1.7.1.3
b	Control of Na_2S content in lime mud feed	
c	Combination of ESP and alkaline scrubber	See Section 1.7.1.1

BAT-associated emission levels

See Table 7.

Changes to legislation: *There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)*

TABLE 7

BAT-associated emission levels for TRS emissions from a lime kiln

Parameter	Yearly averagemg S/Nm^3 at 6 % O_2
Total reduced sulphur (TRS)	< 1 – 10[a]

a For lime kilns burning strong gases (including methanol and turpentine), the upper end of the AEL range may be up to 40 mg/Nm^3.

NO_x emissions

BAT 26. In order to reduce NO_x emissions from a lime kiln, BAT is to apply a combination of the techniques given below.

	Technique	Description
a	Optimised combustion and combustion control	See Section 1.7.1.2
b	Good mixing of fuel and air	
c	Low-NO_x burner	
d	Fuel selection/low-N fuel	

BAT-associated emission levels

See Table 8.

TABLE 8

BAT-associated emission levels for NO_x emissions from a lime kiln

Parameter		Yearly averagemg/Nm^3 at 6 % O_2	Yearly averagekg NO_x/ADt
NO_x	Liquid fuels	100 – 200[a]	0,1 – 0,2[a]
	Gaseous fuels	100 – 350[b]	0,1 – 0,3[b]

a When using liquid fuels originating from vegetable matter (e.g. turpentine, methanol, tall-oil), including those obtained as by-products of the pulping process, emission levels up to 350 mg/Nm^3 (corresponding to 0,35 kg NO_x/ADt) may occur.

b When using gaseous fuels originating from vegetable matter (e.g. non-condensable gases), including those obtained as by-products of the pulping process, emission levels up to 450 mg/Nm^3 (corresponding to 0,45 kg NO_x/ADt) may occur.

Dust emissions

BAT 27. In order to reduce dust emissions from a lime kiln, BAT is to use an electrostatic precipitator (ESP) or a combination of ESP and wet scrubber.

Description

See Section 1.7.1.1.

BAT-associated emission levels

See Table 9.

Changes to legislation: There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)

TABLE 9

BAT-associated emission levels for dust emissions from a lime kiln

Parameter	Dust abatement system	Yearly averagemg/ Nm^3 at 6 % O_2	Yearly averagekg dust/ADt
Dust	New or major refurbishments	10 – 25	0,005 – 0,02
	Existing	10 – 30[a]	0,005 – 0,03[a]

a For an existing lime kiln equipped with an ESP approaching the end of its operational life, emission levels may increase over time up to 50 mg/Nm^3 (corresponding to 0,05 kg/ADt).

1.2.2.4. *Reduction of emissions from a burner for strong odorous gases (dedicated TRS burner)*

BAT 28. In order to reduce SO_2 emissions from the incineration of strong odorous gases in a dedicated TRS burner, BAT is to use an alkaline SO_2 scrubber.

BAT-associated emission levels

See Table 10.

TABLE 10

BAT-associated emission levels for SO_2 and TRS emissions from the incineration of strong gases in a dedicated TRS burner

Parameter	Yearly averagemg/Nm^3 at 9 % O_2	Yearly averagekg S/ADt
SO_2	20 – 120	—
TRS	1 – 5	
Gaseous S (TRS-S + SO_2-S)	—	0,002 – 0,05[a]

a This BAT-AEL is based on a gas flow in the range of 100-200 Nm^3/ADt.

BAT 29. In order to reduce NO_x emissions from the incineration of strong odorous gases in a dedicated TRS burner, BAT is to use one or a combination of the techniques given below.

	Technique	Description	Applicability
a	Burner/firing optimisation	See Section 1.7.1.2	Generally applicable
b	Staged incineration	See Section 1.7.1.2	Generally applicable for new plants and for major refurbishments. For existing mills, applicable only if space allows for the insertion of equipment

Changes to legislation: There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)

BAT-associated emission levels

See Table 11.

TABLE 11

BAT-associated emission levels for NO_x emissions from the incineration of strong gases in a dedicated TRS burner

Parameter	Yearly averagemg/Nm^3 at 9 % O_2	Yearly averagekg NO_x/ADt
NO_x	50 – 400[a]	0,01 – 0,1[a]

a Where at existing plants a switch to staged incineration is not feasible, emissions levels up to 1 000 mg/Nm^3 (corresponding to 0,2 kg/ADt) may occur.

1.2.3. Waste generation

BAT 30. In order to prevent waste generation and minimise the amount of solid waste to be disposed of, BAT is to recycle dust from black liquor recovery boiler ESPs to the process.

Applicability

Recirculation of dust may be limited due to non-process elements in the dust.

1.2.4. Energy consumption and efficiency

BAT 31. In order to reduce thermal energy consumption (steam), maximise the benefit of energy carriers used, and to reduce the consumption of electricity, BAT is to apply a combination of the techniques given below.

	Technique
a	High dry solid content of bark, by use of efficient presses or drying
b	High efficiency steam boilers, e.g. low flue-gas temperatures
c	Effective secondary heating systems
d	Closing water systems, including bleach plant
e	High pulp concentration (middle or high consistency technique)
f	High efficiency evaporation plant
g	Recovery of heat from dissolving tanks e.g. by vent scrubbers
h	Recovery and use of the low temperature streams from effluents and other waste heat sources to heat buildings, boiler feedwater and process water

Changes to legislation: There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)

i	Appropriate use of secondary heat and secondary condensate
j	Monitoring and control of processes, using advanced control systems
k	Optimise integrated heat exchanger network
l	Heat recovery from the flue-gas from the recovery boiler between the ESP and the fan
m	Ensuring as high a pulp consistency as possible in screening and cleaning
n	Use of speed control of various large motors
o	Use of efficient vacuum pumps
p	Proper sizing of pipes, pumps and fans
q	Optimised tank levels

BAT 32. In order to increase the efficiency of power generation, BAT is to apply a combination of the techniques given below.

	Technique
a	High black liquor dry solid content (increases boiler efficiency, steam generation and thus electricity generation)
b	High recovery boiler pressure and temperature; in new recovery boilers the pressure can be at least 100 bars and the temperature 510 °C
c	Outlet steam pressure in the back-pressure turbine as low as technically feasible
d	Condensing turbine for power production from excess steam
e	High turbine efficiency
f	Preheating feedwater to a temperature close to the boiling temperature
g	Preheating the combustion air and fuel charged to the boilers

1.3. BAT CONCLUSIONS FOR THE SULPHITE PULPING PROCESS

For integrated sulphite pulp and paper mills, the process-specific BAT conclusions for papermaking given in Section 1.6 apply, in addition to the BAT in this section.

1.3.1. **Waste water and emissions to water**

Changes to legislation: *There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)*

BAT 33. In order to prevent and reduce emissions of pollutants into receiving waters from the whole mill, BAT is to use a suitable combination of the techniques specified in BAT 13, BAT 14, BAT 15 and BAT 16 and of the techniques given below.

	Technique	Description	Applicability
a	Extended modified cooking before bleaching.	See Section 1.7.2.1	Applicability may be limited due to pulp quality requirements (when high strength is required).
b	Oxygen delignification before bleaching.		
c	Closed brown stock screening and efficient brown stock washing.		Generally applicable.
d	Evaporation of effluents from the hot alkaline extraction stage and incineration of concentrates in a soda boiler.		Limited applicability for dissolving pulp mills, when multistage biological treatment of the effluents provides a more favourable overall environmental situation.
e	TCF bleaching.		Limited applicability for market paper pulp mills producing high brightness pulp and for mills manufacturing speciality pulp for chemical applications.
f	Closed-loop bleaching.		Only applicable to plants that use the same base for cooking and pH adjustment in bleaching.
g	MgO-based pre-bleaching and recirculation of washing liquids from pre-bleaching to brown stock washing.		Applicability may be limited by factors such as product quality (e.g. purity, cleanliness and brightness), kappa number after cooking, hydraulic capacity of the installation and capacity of tanks,

Changes to legislation: There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/ EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)

			evaporators and recovery boilers, and a possibility to clean the washing equipment.
h	pH adjustment of weak liquor before/ inside the evaporation plant.		Generally applicable to magnesium-based plants. Spare capacity in the recovery boiler and ash circuit is needed.
i	Anaerobic treatment of the condensates from the evaporators.		Generally applicable.
j	Stripping and recovery of SO_2 from the condensates of evaporators.		Applicable if it is necessary to protect anaerobic effluent treatment.
k	Effective spill monitoring and containment, also with chemical and energy recovery system.		Generally applicable.

BAT-associated emission levels

See Table 12 and Table 13. These BAT-associated emission levels are not applicable to dissolving pulp mills and to the manufacturing of speciality pulp for chemical applications.

The reference waste water flow for sulphite mills is set out in BAT 5.

TABLE 12

BAT-associated emission levels for the direct waste water discharge to receiving waters from a pulp mill manufacturing bleached sulphite and magnefite paper grade pulp

Parameter	Bleached sulphite paper grade pulp[a]	Magnefite paper grade pulp[a]
	Yearly averagekg/ADt[b]	Yearly averagekg/ADt
Chemical oxygen demand (COD)	10 – 30[c]	20 – 35

a	The BAT-AEL ranges refer to market pulp production and the pulp production part of integrated mills (emissions from papermaking are not included).
b	The BAT-AELs do not apply to natural greaseproof pulp mills).
c	The BAT-AEL for COD and total phosphorus do not apply to eucalyptus based market pulp
d	Sulphite market pulp mills may apply a gentle ClO_2 bleaching stage in order to meet product requirements, thus resulting in AOX emissions.
e	Not applicable to TCF mills

Changes to legislation: *There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)*

Total suspended solids (TSS)	0,4 – 1,5	0,5 – 2,0
Total nitrogen	0,15 – 0,3	0,1 – 0,25
Total phosphorus	0,01 – 0,05[c]	0,01 – 0,07
	Yearly averagemg/l	
Adsorbable organically bound halogens (AOX)	0,5 – 1,5[de]	

a The BAT-AEL ranges refer to market pulp production and the pulp production part of integrated mills (emissions from papermaking are not included).

b The BAT-AELs do not apply to natural greaseproof pulp mills).

c The BAT-AEL for COD and total phosphorus do not apply to eucalyptus based market pulp

d Sulphite market pulp mills may apply a gentle ClO_2 bleaching stage in order to meet product requirements, thus resulting in AOX emissions.

e Not applicable to TCF mills

TABLE 13

BAT-associated emission levels for the direct waste water discharge to receiving waters from a sulphite pulp mill manufacturing NSSC pulp

Parameter	Yearly averagekg/ADt[a]
Chemical oxygen demand (COD)	3,2 – 11
Total suspended solids (TSS)	0,5 – 1,3
Total nitrogen	0,1 – 0,2[b]
Total phosphorus	0,01 – 0,02

a The BAT-AEL ranges refer to market pulp production and the pulp production part of integrated mills (emissions from papermaking are not included).

b Due to process-specific higher emissions, the BAT-AEL for total nitrogen does not apply to ammonium-based NSSC pulping.

The BOD concentration in the treated effluents is expected to be low (around 25 mg/l as a 24-hour composite sample).

1.3.2. **Emissions to air**

BAT 34. In order to prevent and reduce SO_2 emissions, BAT is to collect all highly concentrated SO_2-gas streams from acid liquor production, digesters, diffusers, or blow tanks and to recover the sulphur components.

BAT 35. In order to prevent and reduce diffuse sulphur-containing and odorous emissions from washing, screening, and evaporators, BAT is to collect these weak gases and to apply one of the techniques given below.

	Technique	Description	Applicability
a	Incineration in a recovery boiler	See Section 1.7.1.3	Not applicable to sulphite pulp mills using calcium-based cooking. These mills

Changes to legislation: There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)

			do not operate a recovery boiler
b	Wet scrubber	See Section 1.7.1.3	Generally applicable

BAT 36. In order to reduce NO_x emissions from a recovery boiler, BAT is to use an optimised firing system including one or a combination of the techniques given below.

	Technique	Description	Applicability
a	Optimising the recovery boiler by controlling the firing conditions	See Section 1.7.1.2	Generally applicable
b	Staged injection of spent liquor		Applicable to new large recovery boilers and major recovery boilers refurbishments
c	Selective non-catalytic reduction (SNCR)		Retrofitting of existing recovery boilers may be limited due to scaling problems and associated increased cleaning and maintenance requirements. For ammonium-based mills, no application was reported; but due to specific conditions in the waste gas, SNCR is expected to be without effect. Not applicable to sodium-based mills due to explosion risk

BAT-associated emission levels

See Table 14.

TABLE 14

BAT-associated emission levels for NO_x and NH_3 emissions from a recovery boiler

Parameter	Daily averagemg/Nm^3 at 5 % O_2	Yearly averagemg/Nm^3 at 5 % O_2

a For ammonium-based mills, higher emission levels of NO_x may occur: up to 580 mg/Nm^3 as daily average and up to 450 mg/Nm^3 as yearly average.

Changes to legislation: *There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)*

NO_x	100 – 350[a]	100 – 270[a]
NH_3 (ammonia slip for SNCR)		< 5

a For ammonium-based mills, higher emission levels of NO_x may occur: up to 580 mg/Nm^3 as daily average and up to 450 mg/Nm^3 as yearly average.

BAT 37. In order to reduce dust and SO_2 emissions from a recovery boiler, BAT is to use one of the techniques given below and to limit 'acid operation' of the scrubbers to the minimum required to ensure their proper functioning.

	Technique	Description
a	ESP or multicyclones with multistage venturi scrubbers	See Section 1.7.1.3
b	ESP or multicyclones with multistage double inlet downstream scrubbers	

BAT-associated emission levels

See Table 15.

TABLE 15

BAT-associated emission levels for dust and SO_2 emissions from a recovery boiler

Parameter	**Average over the sampling periodmg/Nm^3 at 5 % O_2**	
Dust	5 – 20[ab]	
	Daily average mg/Nm^3 at 5 % O_2	Yearly average mg/Nm^3 at 5 % O_2
SO_2	100 – 300[cde]	50 – 250[cd]

a For recovery boilers operated in mills using more than 25 % of hardwood (potassium-rich) in raw materials, higher dust emissions up to 30 mg/Nm^3 may occur.

b The BAT-AEL for dust does not apply for ammonium-based mills.

c Due to process-specific higher emissions, the BAT-AEL for SO_2 does not apply for recovery boilers operated permanently under 'acidic' conditions, i.e. using sulphite liquor as wet-scrubber washing media as part of the sulphite recovery process.

d For existing multistage venturi scrubbers, higher emissions of SO_2 up to 400 mg/Nm^3 as a daily average value and up to 350 mg/Nm^3 as a yearly average may occur.

e Not applicable during 'acid operation', i.e. periods in which preventive flushing and cleaning of incrustation in the scrubbers takes place. During these periods emissions can be up to 300 – 500 mg SO_2/Nm^3 (at 5 % O_2) for cleaning of one of the scrubbers and up to 1 200 mg SO_2/Nm^3 (half-hourly mean values, at 5 % O_2) when cleaning the final washer.

The **BAT-associated environmental performance level** is a duration of acid operation of around 240 hours per year for the scrubbers, and less than 24 hours per month for the last monosulphite scrubber.

1.3.3. Energy consumption and efficiency

Changes to legislation: There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)

BAT 38. In order to reduce thermal energy consumption (steam), maximise the benefit of the energy carriers used and to reduce the consumption of electricity, BAT is to use a combination of the techniques given below.

	Technique
a	High dry solids content of bark, by use of efficient presses or drying
b	High efficiency steam boilers, e.g. low exhaust-gas temperatures
c	Effective secondary heating system
d	Closing water systems, including bleach plant
e	High pulp concentration (middle or high consistency techniques)
f	Recovery and use of the low temperature streams from effluents and other waste heat sources to heat buildings, boiler feedwater and process water
g	Appropriate use of secondary heat and secondary condensate
h	Monitoring and control of processes, using advanced control systems
i	Optimise integrated heat exchanger network
j	Ensuring as high pulp consistency as possible in screening and cleaning
k	Optimised tank levels

BAT 39. In order to increase the efficiency of power generation, BAT is to use a combination of the techniques given below.

	Technique
a	High recovery boiler pressure and temperature
b	Outlet steam pressure in the back-pressure turbine as low as technically feasible
c	Condensing turbine for power production from excess steam
d	High turbine efficiency
e	Preheating feedwater to a temperature close to the boiling temperature
f	Preheating the combustion air and fuel charged to the boilers

Changes to legislation: There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)

1.4. BAT CONCLUSIONS FOR MECHANICAL PULPING AND CHEMIMECHANICAL PULPING

The BAT conclusions in this section apply to all integrated mechanical pulp, paper and board mills and to mechanical pulp mills, CTMP and CMP pulp mills. **BAT 49, BAT 51, BAT 52c and BAT 53** also apply to papermaking in integrated mechanical pulp, paper and board mills, in addition to the BAT conclusions in this section.

1.4.1. Waste water and emissions to water

BAT 40. In order to reduce fresh water use, waste water flow, and the pollution load, BAT is to use a suitable combination of the techniques specified in BAT 13, BAT 14, BAT 15 and BAT 16 and of the techniques given below.

	Technique	Description	Applicability
a	Counter-current flow of process water and separation of water systems.	See Section 1.7.2.1	Generally applicable
b	High consistency bleaching.		
c	Washing stage before the refining of softwood mechanical pulp using chip pre-treatment.		
d	Substitution of NaOH by $Ca(OH)_2$ or $Mg(OH)_2$ as alkali in peroxide bleaching.		Applicability for the highest brightness levels may be restricted
e	Fibre and filler recovery and treatment of white water (papermaking).		Generally applicable
f	Optimum design and construction of tanks and chests (papermaking).		

BAT-associated emission levels

See Table 16. These BAT-AELs also apply to mechanical pulp mills. The reference waste water flow for integrated mechanical, CTM and CTMP pulp mills are set out in BAT 5.

TABLE 16

BAT-associated emission levels for the direct waste water discharge to receiving waters from the integrated production of paper and board from mechanical pulps produced on site

Changes to legislation: There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)

Parameter	Yearly averagekg/t
Chemical oxygen demand (COD)	0,9 – 4,5[a]
Total suspended solids (TSS)	0,06 – 0,45
Total nitrogen	0,03 – 0,1[b]
Total phosphorus	0,001 – 0,01

a In the case of highly bleached mechanical pulp (70-100 % of fibre in final paper), emission levels of up to 8 kg/t may occur.

b When biodegradable or eliminable chelating agents cannot be used due to pulp quality requirements (e.g. high brightness), the emissions of total nitrogen might be higher than this BAT-AEL and should be assessed on a case-by-case basis.

TABLE 17

BAT-associated emission levels for the direct waste water discharge to receiving waters from a CTMP or CMP pulp mill

Parameter	Yearly averagekg/ADt
Chemical oxygen demand (COD)	12 – 20
Total suspended solids (TSS)	0,5 – 0,9
Total nitrogen	0,15 – 0,18[a]
Total phosphorus	0,001 – 0,01

a When biodegradable or eliminable chelating agents cannot be used due to pulp quality requirements (e.g. high brightness), the emissions of total nitrogen might be higher than this BAT- AEL and should be assessed on a case-by-case basis.

The BOD concentration in the treated effluents is expected to be low (around 25 mg/l as a 24-hour composite sample).

1.4.2. Energy consumption and efficiency

BAT 41. In order to reduce the consumption of thermal and electrical energy, BAT is to use a combination of the techniques given below.

	Technique	Applicability
a	Use of energy efficient refiners	Applicable when replacing, rebuilding or upgrading process equipment
b	Extensive recovery of secondary heat from TMP and CTMP refiners and reuse of recovered steam in paper or pulp drying	Generally applicable
c	Minimisation of fibre losses by using efficient reject refining systems (secondary refiners)	
d	Installation of energy saving equipment, including	

Changes to legislation: There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)

	automated process control instead of manual systems	
e	Reduction of fresh water use by internal process water treatment and recirculation systems	
f	Reduction of the direct use of steam by careful process integration using e.g. pinch analysis	

1.5. BAT CONCLUSIONS FOR PROCESSING PAPER FOR RECYCLING

The BAT conclusions in this section apply to all integrated RCF mills and to RCF pulp mills. **BAT 49, BAT 51, BAT 52c and BAT 53** also apply to papermaking in integrated RCF pulp, paper and board mills, in addition to the BAT conclusions in this section.

1.5.1. **Materials management**

BAT 42. In order to prevent the contamination of soil and groundwater or to reduce the risk thereof and in order to reduce wind drift of paper for recycling and diffuse dust emissions from the paper for recycling yard, BAT is to use one or a combination of the techniques given below.

	Technique	**Applicability**
a	Hard surfacing of the storage area for paper for recycling	Generally applicable
b	Collection of contaminated run-off water from the paper for recycling storage area and treatment in a waste water treatment plant (uncontaminated rainwater e.g. from roofs can be discharged separately)	Applicability may be restricted by the degree of contamination of run-off water (low concentration) and/or the size of the waste water treatment plants (large volumes)
c	Surrounding the terrain of the paper for recycling yard with fences against wind drift	Generally applicable
d	Regularly cleaning the storage area and sweeping associated roadways and emptying gully pots to reduce diffuse dust emissions. This reduces wind-blown paper debris, fibres and the crushing of paper by on-site traffic, which can cause additional dust emission, especially in the dry season	Generally applicable

Changes to legislation: There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)

e	Storing of bales or loose paper under a roof to protect the material from weather influences (moisture, microbiological degradation processes, etc.)	Applicability may be restricted by the size of the area

1.5.2. **Waste water and emissions to water**

BAT 43. In order to reduce fresh water use, waste water flow, and the pollution load, BAT is to use a combination of the techniques given below.

	Technique	Description
a	Separation of the water systems	See Section 1.7.2.1
b	Counter-current flow of process water and water recirculation	
c	Partial recycling of treated waste water after biological treatment	Many RCF paper mills recycle a partial stream of biologically treated waste water back into the water circuit, especially mills producing corrugated medium or Testliner
d	Clarification of white water	See Section 1.7.2.1

BAT 44. In order to maintain advanced water circuit closure in mills processing paper for recycling and to avoid possible negative effects from the increased recycling of process water, BAT is to use one or a combination of the techniques given below.

	Technique	Description
a	Monitoring and continuous control of the process water quality	See Section 1.7.2.1
b	Prevention and elimination of biofilms by using methods that minimise emissions of biocides	
c	Removal of calcium from process water by a controlled precipitation of calcium carbonate	

Applicability

Techniques (a) – (c) are applicable to RCF paper mills with advanced water circuit closure.

Changes to legislation: *There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)*

BAT 45. In order to prevent and reduce the pollution load of waste water into receiving waters from the whole mill, BAT is to use a suitable combination of the techniques specified in BAT 13, BAT 14, BAT 15, BAT 16, BAT 43 and BAT 44.

For integrated RCF paper mills, the BAT-AELs include emissions from papermaking, since the white water circuits of the paper machine are closely connected with those of the stock preparation.

BAT-associated emission levels

See Table 18 and Table 19.

The BAT-associated emission levels in Table 18 apply also to RCF without deinking pulp mills, and the BAT-associated emission levels in Table 19 apply also to RCF with deinking pulp mills.

The reference waste water flow for RCF mills is set out in BAT 5.

TABLE 18

BAT-associated emission levels for the direct waste water discharge to receiving waters from the integrated production of paper and board from recycled fibres pulp, produced without deinking on site

Parameter	Yearly averagekg/t
Chemical oxygen demand (COD)	0,4[a] – 1,4
Total suspended solids (TSS)	0,02 – 0,2[b]
Total nitrogen	0,008 – 0,09
Total phosphorus	0,001 – 0,005[c]
Adsorbable organically bound halogens (AOX)	0,05 for wet strength paper

a For mills with completely closed water circuits, there are no emissions of COD.

b For existing plants, levels up to 0,45 kg/t may occur, due to the continuous decline in the quality of paper for recycling and the difficulty of continuously upgrading the effluent plant.

c For mills with a waste water flow between 5 and 10 m^3/t, the upper end of the range is 0,008 kg/t.

TABLE 19

BAT-associated emission levels for the direct waste water discharge to receiving waters from the integrated production of paper and board from recycled fibres pulp produced with deinking on site

Parameter	Yearly averagekg/t
Chemical oxygen demand (COD)	0,9 – 3,0 0,9 – 4,0 for tissue paper
Total suspended solids (TSS)	0,08 – 0,3 0,1 – 0,4 for tissue paper
Total nitrogen	0,01 – 0,1 0,01 – 0,15 for tissue paper
Total phosphorus	0,002 – 0,01 0,002 – 0,015 for tissue paper

Changes to legislation: There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)

Adsorbable organically bound halogens (AOX)	0,05 for wet strength paper

The BOD concentration in the treated effluents is expected to be low (around 25 mg/l as a 24-hour composite sample).

1.5.3. **Energy consumption and efficiency**

BAT 46. BAT is to reduce electrical energy consumption within RCF processing paper mills by using a combination of the techniques given below.

	Technique	Applicability
a	High consistency pulping for disintegrating paper for recycling into separated fibres	Generally applicable for new plants and for existing plants in the case of a major refurbishment
b	Efficient coarse and fine screening by optimising rotor design, screens and screen operation, which allows the use of smaller equipment with lower specific energy consumption	
c	Energy saving stock preparation concepts extracting impurities as early as possible in the re-pulping process, using fewer and optimised machine components, thus restricting the energy intensive processing of the fibres	

1.6. BAT CONCLUSIONS FOR PAPERMAKING AND RELATED PROCESSES

The BAT conclusions in this section apply to all non-integrated paper mills and board mills and to the paper and board making part of integrated kraft, sulphite, CTMP and CMP mills.

BAT 49, BAT 51, BAT 52c and BAT 53 apply to all integrated pulp and paper mills.

For integrated kraft, sulphite, CTMP and CMP pulp and paper mills, the process-specific BAT for pulping also apply, in addition to the BAT conclusions in this section.

1.6.1. **Waste water and emissions to water**

BAT 47. In order to reduce the generation of waste water, BAT is to use a combination of the techniques given below.

	Technique	Description	Applicability
a	Optimum design and construction of tanks and chests	See Section 1.7.2.1	Applicable to new plants and to existing

Changes to legislation: *There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)*

			plants in the case of a major refurbishment
b	Fibre and filler recovery and treatment of white water		Generally applicable
c	Water recirculation		Generally applicable. Dissolved organic, inorganic, and colloidal materials may restrict the water reuse in the wire section
d	Optimisation of showers in the paper machine		Generally applicable

BAT 48. In order to reduce fresh water use and emissions to water from speciality paper mills, BAT is to use a combination of the techniques given below.

	Technique	Description	Applicability
a	Improvement of paper production planning	Improved planning to optimise production batch combinations and length	Generally applicable
b	Management of water circuits to fit changes	Adjust water circuits to be able to cope with changes of paper grades, colours and chemical additives used	
c	Waste water treatment plant ready to cope with changes	Adjust waste water treatment to be able to cope with variations of flows, low concentrations and varying types and amounts of chemical additives	
d	Adjustment of the broke system and of chest capacities		
e	Minimisation of release of chemical additives (e.g. grease-/water proof agents) containing per- or polyflourinated compounds or contributing to their formation		Applicable only for plants producing paper with grease- or water-repellent properties

Changes to legislation: There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)

f	Switch to low AOX-containing product aids (e.g. to substitute use of wet strength agents based on epichlorohydrin resins)	Applicable only for plants producing paper grades with high wet strength

BAT 49. In order to reduce emission loads of coating colours and binders which can disturb the biological waste water treatment plant, BAT is to use technique (a) given below or, in case this is technically not feasible, technique (b) given below.

	Technique	Description	Applicability
a	Recovery of coating colours/recycling of pigments	Effluents containing coating colours are collected separately. The coating chemicals are recovered by e.g.: (i) ultrafiltration; (ii) screening-flocculation-dewatering process with return of the pigments to the coating process. The clarified water could be reused in the process	For ultrafiltration, the applicability may be restricted when: — effluent volumes are very small — coating effluents are generated in various places of the mill — many changes in coating occur; or — different coating colour recipes are incompatible
b	Pretreatment of effluents which contain coating colours	Effluents which contain coating colours are treated e.g. by flocculation to protect the subsequent biological waste water treatment	Generally applicable

BAT 50. In order to prevent and reduce the pollution load of waste water into receiving waters from the whole mill, BAT is to use a suitable combination of the techniques specified in BAT 13, BAT 14, BAT 15, BAT 47, BAT 48 and BAT 49.

BAT-associated emission levels

See Table 20 and Table 21.

The BAT-AELs in Table 20 and Table 21 also apply to the paper and board making process of integrated kraft, sulphite, CTMP and CMP pulp and paper mills.

The reference waste water flow for non-integrated paper and board mills is set out in BAT 5.

Changes to legislation: There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)

TABLE 20

BAT-associated emission levels for the direct waste water discharge to receiving waters from a non-integrated paper and board mill (excluding speciality paper)

Parameter	Yearly averagekg/t
Chemical oxygen demand (COD)	0,15 – 1,5[a]
Total suspended solids (TSS)	0,02 – 0,35
Total nitrogen	0,01 – 0,1 0,01 – 0,15 for tissue paper
Total phosphorus	0,003 – 0,012
Adsorbable organically bound halogens (AOX)	0,05 for decor and wet strength paper

a For graphic paper mills, the upper end of the range refers to mills manufacturing paper that use starch for the coating process.

The BOD concentration in the treated effluents is expected to be low (around 25 mg/l as a 24-hour composite sample).

TABLE 21

BAT-associated emission levels for the direct waste water discharge to receiving waters from a non-integrated speciality paper mill

Parameter	Yearly averagekg/t[a]
Chemical oxygen demand (COD)	0,3 – 5[b]
Total suspended solids (TSS)	0,10 – 1
Total nitrogen	0,015 – 0,4
Total phosphorus	0,002 – 0,04
Adsorbable organically bound halogens (AOX)	0,05 for decor and wet strength paper

a Mills having special characteristics, such as a high number of grade changes (e.g. of ≥ 5 per day as a yearly average) or producing very light-weight speciality papers (≤ 30 g/m^2 as yearly average) might have higher emissions than the upper end of the range.

b The upper end of the BAT-AEL range refers to mills producing highly comminuted paper which requires intensive refining and to mills with frequent changes of paper grades (e.g. ≥ 1 – 2 changes/day as yearly average).

1.6.2. **Emissions to air**

BAT 51. In order to reduce VOC emissions from off-line or on-line coaters, BAT is to choose coating colour recipes (compositions) that reduce VOC emissions.

1.6.3. **Waste generation**

BAT 52. In order to minimise the amount of solid waste to be disposed of, BAT is to prevent waste generation and to carry out recycling operations by the use of a combination of the techniques given below (see general BAT 20).

	Technique	Description	Applicability

Changes to legislation: There are currently no known outstanding effects for the Commission Implementing Decision of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (notified under document C(2014) 6750) (Text with EEA relevance) (2014/687/EU), ANNEX. (See end of Document for details)

a	Fibre and filler recovery and treatment of white water	See Section 1.7.2.1	Generally applicable
b	Broke recirculation system	Broke from different locations/phases of paper making process is collected, re-pulped and returned to the fibre feedstock	Generally applicable
c	Recovery of coating colours/recycling of pigments	See Section 1.7.2.1	
d	Reuse of fibre sludge from primary waste water treatment	Sludge with a high fibre content from the primary treatment of waste water can be reutilised in a production process	Applicability may be limited by product quality requirements

1.6.4. Energy consumption and efficiency

BAT 53. In order to reduce the consumption of thermal and electrical energy, BAT is to use a combination of the techniques given below.

	Technique	Applicability
a	Energy saving screening techniques (optimised rotor design, screens and screen operation)	Applicable to new mills or major refurbishments
b	Best practice refining with heat recovery from the refiners	
c	Optimised dewatering in the press section of paper machine/wide nip press	Not applicable to tissue paper and many speciality papers grades
d	Steam condensate recovery and use of efficient exhaust air heat recovery systems	Generally applicable
e	Reduction of direct use of steam by careful process integration using e.g. pinch analysis	
f	High efficient refiners	Applicable to new plants
g	Optimisation of the operating mode in existing refiners (e.g.	Generally applicable

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	reduction of 'no load power requirements)	
h	Optimised pumping design, variable speed drive control for pumps, gearless drives	
i	Cutting edge refining technologies	
j	Steam box heating of the paper web to improve the drainage properties/ dewatering capacity	Not applicable to tissue paper and many speciality papers grades
k	Optimised vacuum system (e.g. turbo fans instead of water ring pumps)	Generally applicable
l	Generation optimisation and distribution network maintenance	
m	Optimisation of heat recovery, air system, insulation	
n	Use of high efficient motors (EFF1)	
o	Preheating of shower water with a heat exchanger	
p	Use of waste heat for sludge drying or upgrading of dewatered biomass	
q	Heat recovery from axial blowers (if used) for the supply air of the drying hood	
r	Heat recovery of exhaust air from the Yankee hood with a trickling tower	
s	Heat recovery from the infrared exhaust hot air	

1.7. DESCRIPTION OF TECHNIQUES

1.7.1. **Description of techniques for the prevention and control of emissions to air**

1.7.1.1. *Dust*

Technique	Description
Electrostatic precipitator (ESP)	Electrostatic precipitators operate such that particles are charged and separated under the influence of an electrical field. They are

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	capable of operating over a wide range of conditions.
Alkaline scrubber	See Section 1.7.1.3 (wet scrubber).

1.7.1.2. *NO_x*

Technique	Description
Reduction of air/fuel ratio	The technique is mainly based on the following features: — careful control of air used for combustion (low excess oxygen), — minimisation of air leakages into the furnace, — modified design of the furnace combustion chamber.
Optimised combustion and combustion control	Based on permanent monitoring of appropriate combustion parameters (e.g. O_2, CO content, fuel/air ratio, un-burnt components), this technique uses control technology for achieving the best combustion conditions. NO_x formation and emissions can be decreased by adjusting the running parameters, the air distribution, excess oxygen, flame shaping and the temperature profile.
Staged incineration	Staged incineration is based on the use of two burning zones, with controlled air ratios and temperatures in a first chamber. The first burning zone operates at sub-stoichiometric conditions to convert ammonia compounds into elementary nitrogen at high temperature. In the second zone, additional air feed completes combustion at a lower temperature. After the two-stage incineration, the flue-gas flows to a second chamber to recover the heat from the gases, producing steam to the process.
Fuel selection/low-N fuel	The use of fuels with a low nitrogen content reduces the amount of NO_x emissions from the oxidation of nitrogen contained in the fuel during combustion. The combustion of CNCG or biomass-based fuels increases NO_x emissions compared to oil and natural gas, as CNCG and all wood-derived fuels contain more nitrogen than oil and natural gas.

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	Due to higher combustion temperatures, gas firing leads to higher NO_x levels than oil firing.
Low-NO_x burner	Low-NO_x burners are based on the principles of reducing peak flame temperatures, delaying but completing the combustion and increasing the heat transfer (increased emissivity of the flame). It may be associated with a modified design of the furnace combustion chamber.
Staged injection of spent liquor	The injection of spent sulphite liquor into the boiler at various vertically staged levels prevents the formation of NO_x, and provides for complete combustion.
Selective non-catalytic reduction (SNCR)	The technique is based on the reduction of NO_x to nitrogen by reaction with ammonia or urea at a high temperature. Ammonia water (up to 25 % NH_3), ammonia precursor compounds or urea solution is injected into the combustion gas to reduce NO to N_2. The reaction has an optimum effect in a temperature window of about 830 °C to 1 050 °C, and sufficient retention time must be provided for the injected agents to react with NO. Dosing rates of ammonia or urea have to be controlled to keep NH_3 slip at low levels.

1.7.1.3. *SO_2/TRS emissions prevention and control*

Technique	Description
High dry solid black liquor	With a higher dry solid content of the black liquor, the combustion temperature increases. This vaporises more sodium (Na), which can bind the SO_2 forming Na_2SO_4 thus reducing SO_2 emissions from the recovery boiler. A drawback to the higher temperature is that emissions of NO_x may increase
Fuel selection/low-S fuel	The use of low-sulphur content fuels with a sulphur content of about 0,02 – 0,05 % by weight (e.g. forest biomass, bark, low-sulphur oil, gas) reduces SO_2 emissions generated by the oxidation of sulphur in the fuel during combustion
Optimised firing	Techniques such as efficient firing rate control system (air-fuel, temperature, residence time), control of excess oxygen or good mixing of air and fuel

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Control of Na_2S content in lime mud feed	Efficient washing and filtration of the lime mud reduces the concentration of Na_2S, thus reducing the formation of hydrogen sulphide in the kiln during the re-burning process
Collection and recovery of SO_2 emissions	Highly concentrated SO_2-gas streams from acid liquor production, digesters, diffusers or blow tanks are collected. SO_2 is recovered in absorption tanks with different pressure levels, both for economic and environmental reasons
Incineration of odorous gases and TRS	Collected strong gases can be destroyed by burning them in the recovery boiler, in dedicated TRS burners, or in the lime kiln. Collected weak gases are suitable for burning in the recovery boiler, lime kiln, power boiler or in the TRS burner. Dissolving tank vent gases can be burnt in modern recovery boilers
Collection and incineration of weak gases in a recovery boiler	Combustion of weak gases (large volume, low SO_2 concentrations) combined with a back-up system. Weak gases and other odorous components are simultaneously collected to be burnt in the recovery boiler. From the exhaust gas of the recovery boiler, the sulphur dioxide is then recovered by counter-current multistage scrubbers and reused as a cooking chemical. As a back-up system, scrubbers are used.
Wet scrubber	Gaseous compounds are dissolved in a suitable liquid (water or alkaline solution). Simultaneous removal of solid and gaseous compounds may be achieved. Downstream of the wet scrubber, the flue-gases are saturated with water and a separation of the droplets is required before discharging the flue-gases. The resulting liquid has to be treated by a waste water process and the insoluble matter is collected by sedimentation or filtration
ESP or multicyclones with multistage venturi scrubbers or multistage double inlet downstream scrubbers	The separation of dust is carried out in an electrostatic precipitator or multistage cyclone. For the magnesium sulphite process, the dust retained in the ESP consists mainly of MgO but also to a minor extent, K, Na or Ca compounds. The recovered MgO ash is suspended with water and cleaned by washing and slaking to form $Mg(OH)_2$ which is then used as an alkaline scrubbing solution in the multistage scrubbers in order to recover the sulphur component of the

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	cooking chemicals. For the ammonium sulphite process, the ammonia base (NH_3) is not recovered, as it is decomposed in the combustion process in nitrogen. After the removal of dust, the flue-gas is cooled down by passing through a cooling scrubber operated with water and it then enters a three or more staged scrubber of the flue-gas where the SO_2 emissions are scrubbed with the $Mg(OH)_2$ alkaline solution in the case of the magnesium sulphite process, and with a 100 % fresh NH_3 solution in the case of the ammonium sulphite process.

1.7.2. Description of techniques to reduce fresh water use/waste water flow and the pollution load in waste water

1.7.2.1. *Process integrated techniques*

Technique	Description
Dry debarking	Dry debarking of wood logs in dry tumbling drums (water being used only in washing of the logs, and then recycled with only a minimum purge to the waste water treatment plant)
Totally chlorine free bleaching (TCF)	In TCF bleaching, the use of chlorine containing bleaching chemicals is completely avoided and thus so are the emissions of organic and organochlorinated substances from bleaching
Modern elemental chlorine free (ECF) bleaching	Modern ECF bleaching minimises the consumption of chlorine dioxide by using one or a combination of the following bleaching stages: oxygen, hot acid hydrolysis stage, ozone stage at medium and high consistency, stages with atmospheric hydrogen peroxide and pressurised hydrogen peroxide or the use of a hot chlorine dioxide stage
Extended delignification	Extended delignification by (a) modified cooking or (b) oxygen delignification enhances the degree of delignification of pulp (lowering the kappa number) before bleaching and thus reduces the use of bleaching chemicals and the COD load of waste water. Lowering the kappa number by one unit before bleaching can reduce the COD released in the bleach plant by approximately 2 kg COD/ADt. The lignin

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	removed can be recovered and sent to the chemicals and energy recovery system
(a) Extended modified cooking	Extended cooking (batch or continuous systems) comprises longer cooking periods under optimised conditions (e.g. alkali concentration in the cooking liquor is adjusted to be lower at the beginning and higher at the end of the cooking process), to extract a maximum amount of lignin before bleaching, without undue carbohydrate degradation or excessive loss of pulp strength. Thus, the use of chemicals in the subsequent bleaching stage and the organic load of the waste water from the bleach plant can be reduced
(b) Oxygen delignification	Oxygen delignification is an option to remove a substantial fraction of the lignin remaining after cooking, in case the cooking plant has to be operated with higher kappa numbers. The pulp reacts under alkaline conditions with oxygen to remove some of the residual lignin
Closed and efficient brown stock screening and washing	Brown stock screening is carried out with slotted pressure screens in a multistage closed cycle. Impurities and shives are thus removed at an early stage in the process. Brown stock washing separates dissolved organic and inorganic chemicals from the pulp fibres. The brown stock pulp may be washed first in the digester, then in high-efficiency washers before and after oxygen delignification, i.e. before bleaching. Carry-over, chemical consumption in bleaching, and the emission load of waste water are all reduced. Additionally, it allows for recovery of the cooking chemicals from the washing water. Efficient washing is done by counter-current multistage washing, using filters and presses. The water system in the brown stock screening plant is completely closed
Partial process water recycling in the bleach plant	Acid and alkaline filtrates are recycled within the bleach plant counter-currently to the pulp flow. Water is purged either to the waste water treatment plant or, in a few cases, to post-oxygen washing. Efficient washers in the intermediate washing stages are a prerequisite for low emissions. A bleach plant effluent flow of 12 – 25 m^3/ADt is achieved in efficient mills (Kraft)

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Effective spill monitoring and containment, also with chemical and energy recovery	An effective spill control, catchment and recovery system that prevents accidental releases of high organic and sometimes toxic loads or peak pH values (to the secondary waste water treatment plant) comprises: — conductivity or pH monitoring at strategic locations to detect losses and spills; — collecting diverted or spilled liquor at the highest possible liquor solids concentration; — returning collected liquor and fibre to the process at appropriate locations; — preventing spills of concentrated or harmful flows from critical process areas (including tall oil and turpentine) from entering the biological effluent treatment; — adequately dimensioned buffer tanks for collecting and storing toxic or hot concentrated liquors
Maintaining sufficient black liquor evaporation and recovery boiler capacity to cope with peak loads	Sufficient capacity in the black liquor evaporation plant and in the recovery boiler ensure that additional liquor and dry solids loads due to the collection of spills or bleach plant effluents can be dealt with. This reduces losses of weak black liquor, other concentrated process effluents and potentially bleach plant filtrates. The multi-effect evaporator concentrates weak black liquor from brown stock washing and, in some cases, also biosludge from the effluent treatment plant and/or salt cake from the ClO_2 plant. Additional evaporation capacity above normal operation gives sufficient contingency to recover spills and to treat potential bleach filtrate recycle streams
Stripping the contaminated (foul) condensates and reusing the condensates in the process	Stripping of contaminated (foul) condensates and reuse of condensates in the process reduces the fresh water intake of a mill and the organic load to the waste water treatment plant. In a stripping column, steam is lead counter-currently through the previously filtered process condensates that contain reduced sulphur compounds, terpenes, methanol and other organic compounds. The volatile substances of the condensate accumulate in the overhead vapour as non-condensable gases and methanol and are withdrawn from

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	the system. The purified condensates can be reused in the process, e.g. for washing in the bleach plant, in brown stock washing, in the causticising area (mud washing and dilution, mud filter showers), as TRS scrubbing liquor for lime kilns, or as white liquor make-up water. The stripped non-condensable gases from the most concentrated condensates are fed into the collection system for strong malodorous gases and are incinerated. Stripped gases from moderately contaminated condensates are collected into the low volume high concentration gas system (LVHC) and incinerated
Evaporating and incinerating effluents from the hot alkaline extraction stage	The effluents are first concentrated by evaporation and then combusted as biofuel in a recovery boiler. Sodium carbonate containing dust and melt from the furnace bottom are dissolved to recover soda solution
Recirculation of washing liquids from pre-bleaching to brown stock washing and evaporation to reduce emissions from MgO-based pre-bleaching	Prerequisites for the use of this technique are a relatively low kappa number after cooking (e.g. 14 – 16), sufficient capacity of tanks, evaporators and recovery boiler to cope with additional flows, the possibility to clean the washing equipment from deposits, and a moderate brightness level of the pulp (≤ 87 % ISO) as this technique may lead to a slight loss of brightness in some cases. For market paper pulp producers or others that have to reach very high brightness levels (> 87 % ISO), it may be difficult to apply MgO pre-bleaching
Counter-current flow of process water	In integrated mills, fresh water is introduced mainly through the paper machine showers from which it is fed upstream towards the pulping department
Separation of water systems	Water systems of different process units (e.g. pulping unit, bleaching and paper machine) are separated by washing and dewatering the pulp (e.g. by wash presses). This separation prevents carry-over of pollutants to subsequent process steps and allows for removing disturbing substances from smaller volumes
High consistency (peroxide) bleaching	For high consistency bleaching, the pulp is dewatered e.g. by a twin wire or other press before bleaching chemicals are added. This allows for more efficient use of bleaching chemicals and results in a cleaner pulp, less

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	carry-over of detrimental substances to the paper machine and generates less COD. Residual peroxide may be recirculated and reused
Fibre and filler recovery and treatment of white water	White water from the paper machine can be treated by the following techniques: a) 'Save-all' devices (typically drum or disc filter or dissolved air flotation units etc.) that separate solids (fibres and filler) from the process water. Dissolved air flotation in white water loops transforms suspended solids, fines, small-size colloidal material and anionic substances into flocks that are then removed. The recovered fibres and fillers are recirculated to the process. Clear white water can be reused in showers with less stringent requirements for water quality. b) Additional ultrafiltration of the pre-filtered white water results in super clear filtrate with a quality sufficient for use as high pressure shower water, sealing water and for the dilution of chemical additives
Clarification of white water	The systems for water clarification used almost exclusively in the paper industry are based on sedimentation, filtration (disc filter) and flotation. The most used technique is dissolved air flotation. Anionic trash and fines are agglomerated into physically treatable flocs by using additives. High-molecular, water-soluble polymers or inorganic electrolytes are used as flocculants. The generated agglomerates (flocs) are then floated off in the clarification basin. In dissolved air flotation (DAF), the suspended solid material is attached to air bubbles
Water recirculation	Clarified water is recirculated as process water within a unit or in integrated mills from the paper machine to the pulp mill and from the pulping to the debarking plant. Effluent is mainly discharged from the points with the highest pollution load (e.g. clear filtrate of the disc filter in pulping, debarking)
Optimum design and construction of tanks and chests (papermaking)	Holding tanks for stock and white water storage are designed so that they can cope

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	with process fluctuations and varying flows also during start-ups and shutdowns
Washing stage before refining softwood mechanical pulp	Some mills pretreat softwood chips by combining pressurised preheating, high compression and impregnation to improve pulp properties. A washing stage before refining and bleaching significantly reduces COD by removing a small, but highly concentrated effluent stream that can be treated separately
Substitution of NaOH by $Ca(OH)_2$ or Mg $(OH)_2$ as alkali in peroxide bleaching	The use of $Ca(OH)_2$ as alkali results in approximately 30 % lower COD emission loads; while keeping brightness levels high. Also $Mg(OH)_2$ is used to replace NaOH
Closed-loop bleaching	In sulphite pulp mills using sodium as a cooking base, the bleach plant effluent can be treated, e.g. by ultrafiltration, flotation and separation of resin and fatty acids which enables closed-loop bleaching. The filtrates from bleaching and washing are reused in the first washing stage after cooking and finally recycled back to the chemical recovery units
pH adjustment of weak liquor before/inside the evaporation plant	Neutralisation is done before evaporation or after the first evaporation stage, to keep organic acids dissolved in the concentrate, in order for them to be sent with the spent liquor to the recovery boiler
Anaerobic treatment of the condensates from the evaporators	See Section 1.7.2.2 (combined anaerobic/aerobic treatment)
Stripping and recovery of SO_2 from condensates of evaporators	SO_2 is stripped from the condensates; concentrates are treated biologically, while the stripped SO_2 is sent for recovery as a cooking chemical.
Monitoring and continuous control of the process water quality	Optimisation of the entire 'fibre-water-chemical additive-energy system' is necessary for advanced closed water systems. This requires a continuous monitoring of the water quality and staff motivation, knowledge and action related to the measures needed to ensure the required water quality
Prevention and elimination of biofilms by using methods that minimise emissions of biocides	A continuous input of microorganisms by water and fibres leads to a specific microbiological equilibrium in each paper plant. To prevent extensive growth of the microorganisms, deposits of agglomerated biomass or biofilms in water circuits and equipment, often bio-dispersants or biocides are used. When using catalytic disinfection

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	with hydrogen peroxide, biofilms and free germs in process water and paper slurry are eliminated [X1by using methods that minimise emissions of biocides]
Removal of calcium from process water by controlled precipitation of calcium carbonate	Lowering the calcium concentration by controlled removal of calcium carbonate (e.g. in a dissolved air flotation cell) reduces the risk of undesired precipitation of calcium carbonate or scaling in water systems and equipment, e.g. in section rolls, wires, felts and shower nozzles, pipes or biological waste water treatment plants
Optimisation of showers in paper machine	Optimising showers involves: a) the reuse of process water (e.g. clarified white water) to reduce fresh water use, and b) the application of special design nozzles for the showers

Editorial Information

X1 Substituted by Corrigendum to Commission Implementing Decision 2014/687/EU of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the production of pulp, paper and board (Official Journal of the European Union L 284 of 30 September 2014).

1.7.2.2. *Waste water treatment*

Technique	Description
Primary treatment	Physico-chemical treatment, such as equalisation, neutralisation or sedimentation. Equalisation (e.g. in equalising basins) is used to prevent large variations in flow rate, temperature and contaminant concentrations and thus to avoid overloading the waste water treatment system
Secondary (biological) treatment	For the treatment of waste water by means of microorganisms, the available processes are aerobic and anaerobic treatment. In a secondary clarification step, solids and biomass are separated from effluents by sedimentation, sometimes combined with flocculation
a) Aerobic treatment	In aerobic biological waste water treatment, biodegradable dissolved and colloidal material in the water is transformed in the presence of air by microorganisms partly into a solid cell substance (biomass) and partly into carbon dioxide and water. Processes used are: — one- or two-stage activated sludge;

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	— biofilm reactor processes; — biofilm/activated sludge (compact biological treatment plant). This technique consists in combining moving bed carriers with activated sludge (BAS). The generated biomass (excess sludge) is separated from the effluent before the water is discharged
b) Combined anaerobic/aerobic treatment	Anaerobic waste water treatment converts the organic content of waste water by means of microorganisms in the absence of air, into methane, carbon dioxide, sulphide, etc. The process is carried out in an airtight tank reactor. The microorganisms are retained in the tank as biomass (sludge). The biogas formed by this biological process consists of methane, carbon dioxide and other gases such as hydrogen and hydrogen sulphide and is suitable for energy generation. Anaerobic treatment is to be seen as pretreatment before aerobic treatment, due to the remaining COD loads. Anaerobic pretreatment reduces the amount of sludge generated from biological treatment
Tertiary treatment	Advanced treatment comprises techniques, such as filtration for further solids removal, nitrification and denitrification for nitrogen removal or flocculation/precipitation followed by filtration for phosphorus removal. Tertiary treatment is normally used in cases where primary and biological treatment are not sufficient to achieve low levels of TSS, nitrogen or phosphorus, which may be required e.g. due to local conditions
Properly designed and operated biological treatment plant	A properly designed and operated biological treatment plant includes the appropriate design and dimensioning of treatment tanks/basins (e.g. sedimentation tanks) according to hydraulic and contaminant loads. Low TSS emissions are achieved by ensuring the good settling of the active biomass. Periodical revisions of the design, dimensioning and operation of the waste water treatment plant facilitate achieving these objectives

1.7.3. Description of techniques for waste generation prevention and waste management

Technique	Description

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Waste assessment and waste management system	Waste assessment and waste management systems are used to identify feasible options for optimising prevention, reuse, recovery, recycling and final disposal of waste. Waste inventories allow for identifying and classifying type, characteristics, amount and origin of each waste fraction
Separate collection of different waste fractions	The separate collection of different waste fractions at the points of origin and, if appropriate, intermediate storage can enhance the options for reuse or recirculation. Separate collection also includes segregation and classification of hazardous waste fractions (e.g. oil and grease residues, hydraulic and transformer oils, waste batteries, scrap electrical equipment, solvents, paints, biocides or chemical residues)
Merging of suitable residue fractions	Merging of suitable fractions of residue depending on the preferred options for reuse/recycling, further treatment and disposal
Pretreatment of process residues before reuse or recycling	Pretreatment comprises techniques such as: — dewatering e.g. of sludge, bark or rejects and in some cases drying to enhance reusability before utilisation (e.g. increase calorific value before incineration); or — dewatering to reduce weight and volume for transport. For dewatering belt presses, screw presses, decanter centrifuges or chamber filter presses are used; — crushing/shredding of rejects e.g. from RCF processes and removal of metallic parts, to enhance combustion characteristics before incineration; — biological stabilisation before dewatering, in case agricultural utilisation is foreseen
Material recovery and recycling of process residues on site	Processes for material recovery comprise techniques such as: — separation of fibres from water streams and recirculation into feedstock; — recovery of chemical additives, coating pigments, etc.; — recovery of cooking chemicals by means of recovery boilers, causticising, etc.

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Energy recovery on- or off-site from wastes with high organic content	Residues from debarking, chipping, screening etc. like bark, fibre sludge or other mainly organic residues are burnt due to their calorific value in incinerators or biomass power plants for energy recovery
External material utilisation	Material utilisation of suitable waste from pulp and paper production can be done in other industrial sectors, e.g. by: — firing in the kilns or mixing with feedstock in cement, ceramics or bricks production (includes also energy recovery); — composting paper sludge or land spreading suitable waste fractions in agriculture; — use of inorganic waste fractions (sand, stones, grits, ashes, lime) for construction, such as paving, roads, covering layers etc. The suitability of waste fractions for off-site utilisation is determined by the composition of the waste (e.g. inorganic/mineral content) and the evidence that the foreseen recycling operation does not cause harm to the environment or health
Pretreatment of waste fraction before disposal	Pretreatment of waste before disposal comprises measures (dewatering, drying etc.) reducing the weight and volume for transport or disposal

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