BEST AVAILABLE TECHNIQUES FOR PREVENTING AND CONTROLLING INDUSTRIAL POLLUTION

Activity 2:
Approaches to Establishing Best Available Techniques (BAT) Around the World

OECD
BETTER POLICIES FOR BETTER LIVES

Best Available Techniques for Preventing and Controlling Industrial Pollution

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The Inter-Organisation Programme for the Sound Management of Chemicals (IOMC) was established in 1995 following recommendations made by the 1992 UN Conference on Environment and Development to strengthen co-operation and increase international co-ordination in the field of chemical safety. The Participating Organisations are FAO, ILO, UNDP, UNEP, UNIDO, UNITAR, WHO, World Bank and OECD. The purpose of the IOMC is to promote co-ordination of the policies and activities pursued by the Participating Organisations, jointly or separately, to achieve the sound management of chemicals in relation to human health and the environment.

Foreword

The Best Available Techniques (BAT) concept has emerged as a key policy tool to prevent and control industrial emissions, thus ensuring a high level of environmental and human health protection. BAT and similar concepts constitute essential elements for setting emission limit values and other permit conditions for industrial emissions in many countries around the world.

The implementation of BAT or similar concepts generally requires a high level of resources. There is thus added value in sharing experience and knowledge amongst OECD Member countries and Partner countries on this issue. The OECD Joint Meeting of the Chemicals Committee and the Working Party on Chemicals, Pesticides and Biotechnology at its 54th meeting in February 2016 therefore approved a new project on BAT for preventing and controlling industrial chemical pollution.

The project consisted of three activities: (i) compile information on policies and practices embodying BAT; (ii) exchange information on how governments gather information on techniques and establish BAT; and (iii) assess methodologies for evaluation of the effectiveness of policies and practices embodying BAT or similar concepts by using Pollutant Release and Transfer Register (PRTR) information or monitoring data.

Building on the Activity 1 report, this report constitutes the final deliverable of Activity 2, aiming to provide governments with good practice insights on how to effectively design or review their approach to establishing BAT or similar concepts.

Information analysed in this report was collected through: (i) extensive contact with national experts, notably the members of OECD's designated Expert Group on BAT, through a survey, subsequent information exchange and visits to selected countries; and (ii) desk research, based on the consultation of online websites, publications and other resources. The draft report was reviewed at the Second Meeting of the Expert Group on BAT in November 2017. All the experts that have contributed to the report are acknowledged in Annex C.

This report is an output of the OECD Environment Directorate. It was prepared under the supervision of the OECD's designated Expert Group on BAT and published under the responsibility of the Joint Meeting of the Chemicals Committee and the Working Party on Chemicals, Pesticides and Biotechnology of the OECD. The report was prepared by Marit Hjort and Takaaki Ito (OECD Secretariat), and benefitted from excellent consultancy work by An Derden and Liesbet Van den Abeele (VITO) as well as Ram Lal Verma, Guilberto Borongan, Timothy Lam and Mara Regine Mendes (Asian Institute of Technology). Hannah Thabet (OECD Secretariat) provided indispensable editorial guidance.

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Abbreviations and acronyms

3iPET: Integrated, Intelligent and International Platform for Environmental Technologies
ACT: Alternative Control Technique
AEE: Assessment of Environmental Effects
AQMA: Air Quality Management Area
AWQC: Ambient Water Quality Criteria
AWQS: Ambient Water Quality Standard
BACT: Best Available Control Technology
BAT: Best Available Techniques
BAT-AEL: Emission Levels Associated with the Best Available Techniques
BATIS: Best Available Techniques Information System
BCT: Best Conventional Pollutant Control Technology
BEMP: Best Environmental Management Practice
BEP: Best Environmental Practice
BIAC: Business and Industry Advisory Committee
BIS: Bureau of Indian Standards
BOD: Biochemical Oxygen Demand
BPJ: Best Professional Judgement
BPM: Best Practicable Means
BPO: Best Practical Options
BPR: Best Practice Report
BPT: Best Practicable Control Technology
BREF: BAT Reference Document
BSER: Best System of Emission Reduction
CAA: Clean Air Act
CAAQM: Continuous Ambient Air Quality Monitoring
CAAQMS: Continuous Ambient Air Quality Monitoring Station
CCAP: Centre of Clean Air Policy
CEMS: Continuous Emissions Monitoring System
CEPI: Comprehensive Environmental Pollution Index
CEQMS: Continuous Effluent Quality Monitoring Systems
CETP: Common Effluent Treatment Plants
CII: Confederation of Indian Industry
COIND: Comprehensive Industry Documents
COINDS: Comprehensive Industry Documents Series
CPS: Categorical Pre-treatment Standards
CPCB: Central Pollution Control Board
CREP: Corporate Responsibility for Environmental Protection
CSE: Centre for Science and Environment
CTG: Control Technique Guidelines
CWA: Clean Water Act
DELG: Dairy Environment Leadership Group
DSTS: Department of Science, Technology and Standards

DWS: Drinking Water Standards
EC: European Commission
EECCA: Eastern Europe, Caucasus and Central Asia
EHS: Environment, Health and Safety
EIPPCB: European Integration Pollution Prevention and Control Bureau
ELV: Emission Limit Value
EMAS: Eco-Management and Audit Scheme
ENVIS: Environmental Information System
EPA (US): Environmental Protection Agency
EPA (India): Environment Protection Act
EPA (New Zealand): Environmental Protection Authority
ETV: Environmental Technology Verification
EU: European Union
FECO: Foreign Economic Cooperation Office
FCCI: Indian Chambers of Commerce and Industry
GATPPCs: Guidelines on Available Technologies of Pollution Prevention and Control
GCPC: Gujarat Cleaner Production Centre
GDP: Gross Domestic Product
GEMS: Global Environment Monitoring System
GIIP: Good International Industry Practice
GIZ: Deutsche Gesellschaft für Internationale Zusammenarbeit
GMP: Good Management Practices
HAP: Hazardous Air Pollutant
IBG: Industry Branch Groups
IED: Industrial Emissions Directive
IEEP: Institute for Engineering and Environmental Problems in Agricultural Production
IFC: International Finance Corporation
IGEP: Indo-German Environment Partnership
IPPC: Integrated Pollution Prevention and Control
ISA: Integrated Science Assessment Reports
JRC: Joint Research Centre
KEI: Key Environmental Issues
KLRI: Korea Legislation Research Institute
LAAQS: Local Ambient Air Quality Standards
LAER: Lowest Achievable Emission Rate
LDAR: Leak Detection and Repair
MACT: Maximum Achievable Control Technology
MCM: Minamata Convention on Mercury
MCP: Medium Combustion Plants
MEP: Ministry of Environmental Protection
MIGA: Multilateral Investment Guarantee Agency
MINARS: Monitoring of Indian National Aquatic Resources System
MINAS: Minimum National Standards
MfE: Ministry for the Environment
MNRE: Ministry of Natural Resources and Ecology
MoE: Ministry of Environment
MoEF&CC: Ministry of Environment, Forest and Climate Change
MTWR: Management of Tailings and Waste-Rock
MWR: Ministry of Water Resources
NAAQS: National Ambient Air Quality Standards
NAQI: National Air Quality Index
NAMP: National Air Quality Monitoring Programme

NEP: National Environment Policy
NES: National Environmental Standard
NESHAP: National Emission Standard for Hazardous Air Pollutants
NGO: Non-Governmental Organisation
NIER: National Institute of Environmental Research
NMS: National Monitoring System
NPDES: National Pollutant Discharge Elimination System
NPS: National Policy Statement
NPS-FM: National Policy Statement for Freshwater Management
NSPS: New Source Performance Standard
NSR: New Source Review
NZFOA: New Zealand Forest Owners' Association
OECD: Organisation for Economic Co-operation and Development
OMP: Operator Management Practices
OPPT: Office of Pollution Prevention and Toxics
PA: Policy Assessment
PCB: Pollution Control Board
PCLS: Pollution Control Law Series
PM_{10}: Particulate Matter - fraction of particles having an aerodynamic diameter of less than 10 µm
PMU: Project Management Unit
POP: Persistent Organic Pollutant
PPA: Pollution Prevention Act
PPCL: Pollution Prevention and Control Law
PRTR: Pollutant Release and Transfer Register
PSD: Prevention of Significant Deterioration
PSES: CPS for Existing Sources
PSNS: CPS for New Sources
P&CGC: Peer and Core Group Committee
QAPPs: Quality Assurance Program Plans
RACT: Reasonably Available Control Technology
RBLC: RACT/BACT/LAER Clearinghouse
RCRA: Resource Conservation and Recovery Act
REA: Risk/Exposure Assessment
REF: Reference Documents
RMA: Resource Management Act
RRC.AP: Regional Resource Centre for Asia and the Pacific
SARA: Superfund Amendments and Reauthorization Act
SIP: State Implementation Plan
SPCB: State Pollution Control Board
SRD: Sectoral Reference Document
SSCPOP: Secretariat of the Stockholm Convention on Persistent Organic Pollutants
STMS: Smoke Stack Tele Monitoring System
SUSPROC: Sustainable Production and Consumption
TBEL: Technology-based standards for point source
TERI: The Energy and Resources Institute
TMDLs: Total Maximum Daily Loads
TRI: Toxics Release Inventory
TSP: Total Suspended Particulate
TWG: Technical Working Group
UNECE: United Nations Economic Commission for Europe
UNEP: United Nations Environment Programme
UNIDO: United Nations Industrial Development Organization
US: United States
UST: Underground Storage Tank

UTPCCs: Union Territories Pollution Control Committees
VITO: Flemish Institute for Technological Research
VOC: Volatile Organic Compound
WBG: World Bank Group
WET: Whole Effluent Toxicity
WTMS: Water Tele Monitoring System
WQBEL: Water Quality-based Effluent Limitation

Executive summary

This report presents the first comprehensive analysis of approaches to establishing BAT and similar concepts to prevent and control industrial emissions in a wide range of countries, including the following OECD Members and Partners: the Russian Federation, Korea, the United States, the European Union, India, the People's Republic of China and New Zealand.

For each country, the report presents extensive information on the procedures for collection of data on techniques for control and prevention of industrial pollution, evaluation of the techniques and identification of BAT. In addition, the report covers international initiatives facilitating the application of BAT, including under the Minamata Convention on Mercury and the Stockholm Convention on Persistent Organic Pollutants.

While acknowledging the inherent differences of the policy contexts in which BAT are applied, the report allows for a cross-country comparison of existing approaches to determine BAT. The report does not prescribe a preferred procedure to establish BAT, but seeks to demonstrate the attributes and limitations of various methodologies, aiming to share good practices between countries that already have BAT-based polices and to assist interested governments that are considering the adoption of such an approach.

The key characteristics of each country's BAT determination procedure are summarised in a comprehensive table in the final chapter, providing a useful overview for policy-makers and other stakeholders. The report also provides a unique compilation of the BAT documents developed by all the countries involved, allowing interested stakeholders to access, and seek guidance from, already identified BAT.

Key characteristics of procedures to determine BAT

While the BAT policies around the world were adopted at different points in time and all have their unique design, the report pinpoints valuable insights on some key characteristics of approaches to establish BAT applying across countries.

Taking a BAT-based approach to setting emission limit values

The report explores how countries' environmental legislation defines the association between BAT and emission limit values (ELVs), providing illustrative examples that can guide the development and review of such legislation in other countries. Constituting a key element for setting legally binding ELVs and other permit conditions, BAT serve as crucial technical guidance, helping industrial operators to design, operate, maintain and decommission their installations so as to prevent or control emissions to air, soil and water.

Engaging stakeholders in industrial pollution management

Official reference documents for BAT or similar concepts result from a series of exchanges of information between a variety of stakeholders, including governmental experts, industry representatives, members of NGOs and research institutes. This approach seeks to ensure enhanced understanding of each party's needs in the process to identify BAT. The report highlights the advantages of multi-stakeholder procedures for the determination of BAT, while also stressing challenges associated with transparency throughout such a process.

Relying on diverse data sources to evaluate techniques

The report offers valuable reflections on essential aspects of the information collection and evaluation procedures involved in the establishment of BAT. Notably, this includes the weighing of environmental, economic and technical aspects of available techniques, the use of data from monitoring systems and other relevant sources, the balancing between preventive and end-of-pipe techniques, the steps for official approval of techniques as BAT, and the time and resources required to finalise BAT documents.

Methodology

Terminology

BAT

The policies examined in this report use different terms and definitions to describe BAT. The European Union (EU) Industrial Emissions Directive (2010) defines BAT as "the most effective and advanced stage in the development of activities and their methods of operation, indicating the practical suitability of particular techniques for providing the basis for emission limit values and other permit conditions designed to prevent and, where this is not practicable, to reduce emissions and the impact on the environment as a whole". However, some countries also include innovative and cutting-edge techniques amongst their BAT.

Some policies do not refer to BAT, but rather other similar concepts, such as available techniques, Best Techno-Economically Available Techniques, Best Available Control Technology and Best Practical Options. This report does not take a stands with regards to the definitions and terminology applied in different countries. For the sake of simplicity, in the context of this report the term BAT refers both to BAT and all similar concepts.

The term *techniques*, as referred to in this report, relies on the definition used in the EU Industrial Emissions Directive, describing techniques as both (i) the technologies used by industrial installations; and (ii) the way in which installations are designed, built, maintained, operated and decommissioned. The OECD recognises the important distinction between techniques for *prevention* versus *control* of industrial emissions. The BAT documents referred to in the report include both prevention and control techniques.

Emission limit values

All the country chapters consider the association between emission limit values (ELVs) and BAT. ELVs are defined as maximum allowed values for emissions to air, water or soil for a certain pollutant and sector, and constitute guiding or legally binding values for industrial installations. In most countries these values are stated in the environmental legislation and in the conditions or guidance documents for emission permits. In many countries, ELVs are known as *standards*. While the report provides some information on how ELVs are defined in the various countries, the primary objective of this information is to describe the context for BAT development and not to conduct an exhaustive analysis of ELVs and associated permitting systems.

Target countries and sectors

This report provides an overview of the outcome of Activity 2 by compiling information on experiences with BAT establishment in the following countries, including both Members and Partners of the OECD:

i. Russian Federation;
ii. Korea;
iii. United States;
iv. European Union;
v. India;
vi. People's Republic of China; and
vii. New Zealand.

This report uses the term *countries* to refer to all of the above, despite the EU being a region. In addition to containing a chapter on each of the countries, the report includes a chapter on selected international BAT initiatives.

Three target sectors were chosen for Activity 2:

i. Processing of non-ferrous metals (hereafter 'non-ferrous metals');
ii. pre-treatment (operations such as washing, bleaching, mercerisation) or dyeing of textile fibres or textiles (hereafter 'textiles'); and
iii. production of pulp and paper (hereafter 'pulp and paper').

While the original objective of the selection of target sectors was to facilitate the data collection for Activity 2 by restricting it to a limited number of sectors, it was feasible to obtain data for a much larger number of industrial sectors. As a consequence, the Activity 2 report uses the target sectors as sources of examples and as a basis for comparison of availability of BAT documents across countries. Further information on the rationale behind the selection of the target sectors is available in Annex A.

Data collection

This report is informed by findings from the Activity 1 report[1] as well as readily available evidence addressing the target countries and/or sectors. Furthermore, information was collected from experts involved in the determination of BAT in the various countries, including representatives from national governments, research institutes, NGOs and groups of operators. Annex C lists these country experts. The information was gathered from the country experts by the following means:

i. an online survey (questionnaire available in Annex B);
ii. follow-up interviews by phone;
iii. stakeholder meetings in India and the People's Republic of China; and
iv. the 2nd Meeting of the Expert Group on BAT, 14-15 November 2017, Seville, Spain.

The information collection, notably the online survey, was structured around a three step model for BAT determination, distinguishing between (Step 1) collection of information on techniques for prevention and control of industrial emissions; (Step 2) evaluation of the techniques and the subsequent identification of BAT; and (Step 3) ranking/prioritisation of BAT.

For Step 1, the survey primarily requested information on (i) tools for collection and exchange of information on techniques; and (ii) stakeholders involved in the information collection and their responsibilities. For Step 2, the survey sought data on (i) the methodology for evaluation of techniques, including whether this involves a preselection, and the subsequent identification of BAT; (ii) the stakeholders involved in this and their responsibilities; and (iii) the criteria for evaluation of techniques, including technical, environmental, economic, social and other aspects. As regards the environmental aspects,

the survey primarily requested information on factors contributing to the reduction of emissions to air, water and soil, but also on other environmental aspects, such as odour, noise, etc. Furthermore, the survey asked for information on other elements of relevance to Step 2, notably approaches to evaluation of cross-media effects, the quality of available data on techniques, confidentiality issues associated with the evaluation of techniques, in addition to decision-making processes.

As regards Step 3, the survey asked for data on tools and criteria for prioritisation of BAT. In addition, the survey sought information on other essential elements of the BAT determination process, such as the selection of industrial sectors/activities subject to implementation of BAT, the selection of key environmental parameters and the procedures for consultation of, and approval by, government authorities. Moreover, the survey respondents were asked to report key attributes and limitations of the procedures for establishment of BAT.

While this three step model was a useful tool to collect information on the above elements, the consultations with national experts demonstrated that such a model does not adequately reflect the reality of BAT establishment in all countries covered by the report. The methods for selection of BAT vary across countries, determined by the function of BAT as a policy tool under the relevant environmental legislation, the relation between BAT and ELVs in each country, the legal status of BAT and ELVs as well as of the documents presenting the BAT. Thus, the steps of the model are not referred to as such in the country chapters. In line with recommendations from the OECD's Expert Group on BAT, the chapters are structured so as to reflect the inherent differences between the countries examined, while at the same time allowing for comparison.

Note

1 OECD (2017), *Report on OECD Project on Best Available Techniques for Preventing and Controlling Industrial Chemical Pollution - Activity I: Policies on BAT or Similar Concepts Across the World*, OECD Publishing, Paris.

Chapter 1. The Russian Federation: A standardised methodology to establish BAT

This chapter presents the Russian Federation's standardised methodology to identify BAT and develop BAT reference documents. It then explores the BAT-associated emissions levels which form the basis for environmental permits as well as the recently introduced system of pollution charges used to enforce compliance with permit conditions.

1.1. Introduction

In the Russian Federation, a BAT-based policy to prevent and control industrial emissions was introduced in 2014, determined by amendments to the Federal Law on Environmental Protection[1] (Government of the Russian Federation, 2014a) and related legislative acts, including the Law on the Protection of the Atmospheric Air (Government of the Russian Federation, 1999)[2]. The policy entered into force in 2018. Its overall objectives are to ensure the protection of the environment as a whole and the lowest possible emission levels of key environmental pollutants. The Russian Federation has a standardised methodology to determine BAT which is based on evaluation and selection of techniques for prevention and control of industrial emissions. While the BAT (i.e. descriptions of technological, technical and managerial solutions) are not legally binding in the Russian Federation, the BAT-associated emission levels (BAT-AELs), referred to as technological parameters, form the basis for permit conditions and are thus mandatory by law.

1.2. BAT reference documents

1.2.1. Key features

Information on techniques identified as BAT in the Russian Federation is presented in BAT reference documents (BREFs). The BREFs are published under the national standardisation system, described by the Federal Law on Standardisation (Government of the Russian Federation, 2015a). The standardised methodology for establishing BAT is based on the recommendations of the EU Reference Document on Economics and Cross-Media Effects (EC, 2006). The Technical Working Groups (TWGs) in charge of determining BAT generally follow the methodology recommended by this document, but alter it when appropriate, in order to take into consideration environmental issues typical to each industrial sector.

The Ministry of Industry and Trade coordinates the development of BREFs through the Russian BAT Bureau (BAT Bureau, n.d.a), while the actual drawing up of each BREF is the responsibility of the relevant TWG. In accordance with the Order on Adopting Staged Time-Schedule for Drawing Up of Sectoral Reference Books on Best Available Technologies in 2015-2017 (Government of the Russian Federation, 2014b), 51 BREFs were developed during the period 2015-2017. Thirty-nine of these are sector-oriented (‘vertical’) BREFs, which include BAT and BAT-AELs, while twelve are cross-sectoral, or 'horizontal', without BAT-AELs, e.g. the BREF on energy efficiency (BAT Bureau, 2017a). BAT-AELs are referred to as ‘technological parameters’ and are specified first of all for the most significant pollutants, known as ‘marker substances’ or ‘marker parameters’. The BAT-AELs can be expressed as concentrations or as specific emission values. The latter is often preferred as it is easier to assess.

The structure of the BREF on the production of ceramics (BAT Bureau, 2015a) is provided below as an example.

i. Introduction
ii. Preface
iii. Scope
iv. Chapter 1: General information about the sector concerned
v. Chapter 2: Applied technological processes (techniques)
vi. Chapter 3: Current emission levels

vii. Chapter 4: Determination of BAT (principles, approaches, candidate BATs)
viii. Chapter 5: Best Available Technologies (techniques)
ix. Chapter 6: Economic aspects of BAT implementation
x. Chapter 7: Prospective technologies (emerging techniques)
xi. Concluding remarks and recommendations
xii. References
xiii. Annexes

Once the BREFs are officially adopted, they are made publicly available on the BAT Bureau's website (www.burondt.ru/index/its-ndt.html). The development of a reference document for one sector normally takes less than one year. The BREFs are considered guidance documents, with a recommendation status. Lists of BAT and associated BAT-AELs become legally binding upon official publication by the Government of the Russian Federation or by the Ministry for Natural Resources and Environment. It is expected that such lists, which in some ways resemble the EU's BAT Conclusions – will be published by June 2019.

1.2.2. Selection of sectors

The Decree on Setting Criteria to Categories I, II, III and IV of Installations Causing Negative Environmental Impacts (Government of the Russian Federation, 2015b) states that operators of Category I installations with a significant level of environmental adverse impact must apply BAT. As a consequence, BAT are established for the sectors covered by Category 1 facilities. These are similar to the sectors listed in Annex I of the EU Industrial Emissions Directive (EU, 2010); however, the list of sectors reflects the specificities of the Russian economy and covers areas such as oil and gas exploration, coal and ore mining, etc.

Operators of Category I facilities are also obliged to obtain an integrated environmental permit, in addition to be equipped with automatic devices to measure the volume and concentration of emissions as well as technical means to transfer such information to the unified state environmental monitoring system. So far, the Federal Supervisory Natural Resources Management Service plans to collect and analyse these data and manage them as a part of the Federal Register of Category I installations.

Table 1 lists all the Russian Federation BREFs. The list includes BREFs for the three target sectors (see Annex A for more information on the target sectors). Only two of the Russian BREFs have been translated into English: pulp and paper (BAT Bureau, 2015b); and detoxification of waste by means of thermal processes (waste incineration) (BAT Bureau, 2015c).

Table 1. Russian BREFs

Industrial sector/activity	Year of publication	Vertical / horizontal
Aluminium production	2016	V
Burning fuel at large combustion plants for energy generation purposes	2017	V
Ceramic goods manufacturing	2015	V
Coal mining and processing	2017	V
Copper production	2015	V
Detoxification of waste by means of thermal processes (waste incineration)	2015	V
Disposal of production and consumption (municipal) waste	2016	H
Enhancing energy efficiency of economic and/or other activities	2017	H
Extraction (production) of natural gas	2017	V
Extraction of (mineral) oil	2017	V
General principles of industrial production, environmental control (monitoring) and its metrological assurance (support)	2016	H
Industrial cooling systems	2016	H
Intensive rearing of pigs	2017	V
Intensive rearing of poultry	2017	V
Manufacture of beverages, milk and dairy products	2017	V
Manufacture of ferrous metals processing products	2017	V
Manufacture of fine chemical synthesis products	2017	V
Manufacture of food products	2017	V
Manufacture of glass	2015	V
Mining and processing of ferrous metals ores	2017	V
Mining and processing of nonferrous metals ores	2017	V
Mining industry, general processes and methods	2016	H
Precious metals mining	2017	V
Precious metals production	2016	V
Production of ammonia, fertilisers and inorganic acids	2015	V
Production of cellulose, pulp, paper and board	2015	V
Production of cement	2015	V
Production of iron, steel and ferro-alloys	2017	V
Production of lead, zinc and cadmium	2016	V
Production of lime	2015	V
Production of magnesium oxide, magnesium hydroxide, magnesium chloride	2016	V
Production of main (large volume) organic chemical substances	2016	V
Production of nickel and cobalt	2016	V
Production of other main (large volume) inorganic chemicals	2017	V
Production of polymers, including biodegradable ones	2017	V
Production of rare and rare earth metals	2017	V
Production of solids and other inorganic chemical substances	2016	V
Production of speciality inorganic chemicals	2017	V
Reducing emissions (waste gas) and effluents (waste water) of pollutants resulting from storage of goods	2017	H
Refining of (mineral) oil	2017	V
Refining of natural and associated gas	2017	V
Slaughterhouses (meet-processing plants and combined slaughterhouses, refrigeration, and storing of meat plants) and animals by-products industries	2017	V
Surface treatment of goods and products using organic solvents	2017	H
Surface treatment of metals and plastics using electrolytic or chemical processes	2017	H
Tanning, dyeing and currying of hides and skins	2017	V
Textiles industry (washing, bleaching, mercerizing, Dying of textile fibres; bleaching, dying of textile products)	2017	V
Utilisation (recycling, treatment) and detoxification of waste (by means other than	2016	H

thermal processes / incineration)		
Waste gas treatment (removing emissions of harmful substances at larger industries (manufacturing products, implementing works and rendering services))	2016	H
Waste water and waste gas treatment systems in the chemical industry	2017	H
Waste water treatment at centralised systems of waste water treatment of settlements and cities	2015	V
Waste water treatment at larger industries (manufacturing products, implementing works and rendering services)	2015	H

Note: The names of the sectors/activities have been translated into English by national experts; these are not the official names of the BREFs.
Source: BAT Bureau, n.d.b

1.2.3. Collection of information on techniques

The BAT Bureau is responsible for the information exchange and gathering of data needed to develop BREFs. A TWG is appointed for each industrial sector, mandated to manage the process. TWGs are formed under the umbrella of the Technical Committee 113 on Best Available Techniques. Each TWG consists of members representing federal and regional authorities concerned, industries and industrial associations, universities, research bodies, engineering and consulting companies as well as NGOs.

The process of forming TWGs in the Russian Federation is organised in such a way that any party can nominate a representative. Interested stakeholders submit an application for participation in the TWG of their interest to the Ministry of Industry and Trade, which eventually approves the list of members of each TWG by special order. The list of members for each TWG is available on the website of the BAT Bureau (www.burondt.ru/informacziya/texnicheskie-rabochie-gruppyi/). By joining a TWG, the members commit to actively collect and provide relevant information, as described by the Government of the Russian Federation (2014c) and understood in line with the EU (2012) Implementing Decision laying down rules concerning guidance on the collection of data and on the drawing up of BAT reference documents. Normally, a call for applications for TWG membership attracts the attention of 20-40 organisations which nominate their representatives. The TWGs normally consist of 100 and sometimes even over 200 members.

NGOs were actively involved in the development and promotion of the BAT concept in the Russian Federation in the early 2000s. They still participate in the public discussion concerning draft BREFs and in numerous awareness raising events conducted by the BAT Bureau, federal and regional authorities, universities, consulting companies, etc.; however, it is rather rare that NGOs nominate representatives to the TWGs.

Prior to the data collection on the technical, environmental and economic aspects of techniques for prevention and control of industrial emissions, the TWGs make a decision on the content of the BREF by defining its scope. The data collection is done based on sector-oriented questionnaires to gain targeted technical, environmental and economic information that is important for the drawing up of BREFs. The TWGs start from a general questionnaire, which they tailor to each sector. The structure of the questionnaire regarding production of polymers, including biodegradable ones (BAT Bureau, 2017b), is presented below as an example:

i. instructions;
ii. general information;
iii. main stages and technologies;

iv. volume of production;
v. emissions to air;
vi. emissions to water and soil;
vii. wastes;
viii. equipment;
ix. physical factors;
x. material resources;
xi. energy resources; and
xii. technological scheme.

The BAT Bureau is responsible for the practical organisation and dissemination of the questionnaires. Operators of sector installations respond to the questionnaires including by describing technological processes, environmental protection techniques and environmental and energy management systems as well as provide information on environmental performance levels, production capacity and economic aspects (e.g. environmental investments and abatement equipment costs). The questionnaires request both quantitative data, such as on emission concentrations, consumption quantities and plant operating parameters, and qualitative data, such as contextual information regarding techniques, process routes, raw material types and output delivered. All data gathered through the questionnaires is stored in a database, making a comparison between different plants possible. If necessary, the TWGs gather additional information via personal contacts. Information gathered through literature research is also considered.

1.2.4. Evaluation of the techniques

The evaluation of techniques is done by the TWGs based on the responses to the questionnaires and on discussions during TWG meetings and online. Initially, there is a preselection of techniques that will be considered for further evaluation and determination of BAT, sometimes referred to as candidate BAT. The subsequent evaluation of the preselected techniques is based on a methodology described in the Government Decree on the procedure for determining technologies as BAT (Government of the Russian Federation, 2014c). The Decree prescribes five main criteria for the determination of BAT:

i. the lowest possible negative environmental impact expressed as a value per time unit or per volume of produces goods, the amount of operations carried out, the amount of services rendered or any other characteristics found in international agreements signed by the Russian Federation;
ii. the economic efficiency of its introduction and operation;
iii. the use of resource and energy saving methods;
iv. the period of time needed to introduce the technique;
v. the successful introduction of the technique in at least two Russian plants that previously had a negative environmental impact.

While the evaluation of the preselected techniques takes into account technical, environmental and economic aspects, the techniques' ability to reduce or prevent emissions is considered the most important aspect. Particular attention is paid to the pollutants that are the most significant for each sector. During the evaluation of the techniques, the best performing techniques for the reduction of parameter X in sector Y are nominated. For a limited list (e.g. the top three-five techniques), an in-depth technical evaluation is carried out, e.g. with regards to how the techniques perform in terms of the reduction of other parameters and their cross-media effects. Techniques are removed

from the list if the evaluation demonstrates that they perform less well compared to other selected techniques.

For each of the remaining techniques on the list, the BREF will contain information on the technical performance level and the financial costs, including equipment prices when available. All the techniques on the list are classified as BAT, and operators have no obligation to install the cheapest one of these. For some sectors, e.g. the food industry, the BREFs present a few general BAT, applicable to all installations in the sector, in addition to some BAT that only apply to specific subsectors.

No prioritisation of BAT is carried out; although it is assumed that primary ('built-in-the-technology') solutions providing opportunities for pollution prevention and consumption optimisation are particularly important, while 'end-op-pipe' techniques also are considered thoroughly. This approach is selected to recognise the important distinction between techniques for *prevention* versus *control* of industrial emissions. Promising techniques not selected as BAT are in some cases presented as 'emerging techniques', i.e. techniques that only are applied at a pilot-scale, in a separate chapter of the BREFs.

The below sections provide additional information on the technical, environmental and economic aspects considered as part of the evaluation of the preselected techniques.

Technical aspects

In order to conduct the evaluation of the technical aspects of the preselected techniques, the TWGs take into account their technical readiness level, safety level and applicability.

To judge the applicability of a technique, the TWGs take into account if the technique is generally useable or only adjusted to specific plants or subsectors. The TWGs will also note whether the technique is applicable in new and/or existing plants, taking into account factors involved in retrofitting (e.g. space availability) and interactions with techniques already installed. Other important factors include the size, capacity or load from the production lines in relation to the techniques, or the type of fuel or raw materials used in the production process.

Furthermore, the TWGs take into account the fifth criterion from the 2014 Government Decree (Government of the Russian Federation, 2014c) – the successful introduction of the technique in at least two Russian plants that previously had a negative environmental impact – which is meant to ensure that the technique already has been used in practice, i.e. has been tried with success on an industrial scale.

Environmental aspects and pollutants

There is a general list of environmental aspects and pollutants which apply to nearly all sectors, but specific aspects known as marker substances or parameters need to be defined at the process or sub-process level for each sector. In general, emissions to water, air and soil are taken into account. Aspects like odour and noise are also taken into consideration, seeing as these affect the neighbourhood of the companies.

The method used to select relevant environmental parameters is a combination of a top-down and a bottom-up approach. Techniques can be identified as BAT if they ensure the reduction or prevention of emissions of one or several key pollutants or when they reduce the use of resources (energy, raw materials or water). The assessment of the cross-media positive and negative environmental effects of a technique is made based on expert judgement and on a case-by-case basis. Data and information used for the technical and

environmental assessment of techniques comes from companies, sector associations, suppliers or research papers.

Economic aspects

The TWGs currently do not have a standardised methodology for the assessment of economic aspects of techniques, and the techniques are not evaluated based on their economic viability. However, the BAT Bureau is working on developing a methodology, which is expected to be completed in 2018. The EU Reference Document on Economics and Cross-Media Effects (EC, 2006) (translated into Russian) is used as guidance in this context. This document addresses methodologies that can provide assistance to the TWGs and permit issuers when considering the conflicts between environmental and economic aspects that can occur when determining which techniques to identify as BAT. The main idea behind this methodology is to ensure that the BAT do not lead to excessive expenses for the companies. At present, the evaluation is done on a case-by-case or sector-by-sector basis and based on expert judgement. Data or information used for the assessment of the economic aspects of techniques is provided by suppliers, individual companies or sector associations. The methodology used to assess economic efficiency as part of the development of the BREF on waste incineration is presented below.

The BREF on waste incineration includes a recommended approach to defining the economic efficiency of a certain technique: annual expenditure, expressed in roubles per unit of emissions reduced, expressed in tons per year. The methodology for calculation of expenditures is established by an algorithm, making possible the gathering and analysis of data on the capital and operation expenditures of buildings, installations, know-how or processes. Examples of economic information gathered for this purpose includes:

i. the cost of the introduction of the technique;
ii. cost structure for the introduction of the technique;
iii. running production costs;
iv. technical maintenance costs; and
v. revenue and savings on costs.

1.2.5. Data handling

The questionnaire for information collection is distributed to companies by the BAT Bureau. In case the responses to the questionnaires contain confidential information, this is only available to the BAT Bureau. The Bureau takes into account this information during the evaluation process and may provide it to the TWG members in a generalised format, meaning that these will receive the data without knowing to which company it pertains. All gathered information is kept in the Bureau's database and is not transmitted to any third parties. The TWGs are responsible for the evaluation of the data.

Besides information gathering via questionnaires, from 2018 on, self-monitoring will become an important issue for the Russian industry. According to the Federal Law on amending the Federal Law on Environmental Protection (Government of the Russian Federation, 2014a), category I enterprises shall submit data obtained via continuous self-monitoring systems to the federal authorities. It is assumed that the Federal Supervisory Natural Resources Management Service will be collecting and managing the data and use them both for statistic and enforcement purposes.

1.2.6. Decision making process

The TWGs and the Ministry of Industry and Trade are responsible for making the final decision on the evaluation of techniques. Before being officially adopted, all draft BREFs undergo a procedure of public consultation. The TWGs have to consider the comments submitted by the various stakeholders when drawing up the final drafts.

The Federal Law on Environmental Protection, as amended in 2014 (Government of the Russian Federation, 2014a), and other legislative acts, which officially introduced the BAT concept in 2014, state that technological parameters (the environmental emission levels associated with the Best Available Techniques – BAT-AELs) shall be officially approved by the Government of the Russian Federation no later than six months after the official adoption of the BREFs. The BAT-AELs only become legally binding upon official publication by the Government of the Russian Federation or the Ministry for Natural Resources and Environment.

1.3. Emission limit values associated with BAT

Environmental permits in the Russian Federation, aiming to reduce emissions into the environment, are based on BAT-AELs rather than on the BAT themselves. This implies that operators are free to use any technique available to them, provided that these ensure that they meet the BAT-AELs. Many industries implement foreign technologies and equipment complying with the Russian BAT requirements, and report being satisfied by these. Some operators currently planning reconstruction of their installations have stated that they will select equipment based on the 'value for money' principle, and believe that this in many cases will lead to the selection of foreign equipment.

The key tool to ensuring compliance with the BAT-AELs and other conditions defined in each facility's individual permit is a penalisation system: starting from the entry into force of the BAT policy in 2018, Russian industries will have to pay pollution charges based on new, enlarged unit pollution base values (each contaminant has a unit value). It is anticipated that the revenue from the pollution charges may go into specific environmental funds, to be invested in solutions to environmental issues at the regional or local level. If an industry fails to meet the technological parameters associated with a particular BREF, it may – instead of paying charges – ask permission to spend the equivalent amount of money on improving their environmental performance by introducing specific measures over the next seven years (or less). Operators that meet the requirements defined in the BREFs, i.e. comply with the BAT-AELs, will be exempt from the charges.

This system differs from the one in place before 2018, under which operators had to pay fees for their emissions even if they respected the emissions conditions defined in their permits. Standard fees calculated on the basis of polluter- and medium-specific rates as well as on the emission composition and quantity applied to industries complying with their permit conditions, while higher fees were required in cases where industries operated in accordance with so-called 'temporary allowed emission limit values', i.e. higher emission limit values for a limited period of time.

As of 2018, industries that meet the BAT-AELs will not have to pay emission charges; however, those operators that fail to meet BAT-AELs will have to pay much higher fees then under the previous policy: a 100 coefficient to the normal fee rates has been introduced.

Permits are managed locally, aiming to improve the local environment by taking into account e.g. special environmental (pollution), climate conditions or combinations of activities. This means that identical industries can have different requirements depending on their location. The consideration of local conditions as part of the permit management may lead to the manifestation of social issues, as stakeholders often bring up peculiar issues such as the necessity to support e.g. the only employer in their town.

1.4. Attributes and limitations

1.4.1. Attributes

The Russian BAT approach is perceived to have a positive impact on the environment by ensuring the reduction of the negative effects of the industry on all environmental media, notably a decrease of emissions to air and water as well as the prevention or reduction of waste, noise and odour.

Since the 1980s, Russian operators have had to comply with the environmental legislation and obtain single-medium permits. As of 2019, the first 300 largest polluters (Category I installations, as defined by the Government of the Russian Federation (2015b)), will be obliged to obtain *integrated environmental permits*, and step by step to meet stricter environmental performance requirements.

The new system for emission charges which is being introduced under the new BAT policy, creating a larger difference between compliant and non-compliant industries in terms of the level of fees, is considered an important incentive for Russian industries to improve their environmental performance by implementing BAT.

Furthermore, key strengths of the Russian methodology to determine BAT include the fact that the evaluation is done by a TWG, which consists of representatives from the government as well as from industries, and rely on an objective approach to selection of techniques.

Finally, the standardised questionnaires, which are used for the collection of quantitative and qualitative data, help structuring the BAT determination process, ensuring enhanced quality and comparability of the information gathered.

1.4.2. Limitations

As the implementation of the new BAT policy only started in 2018, it is difficult to judge if BREFs drawn up contain all the information necessary to assess the environmental performance of Category I installations and to demonstrate that emission values meet BAT-AEL requirements.

However, a limitation that already has been stressed by stakeholders is that the period of time spent on drawing up each BREF is very short (about one year), and thus potentially an impediment to the quality of the document.

Another challenge is that some industry representatives do not participate actively in the TWGs, due to various reasons. Initially, some operators did not recognise the opportunities offered by the BAT system and were thus reluctant to submit quantitative information needed to work out the BREFs. Moreover, in several cases, operators claimed they were unable to fill in questionnaires due to time constraints. Finally, some industries did not really believe that BAT-AELs would be established based on data provided by the operators, and, as a consequence, were not very supportive of the new BAT policy.

Notes

1 The Federal Law on Environmental Protection determines the legal grounds for state policy in the sphere of environmental protection, ensuring conservation of the natural environment, ecological safety, biological diversity and natural resources for the purpose of meeting the demands of current and future generations as well as strengthening law enforcement in the sphere of environmental protection. The law is based upon the following principles: (i) the right of citizens to a favourable environment; (ii) sustainable development; (iii) protection, conservation, reproduction and management of natural resources ensuring ecological safety; (iv) natural resources management requiring payment and compensation for environmental damage; (v) the precautionary principle; and (vi) the priority of ecosystem preservation. The law was amended by, amongst others, Federal Law No. 219-FZ (Government of the Russian Federation, 2014a).

2 The Law on the Protection of the Atmospheric Air establishes the legal basis for the protection of the atmospheric air and is aimed at the realisation of the constitutional rights of the citizens to a favourable environment and access to reliable information on its state. The law includes the following provisions: (i) prevention of the irreversible consequences of atmospheric pollution for the environment; (ii) compulsory state regulation of emissions to the atmosphere and the hazardous physical impact thereof; (iii) completeness and reliability of the information on the state of the atmospheric air and its pollution; and (iv) mandatory observation of the requirements under the national legislation in the sphere of the protection of the atmospheric air and liability for the infringement thereof. The law was amended by, amongst others, Federal Law No. 219-FZ (Government of the Russian Federation, 2014a).

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Chapter 2. Korea: A standardised methodology to establish BAT

This chapter presents Korea's standardised methodology to establish BAT, including the ongoing development of BAT reference documents. Notably, the chapter highlights how emissions monitoring data is used to inform the identification of BAT, in addition to the legally binding BAT-associated emission limits, which form the basis for permit conditions.

2.1. Introduction

Out of the 40 000 industrial installations in Korea, about 1 350 are categorised as highly emitting and are responsible for 70% of the total industrial pollution. Starting from 1990, the environmental impact of the industrial sector in the country was regulated by the Clean Air Conservation Act (CAA) (KLRI, 1990a), the Water Quality and Aquatic Ecosystem Conservation Act (CWA) (KLRI, 1990b), both underlying the Framework Act on Environmental Policy, known as the 'Basic Law' (KLRI, 1990c). However, the Act on the Integrated Control of Pollutant-Discharging Facilities, or the 'IPPC Act' (KLRI, 2015) was adopted in 2015, aiming to effectively integrate the content from all the previous ones. The IPPC Act entered into force in January 2017 (Lee, Yoo and Kim, 2017).

The purpose of the IPPC Act is to promote the development of environmental technology and protect people's health and environment by integrating the prevention and control of pollutant-discharging facilities so as to effectively reduce pollutants produced from each business establishment and by establishing a system under which best techniques for environmental control can be applied to meet conditions of each business establishment (as stated in the Act's Article 1). The IPPC Act shall take precedence over the other Acts, such as CAA and CWA (Article 4). The Act also includes provisions with respect to e.g. integrated permits (Article 6), criteria for permits (Article 7), permissible discharge levels (Article 8), imposition and collection of effluent charges (Article 15), best available techniques (Article 24) and self-measurement (Article 31).

The IPPC Act provides for a BAT-based policy to prevent and control industrial emissions. Korea has a standardised methodology to establish BAT for different environmental media, i.e. air, water and soil, as well as for different sectors. The BAT are the basis for BAT-associated emission levels (BAT-AELs) which again form the basis for the emission limit values (ELVs) stated in permits. Only the ELVs are legally binding, and not the BAT.

2.2. BAT reference documents

2.2.1. Key features

The Korean BAT Reference Documents (BREFs) present the BAT and the BAT-AELs as well as information on innovative techniques that are not identified as BAT. The development of a BREF for one sector typically takes three years. The BREFs are available on the website of the National Institute of Environment Research (NIER) (http://ieps.nier.go.kr/web/board/5/?CERT_TYP=6&pMENUMST_ID=95&tab=seven) (only in Korean). The actors involved in the elaboration of BREFs include the Integrated Permit System Division and NIER, both underlying the Ministry of Environment (MoE), in cooperation with sector-specific Technical Working Groups (TWGs).

2.2.2. Selection of sectors

The selection of industrial sectors for BAT establishment is overseen by the Integrated Permit System Division, and is based on a statistical methodology relying on a system of Environmental Performance Scores, allowing to identify the sectors with the highest environmental impact. The total quantity of emissions, as defined based on the National Gross Emission Amount, forms the basis of the analysis, along with measurements of controllability and environmental urgency. Based on this approach, the Integrated Permit

System Division has defined the dates for enforcement of BAT-based permits for 21 selected sectors over the period 2016-2021, constituting an Action Plan for Integrated Pollution Prevention and Control for the period 2016-2021. The 21 sectors for which BREFs have been, or will be developed, are listed in Table 2 together with their past or expected dates of publication. The list includes BREFs for the three target sectors (see Annex A for more information on the target sectors).

Table 2. Korean sectoral BREFs

Industrial sector/activity	Status	Year of publication
Large Combustion Plants (covers two sectors: electric power and steam production)	published	2016
Waste Incineration	published	2016
Iron and Steel Production	published	2017
Non-Ferrous Metals Industry	published	2017
Large Volume Organic Chemical Industry (covers two sectors)	published	2017
Refining of Mineral Oil and Gas	formal draft completed	2018
Large Volume Inorganic Chemicals	formal draft completed	2018
Organic Fine Chemicals and Speciality Inorganic Chemicals (covers two sectors)	formal draft completed	2018
Fertilizer Industry	formal draft completed	2018
Production of Pulp, Paper and Board (covers two sectors)	in progress	2019
Production of Electronic Parts	in progress	2019
Semiconductor Industry	in progress	2019
Textiles Industry	in progress	2019
Plastic Industry	in progress	2020
Food, Drink and Milk Industry	in progress	2020
Slaughterhouses and Animal By-products Industry	in progress	2020
Auto Parts and Equipment Manufacturing Industry	in progress	2020

Source: Based on information provided by national experts

2.2.3. Collection of information on techniques

The data gathering is overseen by sector-specific TWGs, consisting of experts representing MoE, business operators, technique suppliers, industrial associations and educational experts. The number of members of a TWG varies between 20 and 30, depending on the sector. NGOs are not involved in the TWGs. However, according to the Basic Law, NGOs are entitled to participate in the Central Environmental Policy Committee, also known as the Deliberation Committee, which reviews and makes the final decisions on BREFs.

Information on techniques considered for BAT is based on (i) the investigation of technical literature on the reduction of pollutants domestically and in foreign countries, e.g. EU BREFs and the US EPA's reports; (ii) the investigation of environmental management techniques related to technologies for emission facilities and pollutant emission reduction at a specific installation; and (iii) analysis of the establishment and management standards for each type of industry, current pollution levels and criteria under current regulation and guidelines designed for each industry.

Facility-specific information is gathered through a questionnaire distributed online to all industrial operators regulated by the IPPC Act, as well as to the TWG members. The TWG members also provide and share information during their meetings and via an online registration point.

Furthermore, up to a million data points from emission monitoring systems are collected from industry operators, informing the evaluation of techniques. In line with Article 31 of the IPPC Act and as prescribed by ordinance from MoE, all industrial facilities shall measure the emission of pollutants from their operations on their own, or by requesting the assistance of a measuring agency in line with Article 16 of the Environmental Testing and Inspection Act, and keep records of the results thereof, to ensure the appropriate operation of discharging and prevention facilities. Furthermore, all facilities must report their quantity of fuel consumption in addition to specifications on hardware for emission of pollutants and prevention thereof.

The MoE's procedure for the use of monitoring data consists of two steps, i.e. (i) collection of emissions monitoring data; and (ii) data filtering. The first step involves the collection of facility inventory data, self-monitoring data, site survey data and continuous air and water emissions monitoring data. The continuous air and water emissions monitoring data are reported digitally through the Smoke Stack Tele Monitoring System (STMS) (MoE, n.d.) and the Water Tele Monitoring System (WTMS) (Chung, 2010), respectively. These cover four air pollutants (total suspended particulate (TSP), SOx, NOx and CO) and five water pollutants (BOD, COD, SS, T-N and T-P). Further details on the systems for collection of emissions monitoring data are available in Table 3.

Table 3. Collection of emissions monitoring data in Korea

	Facility Inventory Data	Self-Monitoring Data	Air Continuous Emission Monitoring Data (Smoke Stack Tele-Monitoring System)	Water Continuous Emission Monitoring Data (Water Tele-Monitoring System)
Data Source	National Institute of Environmental Research	National Institute of Environmental Research	Korea Environment Corporation	Korea Environment Corporation
Start year	1997	1997	2002	2007
Quantity of companies or data involved	4,057 companies	1 million data points every year	1,500 stacks; more than 7 billion data points in total	907 companies
Data collection interval	Yearly	Weekly; monthly; quarterly	Every five minutes; every 30 minutes	Hourly; every three hours
Contents	- General information on each company - Total emissions (flow, TSP, SOx, NOx) - Emission facilities - Prevention facilities - Stack information - Fuel	- NH3- Cu - Br - Hg - Cr - F - CN - THC - HCl - HF - O2 - Temperature	- TSP - NOx - SOx - CO - Flow	- COD - T-N - T-P - SS - BOD - Flow (depends on discharges)

Source: Based on information provided by national experts.

Following the collection of monitoring data, the data is first filtered out based on data flags because of e.g. dissatisfying results of accuracy and calibration inspections, abnormal measurement data, equipment inspections, shutdown period and abnormal oxygen ratio. This filtering process is referred to as Continuous Emissions Monitoring System (CEMS) Filtering in Sensor and Data Logger Level. An additional filtering based

on data relationships is carried out via pattern analysis and outlier detection based on the correlation between O_2 and temperature or NOx and temperature. This is referred to as CEMS Filtering with Pattern Analysis and Outlier Detection.

2.2.4. Evaluation of the techniques

The TWGs evaluate the collected information and carry out a preselection of techniques that will be considered for further evaluation and BAT determination, in collaboration with the MoE (NIER, n.d.). The list of preselected techniques includes a combination of preventive, process-integrated and end-of-pipe techniques. The evaluation of these techniques implies (i) an investigation based on information provided by industry operators and experts in the TWGs; (ii) basic data analysis as well as close investigation and analysis of the emission status of pollutants relevant to each of the techniques; and (iii) a detailed analysis of the filtered monitoring data.

The evaluation of the techniques, including not only technologies, but also environmental management techniques, is carried out by the TWGs, considering technical, environmental, economic aspects, with a strong focus on environmental quality, i.e. the environmental impact of the various techniques in the area surrounding industrial installations. More information on the technical, environmental and economic aspects that are considered is provided below.

Technical aspects

For the technical evaluation of techniques, the TWGs take into account the technological readiness level, the safety level, the quality of the production process or products and the applicability. In order to judge the applicability of an environmentally friendly technique, the TWGs take into account if the technique is generally useable or only adjusted to specific plants or subsectors. The TWGs also note whether the technique is usable in new or existing plants, considering factors involved in retrofitting e.g. space availability, and interactions with techniques already installed. Other important factors are the size, capacity or load from the production lines in relation to the techniques, and the type of fuel or raw materials used in the production process.

Environmental aspects and pollutants

There is a general list of environmental aspects and pollutants which applies to all sectors, but specific aspects or pollutants can also be defined at the sub-process level for each sector. In general, emissions to water, air and soil are taken into account. At present, there is a particular focus on PM in general and heavy metal from zinc refinery, including because this also has social implications.

The method used to select relevant environmental parameters is a combination of a top-down and a bottom-up approach. The assessment of the positive and negative environmental effects, i.e. the cross-media effects of a technique, is made based on expert judgement.

Economic aspects

Although the TWGs primarily focus on the environmental and technical aspects of the techniques, economic aspects are also taken into account as part of the BAT determination procedure: the TWGs consider the affordability of the techniques as well as the economic viability of companies that invest in them. External costs, such as the

impact on human health and the cost of restoration of ecosystems, are also taken into account. However, no standardised methodology is available for the assessment of economic criteria; this is done on a case-by-case basis. For some sectors, information about the economic aspects of the techniques is not available due to confidentiality issues.

2.2.5. Decision making process

Each of the TWGs is in charge of preparing the final decision on the evaluation of techniques for their specific sector, which is subsequently reviewed by the Central Environmental Policy Committee. This committee was established and mandated under the Basic Act and is divided into seven sub-committees; the sub-committee on environmental economy is in charge of decision-making on BAT and BAT-AELs.

While the BAT are not ranked during the process of assessment of techniques, they are categorised in the BREFs based on the installation time of the BAT, e.g. before 2007, 2007-2014 and after 2015, or the type of fuel or raw materials used.

2.2.6. Data handling

The TWGs and MoE are responsible for the handling of the data used for BAT selection. The Ministry is entitled to double check the data, based on existing documentation and inspections of facilities. Data confidentiality is dealt with through an online system which only allows access for TWG members.

2.3. Emission limit values associated with BAT

The determination of BAT-AELs in Korea takes place after the identification of BAT and consists of four steps: (i) exclusion of non-usual operating data (outlier data); (ii) classification/grouping of BAT through analysis of emission of pollutants associated with each BAT; (iii) determination of the upper limit values by Rosner's test; and (iv) determination of the lower limit values.

The statistical Rosner's test allows selecting the highest value among the values excluding the outlier data as the upper limit of the BAT-AELs, with 99% confidence level at the normal operation state. The median value of the lowest pollutant emissions is selected as the lower limit of the BAT-AELs.

The BAT-AELs are stated in the BREFs and shall be prescribed by ordinance from MoE after consultations with the heads of relevant central administrative agencies. In Korea, there is no possibility for derogation from the BAT-AELs. This implies that e.g. air quality standards must be respected. To enforce compliance with ELVs for industrial facilities, MoE uses a combination of self-monitoring (as already described) and facility inspections.

In addition to the BAT-AELs defined under the IPPC Act, there are National Ambient Air Quality Standards (NAAQS), defined under the Basic Law. In addition, local governments can choose to set Local Ambient Air Quality Standards (LAAQS), based on local needs and circumstances; these can be more stringent than the NAAQS.

Companies wishing to establish facilities that emit or prevent the emission of pollutants can choose to carry out a prior consultation with MoE regarding their plans before applying for a new or modified IPPC permit. Such a prior consultation can shorten down the time required to obtain the permit. Industrial installations are eligible for a permit if they (i) emit at least 20 tons/year of air pollutants, including dust, sulphur oxides and

nitrogen oxides; or (ii) discharge at least 700m³/day of industrial effluent. If deemed necessary, MoE may impose specific (often more stringent) ELVs on individual facilities, after consulting relevant central government agencies and conducting a modelling exercise, so as to make sure that relevant LAAQS are being met. Consequently, the concerned facilities are required to comply with these ELVs in order to obtain a new IPPC permit or get approval for modifications to an existing one. The ELVs derived from the modelling exercise can determine whether any combinations of techniques should be applied, e.g. a combination of a bag filter and a cyclone.

Information on IPPC permits is made public with the exception of sensitive trade secrets, in line with the Central Environmental Policy Committees' decisions regarding the disclosure of information about integrated environmental control.

2.4. Attributes and limitations

2.4.1. Attributes

There are several strengths of the current method for determination of BAT in Korea. The evaluation of techniques by the TWGs, which consists of representatives from government and industries, constitutes an important asset. Furthermore, the fact that the decisions are based on information from companies gathered via questionnaires and an in-depth data analysis ensures good results.

2.4.2. Limitations

The contradictory opinions between the government and the industry sometimes make it difficult to reach compromises within the TWGs. Furthermore, due to lack of information, it is not always possible to conduct an adequate quantitative economic evaluation of techniques. And in some cases, not all the data wanted by the TWGs is available, making it difficult to carry out the assessment. Moreover, although the whole process is a participative process, it is not always easy to get feedback from all relevant stakeholders. Finally, there is no timeline available for the number and frequency of stakeholder meetings.

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Chapter 3. The United States: Procedures to establish technology-based performance standards

This chapter summarises a wide range of the United States' programmes applying technology-based performance standards to industrial facilities, including the programme-specific methodologies for identification of such standards. With a specific focus on emissions to air, the chapter explores the common features, and the specificities, of the National Ambient Air Quality Standards and the National Emission Standards for Hazardous Air Pollutants, in addition to selected programmes for emissions to water.

3.1. Introduction

The United States (US) has several programmes that apply technology-based performance standards at national, state and local level, generally in the form of quantified emission limit values (ELVs), to industrial facilities. The ELVs can be designed to allow or encourage pollution prevention techniques, e.g. use of non-polluting processes or raw materials, cleaner fuels or more energy efficient processes. Each programme has its own considerations and objectives prescribed by federal environmental legislation, including the Clean Air Act (CAA)[1], the Clean Water Act (CWA)[2] and the Pollution Prevention Act (PPA)[3] (EPA, 1990a). These laws are not technology-based, although some of the sections of the acts include requirements for technology-based programmes. Through the implementation of pollution control programmes, the states are required to achieve and maintain quality standards, e.g. for air and water. The federal laws provide the main objectives and framework for achieving them, including defining roles of the US Environmental Protection Agency (EPA) and of tribal, state and local governments.

Some of the technology-based performance standards are applied nationally across a sector. These are developed by EPA. Others are determined and applied on a case-by-case basis through a permitting process in which the permitting authority is typically a state or local environmental agency. Consequently, the US does not have a national BAT policy, nor one process for determining the technology-based performance standards.

3.2. Technology-based performance standards for emissions to air

3.2.1. Key features

Reference documents

There are no standardised BAT or technology reference documents that apply across programmes. However, data gathered and analysed during the development of technology-based performance standards are generally documented and made available to the public. Proposed and final regulations that apply nationally are initially published in a government publication known as the Federal Register, before being officially codified in the "Code of Federal Regulations". The data, analysis and reasoning supporting the decision are summarised in the Federal Register notice that accompanies the regulations. Supporting documents, including the details of the data and analysis, are made available in a regulatory docket, often in a series of memoranda. Public comments are also filed in the docket. Both the Federal Register and the regulatory dockets are available publicly via the internet. The standards include the national emission standards for hazardous air pollutants (NESHAP) and the new source performance standards (NSPS) and can be accessed on the EPA's website (www.epa.gov/stationary-sources-air-pollution).

Furthermore, EPA maintains the RACT/BACT/LAER Clearinghouse (RBLC). This is a searchable database by pollutant or sector that contains case-specific information on the air pollution technologies and emissions limitations that have been required to reduce the emission of air pollutants from stationary sources. This information has been provided by State and local permitting agencies (EPA, n.d.a; RBLC, n.d.).

Selection of sectors

The sources or sectors to which technology-based performance standards for emissions to air apply are determined by the CAA and the EPA regulations authorised by the CAA, and vary among programmes. In general, programmes address sectors or sources of potentially high environmental concern with respect to the objectives of the programme, taking into account thresholds linked to potential emission levels. Only performance standards pertaining to the three target sectors (see Annex A for more information on the selection of target sectors) are listed in the sections below (Tables 4 and 5), due to the large number of programmes and documents.

Collection of information on techniques

There is not one standard approach for collecting information on emissions performance and techniques for all the air programmes with technology-based performance standards. Sources of information can include academic and industry trade literature, trade associations (e.g. industry or control vendors), and emission sources tests and/or questionnaires completed by members of the regulated sector. Environmental permits issued by state, local and tribal air pollution agencies can also be sources of information. EPA is responsible for the collection of information in developing air pollution standards that apply nationally to a sector. States, local or tribal environmental agencies would gather information for performance standards issued by them. For new source preconstruction programmes, under which a case-by-case permit would be issued, the permit applicant typically gathers information to provide to the permitting authority.

Evaluation of the techniques

Similarly, there is not one standard approach for the evaluation of techniques based on the collected information. Specific factors to be considered and criteria for stringency for technology-based emissions standards vary among the different regulatory air programmes. The CAA and regulations developed to implement the CAA dictate the factors that are considered in each programme.

Data handling

EPA has programmes and requirements for conducting quality management activities for all environmental data collection and environmental technology programmes performed by or for the Agency. The primary goal of these is to ensure that the Agency's environmental decisions are supported by data of known and documented quality. Emissions testing and monitoring methods and requirements include detailed quality assurance and control procedures.

Data providers can request that information submitted be treated as confidential business information, but must be able to support their claim to the satisfaction of EPA that it meets the criteria in the US environmental statutes and regulations. Emissions data cannot be claimed as confidential.

Decision making process

For technology-based standards that apply to an industrial category nationally, EPA is responsible for making the decisions on the performance level through the use of a rulemaking process to set the emission standards. In these cases, EPA proposes a regulation with ELVs based on their analysis, and makes this available so that any

member of the public can consider it and make comments. In the next step, all the comments received on the proposed regulations are considered by EPA. Finally, EPA generally revises the regulation accordingly and issues a final rule.

For performance standards that do not apply nationally, the decision-making is typically done by the state environmental authority. There is also an opportunity for the public to comment on preliminary decisions and it is also important to have a record that supports the decisions reached, including information and analysis as well as consideration and response to public comments. Each state's programme must comply with CAA and EPA requirements for such programmes, and be incorporated in the state implementation plan, which undergoes an approval process by EPA. The CAA allows for states and local agencies to adopt requirements that are more stringent than those of EPA.

3.2.2. *National Ambient Air Quality Standards*

The CAA requires EPA to set NAAQS for pollutants that are common and widespread in outdoor air, considered harmful to public health and the environment, and that come from numerous and diverse sources (EPA, n.d.b, n.d.c, n.d.d, n.d.e). The CAA identifies two types of NAAQS:

(i) *Primary standards* are designed to protect human health, with an adequate margin of safety, including sensitive populations such as children, the elderly, and individuals suffering from respiratory diseases; and

(ii) *secondary standards* are designed to protect public welfare and the environment from any known or anticipated adverse effects of a pollutant.

The pollutants to which NAAQS apply are known as "criteria pollutants," and are particle pollution, often referred to as particulate matter, and ground-level ozone, carbon monoxide, sulphur dioxide, nitrogen dioxide and lead. For NAAQS, EPA sets standards based on periodic review of the latest peer-reviewed studies of each pollutant's health and environmental effects, with assistance from the Clean Air Scientific Advisory Committee. The CAA requires periodic review, e.g. every five years of the science upon which the NAAQS are based and of the NAAQS standards themselves.

After setting/revising the NAAQS, EPA has to determine in what areas the country meets the new/revised standards. This designation process involves the following steps:

i. States and tribes submit recommendations to EPA as to whether or not an area is attaining the national ambient air quality standards for a criteria pollutant, based on air quality data collected from monitors at locations in urban and rural settings as well as other sources of information characterising air quality, such as modelling;
ii. After working with the states and tribes and considering the information, EPA categorises geographic areas based on their attainment or non-attainment of the standard;
    - Attainment areas are geographic areas where the national air quality standard is met;
    - Non-attainment areas are geographic areas that don't meet the national standard;
    - Unclassifiable areas are areas for which EPA is not able to determine an area's status after having evaluated the available information.

Once the designations have taken effect, state and local governments must develop enforceable implementation plans outlining how areas will attain and maintain the standards by reducing emissions of air pollutants. Tribes may choose to develop tribal implementation plans, but are not required to do so.

Although the NAAQS have no technology-basis, elements of control strategies to implement the NAAQS can be technology-based. Descriptions of programmes with technology-based elements that assist in meeting and maintaining the NAAQS are noted below.

New Source Review Permitting

The preconstruction permitting programme, or the "New Source Review" (NSR) programme, is an important part of state and local area plans to attain and maintain the NAAQS. NSR permitting protects air quality when factories, industrial boilers and power plants are newly built or modified. NSR also assures that new or modified industries are as clean as possible. In addition, the programme assures that advances in pollution control occur concurrently with industrial expansion. If a company is planning to build a major new plant or make a major modification to an existing source, then the company must obtain an NSR permit. The permits are issued on a case-by-case basis. Typically, NSR permits are issued by state or local air pollution control agencies.

EPA establishes the basic requirements for a NSR programme in its federal regulations, including the requirements for what a State needs to include in its State Implementation Plan (SIP). States may develop unique NSR requirements and procedures tailored for their air quality needs as long as the programme is at least as stringent as EPA's requirements. EPA must approve these programmes in the SIP.

NSR permitting is determined on a case-by-case basis as part of a preconstruction permitting process for each new major source or major modification to a source. Emission standards applied through the NSR permitting programme can in no way be less stringent than the NSPSs. Their exact stringency is distinguished by the classification of the air quality management area (AQMA), which is based on whether the location of the facility is in an area that does or does not meet the NAAQS:

Attainment areas

Where the enterprise is located in an AQMA that attains the relevant NAAQS, the application of Best Available Control Technology (BACT) is required. BACT is an emission standards based on the maximum degree of control that can be achieved, considering economic, environmental and energy impacts (US Legal, n.d.a). In addition to applying case-by-case BACT, the facilities in these areas must have a Prevention of Significant Deterioration (PSD) permit. The PSD programme is designed to prevent significant deterioration of air quality in locations that have clean air.

The determination of BACT is done for individual sources on a case-by-case basis at the State level, as part of the process to obtain a new source permit under the PSD programme. As guidance to permitting authorities, EPA has developed a recommended top-down process for the analytical aspects in determining BACT. Contrary to many other programmes for technology-based performance standards, EPA's recommended decision process for the determination of BACT includes a ranking of techniques.

In brief, the recommended process to determine BACT calls for all available control technologies for a given pollutant to be identified and ranked in descending order of

control effectiveness. The permit applicant should first examine the highest-ranked ("top") option. The top-ranked option should be established as BACT unless the permit applicant demonstrates to the satisfaction of the permitting authority that technical considerations, or energy, environmental, or economic impacts justify a conclusion that the top ranked technology is not "achievable" in that case. This process consists of five main steps:

i. identify all available control technologies;
ii. eliminate technically infeasible options;
iii. rank remaining control technologies;
iv. evaluate most effective controls and document results (involves assessment of economic, environmental and energy impacts); and
v. select the BACT.

Although the above described process is recommended by EPA, permitting authorities may use another process for determining BACT in permits they issue so long as that process (and each BACT determination made through that process) complies with the relevant statutory and regulatory requirement, including that the state programme applies the applicable criteria in the definition of BACT (EPA, 1990b, 2011).

Non-attainment areas

Where the enterprise is located in an AQMA that exceeds the applicable NAAQS, emission limits called Lowest Achievable Emissions Rate (LAER) are established in each individual permit. LAER is the most stringent emissions standard contained in any state air quality plan or achieved in practice within a source category (US Legal, n.d.b). Furthermore, the enterprise has to implement additional measures to offset any emissions increase, e.g. by installing extra controls at the enterprise or outside their own enterprise via emission trading or paying for controls at another enterprise within the same AQMA. Anywhere in the country for pollutants in areas that do not meet one or more of the NAAQS, a Nonattainment NSR permit is required and the facility must install controls at least as effective as the best performing source of that same category.

New Source Performance Standards

EPA is authorised to develop technology-based standards, e.g. to control emissions of nitrogen oxides, sulphur dioxide and particulate matter, which apply to specific categories of stationary sources. These standards are referred to as NSPS and reflect the degree of emission limitation achievable through the application of the best system of emission reduction which has been determined to be adequately demonstrated, considering costs (BSER). The NSPS are intended to be technology-forcing, but also a limit that all affected sources would be capable of meeting. They are set based on EPA's assessment of what sources are already achieving in practice. The NSPS serve as the floor in any case-by-case BACT determination. So, NSPS is by definition, less stringent than many BACT emission limits in state permits. The NSPS are presented available on EPA's website (www.epa.gov/stationary-sources-air-pollution/new-source-performance-standards) and in Table 4. Due to the multiple updates of each NSPS, their year of publication is not stated in the table.

The NSPS apply nationally to new, modified and reconstructed facilities in specific source categories. Subcategories have been established for the purpose of creating standards that differ among sizes, types, and classes of sources. EPA is required to review these technology-based standards at least every eight years, and to update them when

appropriate. This programme is separate from the requirements that states must apply in order to achieve and maintain the NAAQS. However, emission reductions due to these standards are helpful to states in implementing the NAAQS.

Table 4. US NSPS

Industrial sector/activity
Onshore Natural Gas Plants - SO2 Emissions
Secondary Brass and Bronze Production Plants
Auto and Light Duty Truck Surface Coating
Basic Oxygen Process Furnace (BOPF) Primary Emissions
Basic Oxygen process Furnace (BOPF) Steelmaking Facilities Secondary Emissions
Phosphate Rock Plants
SOCMI Distillation
Sewage Treatment Plant Incineration
Nonmetallic Mineral Processing Plants
Oil and Gas production, Transmission, and Distribution
Primary Copper Smelting
Ammonium Sulfate Manufacturing
Wool Fiberglass Insulation Manufacturing
Primary Zinc Smelters
Graphic Arts Industry - Publication Rotogravure Printing
Petroleum Refineries - Wastewater Systems
Primary Lead Smelting
Pressure Sensitive Tape and Label Surface Coating
SOCMI Reactor Processes
Primary Aluminum Production
Large Appliance Surface Coating
Magnetic Tape Manufacturing
Phosphate Fertilizers: Wet-Process phosphoric Acid Plants
Metal Coil Surface Coating
Plastic Parts for Business Machines (surface coating)
Phosphate Fertilizers: Superphosphoric Acid Plants
Asphalt Processing and Asphalt Roofing Manufacture
Calciners and Dryers in Mineral Industries
Phosphate Fertilizers: Diammonium Phosphate Plants
SOCMI Equipment Leaks
Polymeric Coating of Substrates
Phosphate Fertilizers: Triple Superphosphate Plants
Beverage Can Surface Coating
Municipal Sold Waste landfills
Phosphate Fertilizers: Granular Triple Superphosphate Storage Facilities
Bulk Gasoline Terminals
Coal Preparation and Processing Plants
Ferroalloy Production Facilities

Source: EPA, n.d.f

Existing sources performance standards

Standards based on Reasonably Available Control Technology (RACT) are technology-based standards which states are required to apply for existing stationary sources in geographic areas that do not meet the NAAQS. RACTs are the lowest emission limitations that a particular source is capable of meeting by the application of control

technology that is reasonably available considering technological and economic feasibility.

For RACT, EPA does not issue uniform standards for existing sources of criteria pollutants or their precursors, and the agency has not established universal decision criteria for technological and economic feasibility that would apply in every case, nor decision rules that would have restricted the cost consideration in determining whether a technology is considered cost effective. Rather, RACT standards are determined by state environmental agencies and often apply sector-wide across some or all of a state; states must include RACT in SIPs for geographic areas that do not meet the NAAQS, including for existing sources.

EPA issues Control Technique Guidelines (CTG) for volatile organic compounds (VOCs) covering a variety of industries. CTGs are not regulations and do not impose legal requirements on sources. Rather, they provide recommendations for state agencies to consider in determining RACT for reducing emissions from covered processes and equipment. CTGs include information on control technologies, costs of available controls and recommendations for RACT. They also include model rule language that states could adopt, which would include emission standards and monitoring. States may use different technology and approaches as RACT, subject to EPA approval. EPA has also developed Alternative Control Technique (ACT) documents that identify alternative control measures for VOCs and NOx for various industries, but make no recommendations or guidance specific to RACT. All the guidance documents are available on the EPA's website (https://www.epa.gov/ozone-pollution/control-techniques-guidelines-and-alternative-control-techniques-documents-reducing) (EPA, n.d.g). There are no ACTs or CTGs available for the textiles and pulp and paper industries. There is one ACT that applies to the non-ferrous metals sectors, i.e. on NOx emissions from iron and steel mills (EPA, 1994).

3.2.3. National Emission Standards for Hazardous Air Pollutants

NESHAP are national emissions standards for hazardous air pollutants. The 1990 Amendments to the Clean Air Act specified a list of HAPs and a schedule for adoption of standards by EPA. The listed pollutants are known or suspected to cause cancer or other serious health and environmental effects. Since 1990, EPA has modified the list through rulemaking to currently include 187 HAPs (EPA, n.d.h). National emission standards for HAPs are available for a large variety of sectors and activities. The NESHAPs are set in two phases. The first phase involves setting technology-based standards based on Maximum Achievable Control Technology (MACT), which are national standards set by EPA, applying to specific source categories. These standards apply to both new and existing major and area sources, as defined in the CAA. The CAA defines how MACT levels of controls are to be determined.

The MACT standards represent the maximum degree of reduction in emissions taking into consideration the costs of achieving such emission reduction and any non-air health and environmental impacts and energy requirements. For new (and substantially reconstructed) sources, these MACT standards must be at least as stringent as is achieved by the best-controlled similar source. For existing sources, MACT standards are to be at least as stringent as the average level of emission reduction already achieved by the best performing 12% of sources in the same category. This minimum control level allowed for MACT standards is typically known as the MACT floor, and does not consider cost. In analysing available data, the MACT floor is determined first. Then control options that

are more stringent than the MACT floor are considered. EPA may establish standards more stringent than the floor based on considerations of the cost of achieving the emissions reductions, any non-air quality health and environmental impacts, and energy requirements.

In the second phase, EPA is required to complete an assessment of residual health and environmental risks remaining after imposition of a MACT standard and determine whether more health protective standards are necessary. And, EPA is required to carry out a review periodically to account for improvements in air pollution controls and/or prevention, and to revise such standard where data so indicate.

The NESHAPs, based on MACT, are listed in Table 5 and are available on EPA's website (https://www.epa.gov/stationary-sources-air-pollution/national-emission-standards-hazardous-air-pollutants-neshap-9). Due to the multiple updates of each NESHAP, their year of publication is not stated in the table.

Table 5. US NESHAPs

Industrial sector/activity
Acrylic/Modacrylic Fiber (area sources)
Aerospace
Asbestos
Asphalt Processing and Asphalt Roofing Manufacturing
Asphalt Processing and Asphalt Roofing Manufacturing (area sources)
Auto and Light Duty Truck Surface Coating
Auto Body Refinishing (area sources) - see Paint Stripping and Miscellaneous Surface Coating Operations
Benzene Transfer Operations
Benzene Waste Operations
Beryllium
Beryllium Rocket Motor Firing
Boat Manufacturing
Boilers (see Industrial-Commercial-Institutional Boilers)
Brick and Structural Clay Products Manufacturing (see also Clay Ceramics)
Carbon Black Production (area sources)
Cellulose Products Manufacturing
Chemical Manufacturing Industry (area sources): CMAS
Chemical Preparations Industry (area sources)
Chromium Electroplating
Chromium Compounds (area sources)
Clay Ceramics Manufacturing (see also Brick and Clay Products)
Clay Ceramics Manufacturing (area sources)
Coke Ovens: Charging, Top Side, and Door Leaks
Coke Ovens: Pushing, Quenching, and Battery Stacks
Coke Oven By-product Recovery Plants
Combustion Sources at Kraft, Soda, and Sulfite Pulp & Paper Mills (Pulp and Paper MACT II) (see also Pulp and Paper noncombust MACT)
Commercial Sterilizers (see Ethylene Oxide Emission Standards for Sterilization Facilities)
Degreasing Organic Cleaners (see Halogenated Solvent Cleaners)
Dry Cleaning
Electric Arc Furnace Steelmaking Facilities (area sources)
Engine Test Cells/Stands (see also Beryllium Rocket Motor Firing)
Ethylene Oxide Emission Standards for Sterilization Facilities (see also Hospital Ethylene Oxide Sterilizers)
Fabric Printing, Coating and Dyeing
Ferroalloys Production (major sources)
Ferroalloys Production (area sources)
Flexible Polyurethane Foam Fabrication Operation
Flexible Polyurethane Foam Production and Fabrication (area sources)
Flexible Polyurethane Foam Production
Friction Products Manufacturing
Gasoline Dispensing Facilities (area sources)
Gasoline Distribution (Stage 1)
Gasoline Distribution Bulk Terminals, Bulk Plants, and Pipeline Facilities (area sources)
Generic MACT I - Acetal Resins
Generic MACT I - Hydrogen Floride
Generic MACT I - Polycarbonates Production
Generic MACT I - Acrylic/Modacrylic Fibers
Generic MACT II - Spandex Production
Generic MACT II - Carbon Black Production
Generic MACT II - Ethylene Processes
Glass Manufacturing (area sources)

Glass Manufacturing - Inorganic Arsenic
Gold Mine Ore Processing and Production (area sources)
Halogenated Solvent Cleaning
Hazardous Organic NESHAP (Synthetic Organic Chemical Manufacturing Industry)
Hazardous Waste Combustors
Hospital Ethylene Oxide Sterilizers (area sources) (see also Ethylene Oxide Sterilizers)
Hydrochloric Acid Production
Industrial, Commercial and Institutional Boilers and Process Heaters (major sources)
Industrial, Commercial and Institutional Boilers (area sources) (see also Boiler Compliance at Area Sources)
Industrial Process Cooling Towers
Inorganic Arsenic Emissions from Primary Copper Smelters
Inorganic Arsenic from Arsenic trioxide and Metallic Arsenic Production
Integrated Iron and Steel
Iron and Steel Foundries (major sources)
Iron and Steel Foundries (area sources)
Large Appliances Surface Coating
Lead Acid Battery Manufacturing (area sources)
Leather Finishing Operations
Lime Manufacturing
Magnetic Tape Surface Coating
Manufacturing Nutritional Yeast (formerly Bakers Yeast)
Marine Vessel Loading Operations
Mercury Cell Chlor-Alkali Plants
Mercury Production
Metal Can Surface Coating
Metal Coil Surface Coating
Metal Fabrication and Finishing Source Nine Categories (area sources)
Metal Furniture Surface Coating
Mineral Wool Production
Miscellaneous Coating Manufacturing
Miscellaneous Metal Parts and Products Surface Coating
Misc. Organic Chemical Production and Processes (MON)
Municipal Solid Waste Landfills
Natural Gas Transmission and Storage
Nonferrous Foundries: Aluminum, Copper, and Other (area sources)
Off-Site Waste Recovery Operations
Oil and Natural Gas Production includes Area Sources
Oil-Water Separators and Organic-Water Separators
Organic Liquids Distribution (non-gasoline)
Paints and Allied Products Manufacturing (area sources)
Paint Stripping and Miscellaneous Surface Coating Operations (area sources) (see also Collision Repair Campaign)
Paper and Other Web Surface Coating
Pesticide Active Ingredient Production
Petroleum Refineries
Petroleum Refineries
Pharmaceuticals Production
Phosphoric Acid
Phosphate Fertilizers
Plastic Parts Surface Coating
Plating and Polishing Operations (area sources)
Plywood and Composite Wood Products (formerly Plywood and Particle Board Manufacturing)
Polyether Polyols Production

Polymers & Resins I
Polymers & Resins II
Polymers & Resins III
Polymers & Resins IV
Polyvinyl Chloride and Copolymers Production
Polyvinyl Chloride and Copolymers Production (area sources)
Portland Cement Manufacturing
Prepared Feeds Manufacturing (area sources)
Primary Aluminum
Primary Copper Smelting
Primary Copper Smelting (area sources)
Primary Lead Processing
Primary Magnesium Refining
Primary Nonferrous Metals-Zinc, Cadmium, and Beryllium (area sources)
Printing and Publishing Surface Coating
Publicly Owned Treatment Works (POTW)
Pulp and Paper (non-combust) MACT (see also Combustion Sources at Kraft, Soda, and Sulfite Pulp & Paper Mills -Pulp and Paper MACT II)
Reciprocating Internal Combustion Engines (RICE) includes area sources
Refractory Products Manufacturing
Reinforced Plastic Composites Production
Rubber Tire Manufacturing
Secondary Aluminum
Secondary Copper Smelting (area sources)
Secondary Lead Smelters
Secondary Nonferrous Metals Processing (Brass, Bronze, Magnesium and Zinc) (area sources)
Semiconductor Manufacturing
Shipbuilding and Ship Repair Surface Coating
Site Remediation
Solvent Extraction for Vegetable Oil Production
Stationary Combustion Turbines
Steel Pickling - HCL Process
Taconite Iron Ore Processing
Utility NESHAP
Vinyl Chloride
Wet Formed Fiberglass Mat Production
Wood Building Products Surface Coating (formerly Flat Wood Paneling Products)
Wood Furniture Surface Coating
Wood Preserving (area sources)
Wool Fiberglass Manufacturing
Wool Fiberglass Manufacturing (area sources)

Source: EPA, n.d.i

3.3. Technology-based performance standards for emissions to water

3.3.1. Key features

Under the CWA, national wastewater discharge standards are developed by EPA on an industry-by-industry basis. These are technology-based regulations, and are intended to represent the greatest pollutant reductions that are economically achievable for an industry. The standards are applicable to stationary sources, in particular to waste water treatment plants, industrial process water, cooling water and in some cases industrial

storm water. Thresholds are linked to the severity of pollution, area and size of installations.

3.3.2. Technology-based standards for point sources (TBELs)

TBELs are technology-based standards for point source discharges. EPA develops these standards for categories of dischargers, based on the performance of pollution control technologies without regard to the conditions of a particular receiving water body. For industrial and other non-municipal facilities, TBELs are derived by using national effluent limitations guidelines and standards established by EPA, and/or using Best Professional Judgement (BPJ) on a case-by-case basis in the absence of national guidelines and standards (EPA, 2010).

TBELs require a minimum level of treatment of pollutants for point source discharges based on available treatment technologies, while allowing the discharger to use any available control technique to meet the limits. TBELs are set up for specific pollutants at several levels of control, e.g. existing or new sources, direct or indirect discharge, priority, conventional or non-conventional pollutants:

i. Existing sources – direct dischargers:
   - Best Practicable Control Technology Currently Available (BPT);
   - Best Conventional Pollutant Control Technology (BCT);
   - Best Available Technology (Economically Achievable) (BAT(EA));
ii. Existing sources – indirect dischargers:
   - Categorical Pre-treatment Standards (CPS) for Existing Sources (PSES);
iii. New/modified sources – direct dischargers:
   - New Source Performance Standards (NSPS);
iv. New/modified sources – indirect dischargers:
   - Categorical Pre-treatment Standards for New Sources (PSNS).

3.3.3. Ambient Water Quality Standards for point sources (AWQS)

The Deriving Ambient Water Quality Criteria for the Protection of Human Health – Revised Methodology (EPA, 2000) is used by states and tribes to develop Ambient Water Quality Criteria (AWQC) for the promotion of human health. Revisions to the 1980 guidelines incorporate significant scientific advances in key areas such as cancer and non-cancer risk assessments, exposure assessments and bioaccumulation of fish. The in 2000 revised methodology provides more flexibility for decision-making at the state, tribal and EPA regional levels. It is most likely that the methodology will result in more stringent criteria for bio-accumulatives and generally similar values of non-bio-accumulatives.

3.3.4. Permits for point sources of pollution and associated technology-based performance standards

The National Pollutant Discharge Elimination System (NPDES) is a permit system for regulating point sources of pollution from (i) industrial facilities (including manufacturing, mining, oil and gas extraction, and service industries), (ii) municipal governments and other government facilities, such as military bases and (iii) some agricultural facilities, such as animal feedlots. NPDES permits must be reissued every five years. They also include conditions concerning periodically monitoring and discharge monitoring reports (EPA, n.d.j).

After the application of technology-based standards to a permit, if water quality remains impaired for the particular water body, the permit agency, e.g. the state or EPA, may add water quality-based limitations to the permit. The additional limitations, e.g. Total Maximum Daily Loads (TMDLs), Water Quality-based Effluent Limitations (WQBELs) and Whole Effluent Toxicity (WET) are to be more stringent than the technology-based limitations and require the permittee to install additional controls. Water quality standards consist of four basic elements:

i. designated uses,
ii. water quality criteria,
iii. anti-degradation policies and
iv. general policies.

3.4. Other BAT-related initiatives

3.4.1. The Toxics Release Inventory

The Pollution Prevention Act (EPA, 1990) expanded the information facilities are required to submit on their Toxics Release Inventory (TRI) reporting forms to the US EPA. The TRI is the United States' pollutant release and transfer register (PRTR). In recognising the potential of the TRI to be a powerful pollution prevention tool, the authors of the PPA expanded the information required to be reported by facilities under Section 313 of the Emergency Planning and Community Right-to-Know Act to include information specific to source reduction and preferred waste management techniques. As described under Section 6607 of the PPA, for a given chemical this additional information includes the quantities of the chemical that were recycled, used for energy recovery, or treated at the facility or elsewhere. The PPA also *requires* reporting of any source reduction practices (e.g., process modifications, substitution of raw materials) implemented at a facility during the reporting year. Data fields were added to the TRI reporting Form R for these additional required data elements

3.5. Attributes and limitations

3.5.1. Attributes

The fact that the performance standards generally are applied in the form of quantified emission limits gives companies flexibility to decide the best way to achieve the ELVs, considering costs and other factors.

3.5.2. Limitations

No limitations have been reported.

Notes

1 The CAA is designed to protect public health and welfare from different types of air pollution caused by a diverse array of pollution sources. It provides the principal framework for national, state, tribal and local efforts to protect air quality.

2 The CWA aims to restore and maintain the chemical, physical, and biological integrity of the nation's waters by preventing pollution from point and non-point sources, providing assistance to publicly owned treatment works for the improvement of wastewater treatment, and maintaining the integrity of wetlands.

3 The PPA focuses on industrial and governmental efforts as well as, public awareness regarding the reduction of quantities of pollution through the application of technology-based principles and cost-effective changes in production, operation and raw materials use. This approach includes equipment or technology modifications, process or procedure modifications, reformulation or redesign of products, substitution of raw materials and improvements in housekeeping, maintenance, training or inventory control.

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Chapter 4. The European Union: A standardised methodology to establish BAT

This chapter presents the European Union's standardised methodology to develop BAT reference documents and BAT Conclusions, known as the Seville Process and applied under the Industrial Emissions Directive. In addition, the chapter introduces variations of this approach, applying under other directives, regulations and for specific sectors.

4.1. Introduction

The European Union (EU) has had a BAT-based policy to prevent and control industrial emissions since 1996. The principal framework to protect air, water and soil in the EU is provided by technique-based policies to prevent and control industrial emissions, in particular the Industrial Emissions Directive (IED) (EU, 2010). The IED provides a general framework to prevent and control industrial emissions based on integrated permitting, implying that permits must take account of a plant's complete environmental performance to avoid pollution being shifted from one environmental medium to another. The IED stresses that an integrated approach to prevention and control of emissions to air, water and soil, as well as to waste management, energy efficiency and accident prevention, is essential to achieve a level playing field in the EU by aligning environmental performance requirements for industrial installations. The basic premise of the IED is that installations must prevent and control industrial emission by applying BAT, efficient energy use, waste prevention and management and measures to prevent accidents and limit their consequences.

The EU has a standardised methodology for the procedure of selection and evaluation of techniques for the determination of BAT, known as the *Seville Process*. The BAT identified through this process form the basis for BAT-associated emission levels (BAT-AELs), which constitute the basis for the emission limit values (ELVs) in permits. The BAT and BAT-AELs are described in BAT reference documents (BREFs), while the latter also are presented in BAT Conclusions. Only the BAT-AELs are legally binding, and not the BAT. The *Seville Process* is defined under the IED and formalised in the EU (2012) Commission Implementing Decision, known as the BREF Guidance Document, which lays down rules concerning guidance on the collection of data and on the drawing up of BREFs and on their quality assurance. The BREF Guidance Document incorporates the IED's Annex III, which lists the criteria for determining BAT.

The IED defines BAT as the most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing the basis for emission limit values and other permit conditions designed to prevent and, where that is not practicable, to reduce emissions and the impact on the environment as a whole. More specifically, the definition of BAT is based on the following elements:

i. 'techniques' includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned;
ii. 'available techniques' means those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator;
iii. 'best' means most effective in achieving a high general level of protection of the environment as a whole (EU, 2010).

In addition to the *Seville Process* under the IED, there are analogous EU BAT identification systems under other pieces of legislation, using slightly different approaches for the selection of BAT to that used under the IED. This includes systems used under the Eco-Management and Audit Scheme (EMAS) Regulation (EU, 2009), the Medium Combustion Plant Directive (EU, 2015), the Mining Waste Directive (EU, 2006) and for the Hydrocarbons BREF.

4.2. Industrial Emissions Directive: BAT reference documents and BAT Conclusions

4.2.1. Key features

The development of BREFs under the IED is steered by the European IPPC Bureau (EIPPCB) at the EU Joint Research Centre (JRC) in Seville, Directorate B – Growth and Innovation, which was established under the IPPC Directive (EU, 2008), the predecessor of the IED. The procedures for identifying BAT under the IED are generally the same as those under the IPPC Directive. However, the BAT established under the latter were published as BREFs only, while there are two products of the IED BAT identification procedure: BREFs and BAT Conclusions.

BAT Conclusions are published in the Official Journal of the European Union as standalone Commission Implementing Decisions, describing the techniques selected as BAT and the expected environmental performance of those techniques. Implementing Decisions are translated into all 23 official EU languages. At present, Implementing Decisions have been published for 13 industrial sectors. A further 19 sectors benefit from BREFs elaborated under the IPPC legislation; these are in the process of being reviewed to create Implementing Decisions. Thus, there are currently a total of 32 sectoral BREFs, developed over the period 1997-2018.

The BREF Guidance Document (EU, 2012) foresees that the technical stages of BREF elaboration can take up to 39 months; on top of which the opinion of the Article 13 Forum[1], the vote by the Article 75 Committee[2] and formal adoption can add up to another 12 months. Thus, the development of a BREF and BAT Conclusions for one sector should in theory take about four years. This timescale has been achieved for some sectors; e.g. production of wood-based panels; however, in practice, there can be technical and procedural difficulties that impinge on this ideal planning.

The BREFs are adopted and published by the European Commission, and made publically available on the EIPPCB's BREF website (http://eippcb.jrc.ec.europa.eu/reference/). The documents are published in English; some are partly or fully translated into other languages by national authorities in the EU Member States. In accordance with the IED recitals, the EIPPCB aims to review BREFs every eight years; the BREF website displays the status of each of the BREFs, showing which BREFs are finalised and which are under review.

BREFs are used by permits issuers, but also by industrial facilities, and typically contain the following information:

i. general information about the concerned sector;
ii. applied processes and techniques;
iii. current consumption and emission levels;
iv. techniques to consider in the determination of BAT;
v. BAT Conclusions (see description below);
vi. emerging techniques;
vii. concluding remarks and recommendations for future work; and
viii. a glossary.

The BAT Conclusions, constituting a separate and standalone product of the BAT identification process, aim to contain the following elements (as prescribed by Article 3(12) of the IED):

i. A description of the techniques;
ii. information to assess their applicability;
iii. the environmental performance levels (BAT-AEPLs) associated with the use of BAT, usually including legally binding associated emission levels (BAT-AELs), expressed as a numerical range of emission levels, including – if the data submitted allows doing so – short-term and long-term averages (information can be added to explain under what conditions the lower end of the BAT-AELs can be achieved or to reflect the performances of different techniques);
iv. associated monitoring;
v. associated consumption level; and
vi. relevant site remediation measures (where appropriate).

The BAT Conclusions constitute the references for setting permit conditions, including ELVs. ELVs must be set at a level ensuring that pollutant emissions do not exceed the BAT-AELs. The IED allows competent authorities in the EU Member States some flexibility to grant derogations in individual permits that set less strict ELVs, in exceptional and tightly defined circumstances. Such derogation may apply only where an assessment shows that the adoption of techniques as described in the BAT Conclusions would lead to disproportionately high costs compared to the environmental benefits, due to the geographical location, local environmental conditions or technical characteristics of the installation concerned.

Furthermore, the techniques listed and described in the BAT Conclusions are neither prescriptive nor exhaustive; other techniques may be used if they ensure at least an equivalent level of environmental protection. Consequently, industrial operators have the flexibility to use their own technique, or choice of techniques, as long as the end result is the same.

The procedure to determine BAT Conclusions is summarised in the preface of each BREF and includes the steps listed below. The procedure guides the approach to collection of information on techniques and identification of BAT.

i. Identification of the Key Environmental Issues for the sector concerned;
ii. examination of the techniques most relevant to address these key issues;
iii. identification of the best environmental performance levels, on the basis of the available data in the EU and worldwide;
iv. examination of the conditions under which these environmental performance levels were achieved, such as costs, cross-media effects, and the main driving forces involved in the implementation of the techniques; and
v. selection of BAT, their associated emission levels (and other environmental performance levels) and the associated monitoring for this sector according to Article 3(10) of, and Annex III to, the IED.

Besides BREFs, the EIPPCB also elaborates horizontal Reference Documents (REFs) on a small number of cross-cutting issues. These assist permit writers and operators but do not generate legally binding BAT Conclusions. For example, the REF on Economics and Cross-Media Effects (EC, 2006) addresses methodologies that can provide assistance to the TWGs and permit issuers when considering the environmental and economic conflicts that can occur when determining which techniques to identify as BAT.

4.2.2. Selection of sectors

The standardised methodology for the determination of BAT under the IED is fundamentally the same for all industrial sectors as well as for the different environmental

media (air, water and soil). However, in practice, BAT is more frequently identified for air and water emissions than for soil. Where relevant, BAT is also defined for resource use (e.g. energy, water or raw materials), the management of waste/residues/by-products and re-use/recycling.

Annex I of the IED (EU, 2010) defines the polluting industrial sectors that are within the directive's scope. BREFs have been developed for most of these sectors; however, there is not an exact match between Annex I and the list of available BREFs. BREFs are only elaborated where this represents a more efficient way to reach the pan-European agreement on BAT. The EU does not establish BAT for industrial sectors where there is limited benefit in reaching consensual agreement, e.g. sectors with a very small number of installations or where production activities are highly specialised. These instances, of which there are relatively few, are accommodated by Article 14(6) of the IED which provides for Member State Competent Authorities to carry out a more targeted identification of BAT in consultation with the affected operators, taking into account the criteria listed in the IED's Annex III.

For the purposes of identifying BAT, similar industrial activities are grouped together for information exchanges. These groupings are subject to approval by the IED's Article 13 Forum. For some sectors, the IED includes a variety of thresholds which aim to restrict legal application to the largest and potentially most polluting activities. The thresholds take various forms, e.g. production capacity per unit of time, scale of the unit operation or number of animal heads. It should be noted that the IED defines no thresholds for the chemicals sector, implying that all industrial scale chemical plants must comply with the IED and relevant BREFs.

Table 6 lists all the 32 industrial sectors for which BREFs and/or BAT Conclusions are available, in addition to the two horizontal REFs. The list includes BREFs for the three target sectors (see Annex A for more information on the target sectors).

Table 6. EU BREFs, BAT Conclusions and REFs

Industrial sector/activity	Type of document	Date of publication / status
Ceramic Manufacturing Industry (CER)	BREF	08.2007
Common Waste Water and Waste Gas Treatment/ Management Systems in the Chemical Sector (CWW)	BATC and BREF	06.2016
Common Waste Gas Treatment in the Chemical Sector (WGC)		Drafting of BREF in progress
Emissions from Storage (EFS)	BREF	07.2006
Energy Efficiency (ENE)	BREF	02.2009
Ferrous Metals Processing Industry (FMP)	BREF	12.2001
Food, Drink and Milk Industries (FDM)	BREF	08.2006; D1 01.2017
Industrial Cooling Systems (ICS)	BREF	12.2001
Intensive Rearing of Poultry or Pigs (IRPP)	BATC and BREF	07.2017
Iron and Steel Production (IS)	BATC and BREF	03.2012
Large Combustion Plants (LCP)	BATC and BREF	07.2017
Large Volume Inorganic Chemicals – Ammonia, Acids and Fertilisers (LVIC-AAF)	BREF	08.2007
Large Volume Inorganic Chemicals – Solids and Others Industry (LVIC-S)	BREF	08.2007
Large Volume Organic Chemical Industry (LVOC)	BATC and BREF	12.2017
Manufacture of Glass (GLS)	BATC and BREF	03.2012
Manufacture of Organic Fine Chemicals (OFC)	BREF	08.2006
Non-ferrous Metals Industries (NFM)	BATC and BREF	06.2016
Production of Cement, Lime and Magnesium Oxide (CLM)	BATC and BREF	04.2013
Production of Chlor-alkali (CAK)	BATC and BREF	12.2013
Production of Polymers (POL)	BREF	08.2007
Production of Pulp, Paper and Board (PP)	BATC and BREF	BATC 09.2014; BREF 2015
Production of Speciality Inorganic Chemicals (SIC)	BREF	08.2007
Refining of Mineral Oil and Gas (REF)	BATC and BREF	10.2014
Slaughterhouses and Animals By-products Industries (SA)	BREF	05.2005
Smitheries and Foundries Industry (SF)	BREF	05.2005
Surface Treatment Of Metals and Plastics (STM)	BREF	08.2006
Surface Treatment Using Organic Solvents (including Wood and Wood Products Preservation with Chemicals) (STS)	BREF	08.2007; D1 10.2017
Tanning of Hides and Skins (TAN)	BATC and BREF	02.2013
Textiles Industry (TXT)	BREF	07.2003; review started
Waste Incineration (WI)	BREF	08.2006; D1 05.2017
Waste Treatment (WT)	BREF	08.2006; FD 10.2017
Wood-based Panels Production (WBP)	BATC and BREF	11.2015
Economics and Cross-media Effects (ECM)	REF	07.2006
Monitoring of emissions from IED-installations (ROM)	REF	07.2003; revised FD 06.2017

Note: BATC: BAT Conclusions; BREF: BAT Reference Document; REF: Reference Document; D1: draft 1; FD: final draft.
Source: EIPPCB, n.d.

4.2.3. Information collection

In line with the BREF Guidance Document (EU, 2012), the collection of data on techniques for prevention and control of industrial emissions is done based on a combined method of stakeholder consultation and literature research. Stakeholders, grouped in technical working groups (TWGs) (one for each sector), can share or provide information through questionnaires, during stakeholder meetings or via the online information exchange portal Best Available Techniques Information System (BATIS. The portal can only be accessed by TWG members).

A TWG is set up (or reactivated) by the EIPPCB every time a BREF is to be developed or revised. Each TWG consists of technical experts representing Member States, industries, NGOs promoting environmental protection and the European Commission. TWG members are nominated to participate in the information exchange primarily based on their technical, economic, environmental or regulatory expertise (especially with regards to permitting or inspecting industrial installations for the sector in question) as well as on their ability to bring the BREF end-user perspective into the information exchange process. The number of TWG members generally varies between 100 and 260, depending on the sector.

A TWG kick-off meeting will typically identify the scope, the Key Environmental Issues for the sector in question, i.e. the issues for which BAT have the highest likelihood of resulting in noteworthy additional environmental benefits (EC, 2015a), and the extent of the information to be collected during the BAT elaboration. Sector-specific questionnaire templates are usually developed by the EIPPCB for the collection of information at the plant or installation level (i.e. not aggregated information) in a consistent format that will allow for data comparison.

The TWGs are the main source of information for the development and revision of BREFs by:

i. actively collecting information for their area of responsibility;
ii. peer reviewing information collected by other TWG members;
iii. carrying out data analysis together with the EIPPCB; and
iv. participating in taking decisions on the nature of BAT and their associated environmental performance.

Additional parties that are involved in the gathering of information on techniques might be representatives of the Member States' Ministries of Economic Affairs, experts nominated by the Ministries or business associations, business operators, academia and technique suppliers. These may not be direct members of the TWGs, but are consulted by the TWG members, e.g. in the framework of national shadow groups.

To address specific issues within the scope of their work, the TWGs may decide to establish sub-groups in order to undertake specific tasks such as discussing data or comments on proposed draft texts, or preparing and developing templates or documents. Site visits are also instrumental in gathering and validating information for drawing up and reviewing BREFs.

4.2.4. Evaluation of the techniques

The evaluation of techniques is carried out by the EIPPCB in collaboration with the TWGs, based on responses to questionnaires, written consultations and discussions during TWG meetings. The TWGs evaluate the available information, coming from companies, sector associations, suppliers, national regulators and available research, and make a preselection of techniques that will be considered for further evaluation and determination of BAT – referred to as *candidate BAT*. The list of candidate BAT is typically a combination of preventive, process-integrated and end-of-pipe techniques. As far as possible the list of candidate BAT is the result of a consensual decision by a TWG based on objective assessment of information made available to all its members. In addition, the EIPPCB plays a pivotal role in supporting the work of the TWGs by undertaking detailed data analysis and proposing BAT Conclusions.

In evaluating the candidate BAT, the TWG refers to the criteria for determination of BAT as defined in Annex III of the IED and incorporated into the BREF Guidance Document (EU, 2012):

i. the use of low-waste technology;
ii. the use of less hazardous substances;
iii. the furthering of recovery and recycling of substances generated and used in the process and of waste, where appropriate;
iv. comparable processes, facilities or methods of operation which have been tried with success on an industrial scale;
v. technological advances and changes in scientific knowledge and understanding;
vi. the nature, effects and volume of the emissions concerned;
vii. the commissioning dates for new or existing installations;
viii. the length of time needed to introduce the BAT;
ix. the consumption and nature of raw materials (including water) used in the process and energy efficiency;
x. the need to prevent or reduce to a minimum the overall impact of the emissions on the environment and the risks to it;
xi. the need to prevent accidents and to minimise the consequences for the environment;
xii. information published by public international organisations.

When selecting BAT, the TWGs generally primarily seek to identify preventive and process-integrated measures, and – as a second best option – end-of-pipe techniques (EU, 2012). Another important differentiation is sometimes made between BAT that are generally applicable and those that only can be used for specific activities (e.g. production of product A and not product B) or under certain circumstances (e.g. when combining certain activities), and between BAT-AEPLs for new installations versus those for existing ones. A hierarchy of BAT can also be defined in other cases, when a TWG considers this appropriate or at the site-specific level by national environmental regulators. Moreover, a TWG can choose to identify non-BAT. For example, the Implementing Decision (EU, 2013) and the BREF (EC, 2014) for the production of chlor-alkali first states that the mercury cell technique is *not* BAT, before listing techniques that are considered BAT.

Further information on the technical, environmental and economic aspects that are taken into account during the evaluation of candidate BAT is provided below.

Technical aspects

When assessing the technical aspects of the techniques, the TWGs take into account their safety and technological readiness level, the quality of the production process or products as well as the applicability. To judge the applicability of a technique, the TWG consider whether the technique is generally useable or only adapted to specific plants or subsectors. The TWGs will also note whether the technique is usable in new versus existing plants, taking into account factors involved in retrofitting (e.g. space availability) and interactions with techniques already installed. Other important factors are the size, capacity or load from the production lines in relation to the technique, in addition to the type of fuel or raw materials used in the production process. For some sectors, climatic conditions are also taken into account. In the case of the BREF for intensive rearing of poultry or pigs, animal welfare is also considered.

Environmental aspects and pollutants

As stated above, each TWG initiates the process to develop or revise a BREF by identifying the Key Environmental Issues for the industrial sector concerned. The selection of Key Environmental Issues is based on a combined approach consisting of (i) a top-down method, starting from a general list of aspects and pollutants for all industrial sectors and selecting the ones that are relevant for the sector in question, and (ii) a bottom-up method, selecting relevant aspects and pollutants for the concerned sector based on monitoring and experience (EC, 2015a). For a small number of horizontal reference documents where BAT are identified in a cross-cutting way for all industrial sectors, only the top-down method is used.

The positive and negative cross-media environmental effects of the techniques are assessed based on expert judgement within the TWGs, in combination with the methods described in the BREF on Economics and Cross-Media Effects(EC, 2006) when deemed necessary.

Economic aspects

The assessment of economic data constitutes an important element of the evaluation of candidate BAT. Where available, the BREFs present economic data together with the descriptions of techniques, in order to give a rough indication of the magnitude of relevant costs and benefits. The BREFs state, however, that the actual costs and benefits of applying a technique may depend strongly on the specific situation of the installation concerned, and that this cannot be evaluated fully in the BREFs.

Notably, the TWGs seek to assess whether it would be economically viable for companies to implement a technique or a set of techniques. A technique is generally considered economically viable when it is demonstrably operational at a scale which allows for widespread implementation in the relevant industrial sector, taking into consideration total financial costs and environmental benefits, i.e. widely implemented, without associated government subsidies. The technique does not have to be used or produced in an EU Member State, but it should be reasonably accessible to operators (i.e. not covered by a restrictive patent). In the absence of data concerning costs, conclusions on the economic viability of techniques are drawn from observations on existing installations; thus, stakeholders play an important role in the process of assessing economic viability by providing empirical information and reacting to proposals.

While cost-effectiveness is not a separate criterion for BAT selection, it is normally considered as part of the assessment of economic viability. For example, stakeholders report that for the evaluation of candidate BAT resulting in the BREF for the Non-Ferrous Metals Industries (EC, 2017a) and the associated BAT Conclusions (EU, 2016), some data on investments were considered, even if no particularly detailed information on each of the various techniques was processed. Consequently, elements relevant to economic viability were not extensively reflected in the BAT Conclusions. Stakeholders point out that it is important, in the analysis of economic viability, to distinguish between existing installations, as these often have a fixed investment cycle, and new plants, which often can implement modifications (‘greenfield’ projects) more easily. For example, the non-ferrous metals sector is highly capital intensive, with major investments in existing plants; thus, ongoing investment cycles represent an important boundary condition for the definition of the economic viability of candidate BAT.

The evaluation of affordability is not usually a criterion for BAT selection, but is – when considered – demonstrated empirically, i.e. a particular technique is considered affordable if it is already adopted in a given sector. However, care must be taken to identify if financial support has been given to assist the adoption of a technique, as this would preclude it from being generally affordable in the sector as a whole.

4.2.5. Data handling

It is the responsibility of the data providers to confirm the validity of their data. However, the cooperative nature of the TWGs ensures considerable review by other stakeholders (e.g. national competent authorities at the site-specific level). In addition, the EIPPCB plays a proactive role in collating data and checking the veracity of any apparent outliers.

Since the *Seville Process* mainly focuses on emissions data, which is publically available, there is generally no need to access confidential industry information or sensitive information covered by competition laws. If needed, such data may be aggregated or anonymised in order to allow for it to be released in a non-confidential format. However, there are certain cases where confidential industry information, such as production volume, would be useful for the identification of BAT. If data providers do not wish to share such information, they must clearly state when and what information is considered confidential, and justify this claim in accordance with the criteria in EU directive on public access to environmental information (EU, 2003). Consequently, this information may be excluded from the BREF.

4.2.6. Decision making process

As far as possible, the BAT selection is the result of a consensual decision of a TWG based on objective assessment of information made available to all its members. In addition, the EIPPCB plays a pivotal role in supporting the work of the TWG by undertaking detailed data analysis and proposing BAT Conclusions.

Following the vote on the BAT Conclusion, the EIPPCB finalises and publishes the BREFs. After the adoption and publication of the associated BAT Conclusions as Commission Implementing Decisions in the Official Journal of the EU, the permits of installations covered by the scope of a BREF must be aligned with the BAT Conclusions in each of the Member States within four years.

4.2.7. Local example: Establishing BAT in Flanders, Belgium

Flanders, Belgium, has its own procedure for identification of BAT, consisting of four steps: Techniques considered for BAT selection are evaluated with respect to their technical viability (step 1), environmental benefit (step 2) and economic viability (step 3). Subsequently, different techniques are compared and/or grouped (step 4), leading to the proposal of BAT. The procedure is a participatory process, involving both authorities and industry, and results in the publication of Flemish BAT studies which are available online (https://emis.vito.be/en/bat-studies).

A description of the Flemish BAT selection procedure was published in the Journal on Cleaner Production in 2000 (Dijkmans, 2000) by the Flemish Knowledge Centre for Best Available Techniques. This centre has also developed a practicable, objective and transparent methodology for determining BAT-AELs for industrial waste water, published in the Journal on Cleaner Production in 2012 (Polders et al., 2012). The

methodology is based on a detailed analysis of industrial emissions data and includes five steps:

i. selection and grouping of industrial installations; the use of less hazardous substances;
ii. collection of emission data;
iii. selection of parameters (pollutants);
iv. analysis of available emission data relevant for BAT; and
v. determination of (differentiated) BAT-AELs.

4.3. Extractive Waste Directive: BAT reference document

4.3.1. Key features

The review of the BREF on the management of tailings and waste-rock in mining activities (MTWR BREF) (EC, 2009), originally elaborated over the period 2001-2004 and published in 2009, after the entry into force of the Mining Waste Directive[3] (EU, 2006), is scheduled for completion in 2018. Contrary to other EU BREFs, the review of MTWR BREF did not take place under the IED framework; however, the procedure for the review of the document is largely aligned to the *Seville Process* developed for IED BREFs and the review was carried out by the European Commission's Joint Research Centre (JRC) in Seville, Directorate B – Growth and Innovation.

4.3.2. Information collection and evaluation of techniques

A Technical Working Group (TWG) comprising technical experts from the extractive sector, representing EU Member States, industries and environmental NGOs, was reactivated to review the MTWR BREF (JRC, 2016). Members of the IED Forum and Technical Adaption Committee of the Extractive Waste Directive nominated experts for the TWG in December 2013. The scope and time frame for the review of the MTWR BREF were discussed and decided upon at a Kick-Off Meeting held in Seville in May 2014.

At the Kick-Off Meeting, it was also agreed to use a questionnaire to collect site specific data and information on consumptions and emissions from the management of extractive waste, as well as on BAT used in the sector (JRC, 2016), apart from collecting bulk data and information relevant for the sector and the BREF review. The questionnaire was finalised in March 2015 and circulated to the TWG members for further distribution to operators willing to contribute to the data and information collection exercise. By September 2015, 88 responses to the questionnaire had been collected, including from representatives of the mining, quarrying and on-shore oil & gas extractive industries (JRC, 2016).

After cross-checking the completed questionnaires by the TWG, the JRC used all exchanged data and information to elaborate the draft review of the MTWR BREF, which was published in June 2016 and distributed for commenting by the TWG until the beginning of November 2016 (JRC, 2016). The original title of the document was changed to Best Available Techniques Reference Document for the Management of Waste from the Extractive Industries (MWEI BREF), to reflect its revised scope. In February 2017, the JRC organised two webinars, mainly dedicated to the presentation of collected data and the introduction of a risk-specific structure for the different BAT. A revised draft BREF was then distributed in September 2017, in preparation of the Final

TWG Meeting, held at the end of November 2017 in Seville. This meeting, where conclusions on different best available techniques and other aspects of the reviewed BREF were jointly formulated by the TWG, signified the end of the technical discussions in the review process. The JRC is currently, as of March 2018, finalising the document.

4.4. Eco-Management and Audit Scheme Regulation: Sectoral Reference Documents and Best Practice Reports

4.4.1. Key features

The Eco-Management and Audit Scheme (EMAS) Regulation (EU, 2009) establishes the voluntary participation by organisations in EMAS, the European Community's eco-management and audit scheme. The Regulation seeks to promote continuous improvements in the environmental performance of organisations by the establishment and implementation of environmental management systems, the systematic, objective and periodic evaluation of the performance of such systems, the provision of information on environmental performance, an open dialogue with the public and other interested parties and the active involvement of employees in organisations and appropriate training. The Regulation promotes the use of Best Environmental Management Practice (BEMP), defined as "the most effective way to implement the environmental management system by organisations in a relevant sector and that can result in best environmental performance under given economic and technical conditions". For this purpose, the European Commission's Joint Research Centre (JRC) develops two different documents describing the BEMPs for each sector: a concise Sectoral Reference Document (SRD) and a detailed Best Practice Report (BPR).

An organisation wishing to participate in EMAS must go through a procedure to obtain an accredited environmental verifier's approval of their environmental review, management system, audit procedure and statement. The validated statement is registered and made publicly available. An organisation successfully completing all stages may use the EMAS logo to demonstrate its commitment to improving its environmental performance.

The SRDs, as stipulated in Article 46.1 of the EMAS Regulation, briefly describe all the BEMPs identified for a specific sector in addition to the conditions under which they can be applied. An EMAS-registered organisation must take into account the relevant SRDs when assessing its own environmental performance. For each BEMP, the SRD also contains environmental performance indicators and benchmarks of excellence (EC, 2017). The presentation of each BEMP is structured as follows:

i. description;
ii. achieved environmental benefits;
iii. appropriate environmental indicators;
iv. cross-media effects;
v. operational data;
vi. applicability;
vii. economics;
viii. driving force for implementation;
ix. reference organisation; and
x. reference literature.

The BPRs constitute a more detailed and elaborate report presenting the results of the research conducted by the JRC for the production of a specific SRD. Organisations wishing to apply the BEMPs listed in a certain SRD are recommended to refer to the comprehensive guidance offered in the BPRs. Both the SRDs and the BPRs, including main draft versions, are publically available on the website of the JRC (http://susproc.jrc.ec.europa.eu/activities/emas/index.html), along with other relevant working documents for each sector.

SRDs are based on a cradle-to-grave approach and are designed for all actors along the value chain within a given sector and not only industrial facilities. In cases where an SRD and a BREF, published under the IED, have a similar scope, the SRD will refer to the BREF where possible, in addition to focusing on non-BREF areas such as environmental impacts from the whole life cycle, i.e. upstream and downstream in the value chain, as well as smaller installations.

4.4.2. Selection of sectors

Eleven sectors have so far been selected for elaboration of SRDs and BPRs. To date, SRDs have been published for three of the sectors, and BPRs for an additional five. Table 7 provides an overview of SRDs and BPRs that have been, or will be, developed.

Table 7. EU SRDs and BPRs

Sector	Type of document	Year of publication or status
Retail Trade	BPR	2013
	SRD	2015
Tourism	BPR	2013
	SRD	2016
Construction	BPR	2012
	SRD	in the adoption process
Public Administration	BPR	2015
	SRD	in the adoption process
Agriculture	BPR	2015
	SRD	in the adoption process
Food and Beverage Manufacturing	BPR	2015
	SRD	2017
Electrical and Electronic Equipment Manufacturing	BPR	2016
	SRD	in progress
Car manufacturing	BPR	2016
	SRD	in progress
Waste management	BPR	2018
Manufacture of Fabricated Metal Products	BPR.	in progress
Telecommunications	BPR	in progress

Source: EC, n.db.; JRC, n.d.

4.4.3. Information collection and evaluation of techniques

The development of SRDs and BPRs is overseen by the same JCR unit as the one in charge of producing BREFs under the IED. Applying a process similar to the *Seville Process*, JRC sets up sector-specific Technical Working Groups (TWGs) for the elaboration of the documents. However, there is no formal process for the nomination of TWG members such as under the IED. When elaborating an SRD, the JRC engages an

external contractor to prepare a background report to be used as a starting point for the identification of BEMPs.

Further information is gathered through literature review, direct contacts with organisations within the sector concerned, site visits and from the TWG members, who collect and evaluate information on the BEMPs. The JRC is responsible for organising the work of the TWGs by facilitating the exchange of information and conducting a scientific and technical analysis of the collected information. The JRC normally organises two TWG meetings for the elaboration of each document. In addition, the TWG members are requested to review draft versions of the documents several times.

4.4.4. Decision making process

Before being officially adopted by the European Commission, SRDs must be approved by representatives of EU Member States in the EMAS Committee. Once adopted, the SRDs are published in the Official Journal of the European Union and made available on the JRC's website. The BPRs are published by the JRC as JRC Scientific and Policy Reports.

4.5. Hydrocarbons sector: BAT reference document

4.5.1. Key features

The European Commission is currently developing a BREF on hydrocarbons exploration and extraction (EC, 2015b). The document will outline BAT already applied under economically viable conditions in the hydrocarbons sector, so as to help create a common understanding of high-level performance in the sector. The Hydrocarbons BREF is not directly linked to the implementation of a particular Directive, and will not result in a set of legally binding BAT Conclusions. The document will address installations linked to actual wells in the extractive oil and gas industry, i.e. the development and operation of offshore facilities or onshore well pads, including directly related activities such as onsite storage prior to distribution, but excluding delivery infrastructure such as pipelines. Notably, the BREF will concentrate on BAT to manage impacts of releases of pollutants and best risk management techniques to manage risks of releases of substances as a result of incidents for the purpose of protecting human health and the environment (EC, 2016a).

The Hydrocarbons BREF is considered an opportunity to create a level, predictable and transparent playing field for oil and gas activities, in order to help tackle public concerns associated with domestic oil and gas production and facilitate an exchange with and across competent authorities.

4.5.2. Information collection and evaluation of techniques

The procedure for development of the Hydrocarbons BREF is to a large extent based on the *Seville Process*, including an information exchange in a TWG consisting of representatives from Member States, the industries concerned and NGOs promoting environmental protection. However, the information exchange and the identification of BAT are facilitated by contractors engaged by the European Commission rather than by the JRC. The TWG kicked off its work in October 2015, including by establishing a sub-group in charge of gathering evidence on existing guidance on environmental issues for offshore activities. A second meeting of the TWG was held in October 2016. The review is still in progress (EC, 2016a).

4.6. Medium Combustion Plant Directive: report on best available, and emerging, technologies

In order to fulfil its obligations under the Medium Combustion Plant (MCP) Directive[4] (EU, 2015), the European Commission has committed to engage contractors to identify the environmental performances and costs of best available, and emerging, technologies used in medium combustion plants. The terms of reference for the project (EC, 2017b) were published in November 2017, stating that the contractor shall facilitate an information exchange process between EU Member States, the industries concerned, including operators and technology providers, NGOs promoting environmental protection and other relevant organisations. The objective of the information exchange will be to collect information on the environmental performance and costs of best available, and emerging, technologies for MCPs.

The contractor engaged by the European Commission will be relying on data collected through the information exchange and other means to indicate the emission levels and costs that can be associated with the use of best available, and emerging, technologies, before validating these through an information exchange Working Group. Furthermore, the contractor will be documenting any significant general potential of further reducing emission from new MCPs, the advantages and limitations of regulating CO and of setting minimum energy efficiency standards reflecting best available technologies under the MCP Directive. The information exchange and the contractor's conclusions on the environmental performance and costs of best available, and emerging, technologies for MCPs, will be summarised in a report.

4.7. Attributes and limitations

4.7.1. Attributes

Stakeholders highlight that the methodology for establishing BAT under the IED, i.e. the *Seville Process*, is proven and trusted. A prototype of the current information exchange started in 1997 with the elaboration of BAT for the iron and steel sector under the IPPC Directive (EU, 2008). Over the following 20 years, the BAT elaboration process has evolved to address shortcomings and to incorporate new working methods (e.g. IT). The current model reflects a myriad of incremental improvements that have been made over almost 50 completed information exchanges.

The approach is also very robust. It is a consensual system involving a wide range of stakeholders and based on the actual environmental performance of installations. The checks and balances provided by a diverse group of experts allows for the objective conclusion of BAT, whilst still giving opportunity for dissenting (spilt) views.

The methodology forces environmental improvement. The main outputs of the process (BAT Conclusions) become binding EU law and have tangible benefits for the environmental performance of EU installations since they become embedded in permits. This has driven a demonstrable reduction in the emissions from EU industry.

All the important stakeholders (governments, industries and NGOs) are involved and have the opportunity to take part in the debate. The discussions are based on technical data but take into account all relevant factors.

4.7.2. Limitations

The *Seville Process* can be very lengthy and resource intensive. For example, the revision of the BREF for Large Combustion Plants has involved a TWG of 289 people working for over five years. Whilst there will be significant environmental benefits from the application of this BREF, it is undeniable that considerable resource have been expended in getting to this stage.

The extensive time needed to write one BREF is in contradiction to the sometimes fast evolutions in technological developments. The legislation aims for BAT to be dynamic and for BREFs to be updated every eight years. In practice, this means that there will be a constant, rolling programme of BREF elaboration to reflect BAT advances, albeit not always every eight years. Combined with the lengthy time required to elaborate each sectoral BAT (see above), it is possible that step changes in BAT may not be best served by the current approach.

The BAT, as defined within the EU, aim only to control direct emissions from core industrial processes. Wider life cycle considerations are dealt with in other parts of the EU's environmental legislation. For example, the production of 'chemical X' would be constrained to use BAT, but the IED legislation would have no legal locus on whether the production of 'chemical X' was environmentally desirable per se. Thus, the identification of BAT under the IED considers just one component of the environmental impacts that can derive from anthropological activities.

Some stakeholders have sometimes stated that the process lacks transparency, notably with regards to how decisions concerning new BAT and BAT-AEL are taken. There is also a need for more in-depth discussions during the TWG meetings and the phyiscal limitations of meetings can restict this.

Notes

1 The Article 13 Forum is a formal expert group established by the European Union (2011), "Commission Decision of 16 may 2011 establishing a forum for the exchange of information pursuant to Article 13 of the Directive 2010/75/EU on industrial emissions", *Official Journal of the European* Union, C 146/3. The Forum is composed of representatives from Member States, industry and environmental NGOs. The Forum has a crucial role delivering opinion on the rolling work programme for the elaboration and review of BREFs and on the proposed content of the final draft BREFs. This last opinion has to be made publicly available by the European Commission and has to be taken into account for the purposes of adopting decisions on the BAT conclusions through the IED Article 75 Committee (see Footnote 11) (EC, n.d.a).

2 The Article 75 Commitee is a body established by Article 75(1) of the IED, assisting the European Commission in elaboration of implementing acts. The Committee is composed of the Member States and is chaired by the Commission. The Committee adopts decisions on BAT Conclusions (EC, n.d.a).

3 The Extractive Waste Directive (EU, 2006) provides measures, procedures and guidance for prevention and reduction of adverse effects on the environment (e.g. water, air, soil, fauna and flora and landscape), and to human health from the management of waste from the extractive industries (i.e. waste from on-shore extraction and processing of mineral resources). These measures should be based on the concept of BAT and the exchange of information in that policy.

4 The Medium Combustion Plant (MCP) Directive lays down rules to control air emissions of sulphur dioxide, nitrogen oxides and dust from medium combustion plants, as well as rules to monitor carbon monoxide emissions from these plants. Medium combustion plants are plants with a rated thermal input equal to or greater than 1 megawatt (MWth) and less than 50 MWth. The aim is to reduce emissions to air and the potential harm to human health and the environment from these plants. Emission limits values are set out in Annex II of the Directive. The emission limit values set in the MCP Directive will have to be applied from 20 December 2018 for new plants and by 2025 or 2030 for existing plants, depending on their size (EC, 2016b).

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Chapter 5. India: Procedures to develop comprehensive industry documents and national emission standards

This chapter presents India's standardised methodology for the setting of national emission standards – the MINAS – and explains how the development of industry-specific guidelines – the COINDS – fits into this procedure. The chapter also presents a set of other BAT-related programmes and documents.

5.1. Introduction

India does not operate with a BAT concept identical to that of other countries and regions such as the European Union, Korea and the Russian Federation. However, India has passed several rules, notifications and guidelines concerning the control and prevention of industrial pollution under the Pollution Control Law Series (CPCB, 2010), comprising the Water (Prevention and Control of Pollution) Act, 1974[1] (MoEF&CC, 1974), the Air (Prevention and Control of Pollution) Act, 1981[2] (MoEF&CC, 1981) and the Environment Protection Act (EPA), 1986[3] (MoEF&CC, 1986). This includes legally binding emission standards or discharge limit values specific to each industrial sector, with which industrial facilities must comply in order to obtain permission from the State Pollution Control Boards (SPCBs) or Union Territory Pollution Control Committees (UTPCCs) to operate. The industry-specific emission standards or discharge limits are called Minimal National Standards (MINAS).

The MINAS, by definition, are techno-economically norms achievable by the industry, constituting quantitative limit values for the emission of pollutants into the environment, including air pollutants emitted from stacks, fugitive emissions and water pollutants in wastewater. Techniques for prevention and control of chemical pollution from industries (often termed Best Techno-Economically Available Techniques, rather than BAT) are considered as part of the development of the MINAS, and in many cases presented in the accompanying Comprehensive Industry Documents Series (COINDS), which constitutes a set of sector-specific guidelines. While the COINDS often are developed as part of the process to set the MINAS, they may also be developed at a later stage. In some cases, guidance on techniques for prevention and control of pollution is also included in the MINAS. This chapter describes the commonly used methodology to develop MINAS and COINDS. The methodology is not embedded in a legal document and may vary slightly on a case-by-case basis.

5.2. Minimal National Standards (MINAS) and the Comprehensive Industry Document Series (COINDS)

5.2.1. Key features

MINAS

The Central Pollution Control Board (CPCB) has developed MINAS for 103 sectors. The majority of the MINAS were published under The Environment (Protection) Rules of 1986, while some were developed or revised over the period 2011-2017. The MINAS are available on CPCB's website (http://cpcb.nic.in/effluent-emission/).

Developing a MINAS normally takes two to three years. The driving force behind the development of a new MINAS or the revision of an existing one can be the availability of new technologies for improvement in prevention, control, and abatement of pollution. The public pressure generated by civil society organisations or NGOs also plays an important role in raising environmental issues which could be addressed by revised or new MINAS.

COINDS

The COINDS are a series of comprehensive documents designed to summarise the status of specific industrial sectors in the country, and make reference to the MINAS applicable

to each sector. The CPCB has published COINDS for 37 sectors. Most of these are available on CPCB's website (http://cpcb.nic.in/publication-details.php?pid=Mw). Only a few of the documents are available in their entirety for free; most of the others can be purchased.

The COINDS generally include information on manufacturing plants of a specific type of industry being operated in the country, with information on the location and manufacturing capacity of each plant. Furthermore, the COINDS include a description of the type of products manufactured in the sector, the raw materials used, existing manufacturing processes, an estimation of the quantity of pollutants generated by the industry and a description of the techniques and measures used for prevention and control of pollution including waste generation.

For example, the COIND On Electric Arc and Induction Furnaces (CPCB, 2010), outlines the background of steel manufacturing in the country, future scenarios for the Indian steel manufacturing industry, processes involved in steel manufacturing, sources of pollution, data from a field study showing the results of environmental monitoring in the sector, emission monitoring results, pollution control technologies used in the industry, the MINAS for the steel industry and good practices for pollution control.

The technologies and processes for prevention, control, and abatement of pollution presented and discussed in the COINDS constitute guidelines; they are not legally binding for industry operators. Industry operators are free to use any technologies in the manufacturing process as well as for prevention, control, and abatement of pollution, provided they meet the MINAS or other norms or standards prescribed by the SPCBs or UTPCCs. However, industry operators are obliged to inform the State Pollution Control Board (SPCB) whenever they change manufacturing processes or technologies, including pollution control technology or equipment.

5.2.2. Selection of sectors

CPCB initiates and prioritises the sectors for which MINAS and COINDS are to be developed, based on the sectors' growth or pollution potential, i.e. their pollution contribution or impacts, and the availability of better production and pollution control technologies. Table 8 lists the industries, activities and pollutants for which MINAS have been published and Table 9 lists all the available COINDS. These include several that apply to the three target sectors (see Annex A for more information on the target sectors). For the majority of the COINDS, the serial number (document code) and year of publication are not available. Hyperlinks for each of the documents are not available.

In addition to having developed a MINAS and a COIND for the textiles industry, CPCB has recently issued a regulation aiming for facilities to attain a zero liquid discharge target, i.e. that no effluents are discharged into environment by industry. Consequently, the Indian textile industries are currently in the process of adopting techniques through which this target can be met.

Table 8. Published MINAS

Industrial sector/activity or source of pollution	Year of publication
Caustic Soda Industry	1986
Man-Made Fibres (Synthetic)	1986
Petroleum Oil Refinery	1986
Sugar Industry	2016
Thermal Power Plants	2015
Cotton Textile Industries (Composite and Processing)	2016
Dye and Dye Intermediate Industry	2014
Electroplating Industries	2012
Cement Plants with co-processing	2016
Cement Plants with without co-processing	2016
Coke Ovens (not available online)	2012
Synthetic Rubber	1986
Small Pulp and Paper Industry	1986
Fermentation Industry (Distilleries, Maltries and Breweries)	1986
Leather Tanneries	1986
Fertilizer Industry	1986
Iron Ore Mining and Ore Processing	2010
Calcium Carbide	1986
Carbon Black	1986
Copper, Lead and Zinc Smelting	2011
Nitric Acid (Emission Oxides of Nitrogen)	1986
Sulphuric Acid Plant	1986
Iron & Steel (Integrated)	2012
Thermal Power Plants	1986
Natural Rubber Industry	1986
Asbestos Manufacturing Units	1986
Chlor Alkali (Caustic Soda)	1986
Large Pulp and Paper	1986
Integrated Iron and Steel Plants (not available online)	n.a.
Re-Heating (Reverberatory) Furnaces	1986
Foundries	1986
Thermal Power Plants	1986
Small Boilers	1986
Coffee Industry	1986
Aluminium Plants	1986
Stone Crushing Unit	1986
Petrochemicals (Basic & Intermediates)	2012
Hotel Industry	1986
Pesticide Manufacturing and Formulation Industry	2011
Tannery (After Primary Treatment)	1986
Paint Industry (Waste Water Discharge)	1986
Inorganic Chemical Industry (Waste Water Discharge)	1986
Bullion Refining (Waste Water Discharge)	1986
Dye & Dye Intermediate Industry (Waste Water Discharge)	1986
Noise Limits for Automobiles (Free Field)	1986
Domestic appliances and Construction Equipments at the manufacturing stage	1986
Glass Industry	1986
Lime Kiln	1986
Slaughter House, Meat & Sea Food Industry	2016
Food and Fruit Processing Industry (not available online)	n.a.
Jute Processing Industry (not available online)	n.a.
Large Pulp & Paper News Print/Rayon Grade Plants of [Capacity above 24000 MT Per Annum]	1986
Small Pulp and Paper (Paper Plant of Capacity up to 24000 MT /Annum)	1986
Common Effluent Treatment Plants	2016
Dairy	1986
Tanneries	1986
Natural Rubber Processing Industry	2011

Bagasse-Fired Boilers	1986
Man-made Fibre Industry (Semi-Synthetic)	1986
Ceramic Industry	1986
Viscose Filament Yarn	1986
Starch Industry	1986
Beehive Hard Coke Oven	1986
Briquette Industry (Coal)	1986
Soft Coke Industry	1986
Edible Oil & Vanaspati Industry	1986
Organic Chemicals Manufacturing Industry	2010
Flour Mills, Grain processing, Paddy processing, pulse making or Grinding mills	2012
Boilers (Small)	1986
Pesticides Industry (not available online)	n.a.
Oil Drilling and Gas Extraction Industry	1986
Pharmaceutical (Manufacturing and Formulation) Industry	1986
Brick Kilns	1986
Soda Ash Industry (Solvay Process)	2011
SO2 from Cupola Furnace	1986
Specifications of Motor Gasoline for Emission related parameters	1986
Specification of Diesel Fuel for Emission related Parameters	1986
Coke Oven Plants	1986
Specifications of Two-Stroke Engine Oil	1986
Battery Manufacturing Industry	1986
Gas/Naphtha-Based Thermal Power Plants	1986
Control of Noise Pollution from Stationary Diesel Generator (DG) Sets (omitted) (not available online)	n.a.
Temperature Limit for Discharge of Condenser Cooling water from Thermal power plant	1986
Coal Washeries	1986
Water quality Standards for Coastal Waters Marine Outfalls	1986
Rayon Industry	1986
New Generator Sets (up to 19 KW run on) Petrol and Kerosene with implementation Schedule	2013
Noise Standards for Fire Crackers	1986
Coal Mines	1986
Noise Limit for Generator Sets run with Petrol or Kerosene (not available online)	n.a.
Primary Water Quality Criteria for Bathing Water	1986
Noise Limit for Generator Sets run with Diesel	1986
Emission Limits for New Diesel Engines (up to 800 KW) for Generator Sets Applications	2013
Emission Standards for Diesel Engines (Engine Rating more than 0.8 MW (800 KW) for Power Plant.	2002
Boilers using Agricultural Waste as Fuel	1986
Guidelines for Pollution Control in Ginning Mills	1986
Sponge Iron Plant (Rotary Kiln)	2008
Common Hazardous Waste Incinerator	1986
Incinerator for Pesticide Industry (not available online)	n.a.
Refractory Industry	1986
Cashew Seed Processing Industry	1986
Plaster of Paris Industry	1986
Composite Woolen Mills	1986

Source: CPCB, n.d.a

Table 9. Available COINDS

Title	Document code	Year of publication
Guidelines for (i) Siting of rice shellers/mills, (ii) handling and storage of rice husk and (iii) handling, storage and disposal of ash generated in boiler using rice husk as fuel	COINDS/82/2012-13	2012
Comprehensive Industry Document on Electric Arc and Induction Furnaces	COINDS/80/2009-10	2010
Comprehensive Industry Document on Stone Crushers	COINDS/78/2007-08	2009
Comprehensive Industry Document on Tea Processing Industry (not available online)	COINDS/72/2006-07	2007
Development of Standards for Rubber Products Manufacturing Industry	COINDS/67/2007	2007
Comprehensive Industry Document on Sponge Iron Industry (not available online)	COINDS/66/2006-07	2007
Comprehensive Industry Document on Iron Ore Mining	COINDS/__/2007-08	2007
Comprehensive Industry Document on Man-Made Fibre Industry (only foreword available for free)	n.a.	n.a.
Comprehensive Industry Document on Oil Refineries (only foreword available for free)	n.a.	n.a.
Comprehensive Industry Document on Chlor-Alkali Industry (abridged) (only foreword available for free)	n.a.	n.a.
Comprehensive Industry Document on Sugar Industry (only foreword available for free)	n.a.	n.a.
Comprehensive Industry Document on Fermentation Industries (only foreword available for free)	n.a.	n.a.
Comprehensive Industry Document on Lime Kilns Industry (only foreword available for free)	n.a.	n.a.
Comprehensive Industry Document on Gas-based Thermal Power Plant (only foreword available for free)	n.a.	n.a.
Comprehensive Industry Document on Brick Kilns (not available online)	n.a.	n.a.
Comprehensive Industry Document for Small Pulp and Paper Industry (only foreword available for free)	n.a.	n.a.
Comprehensive Industry Document on Integrated Iron & Steel Plants (only foreword available for free)	n.a.	n.a.
Comprehensive Industry Document on Integrated Aluminium Industry (Emission Control) (only foreword available for free)	n.a.	n.a.
Comprehensive Industry Document for Large Pulp and Paper Industry (only foreword available for free)	n.a.	n.a.
Comprehensive Industry Document on Slaughter House, Meat and Sea Food Processing (only foreword available for free)	n.a.	n.a.
Comprehensive Industry Document on Edible Oil & Vanaspati Industry (only foreword available for free)	n.a.	n.a.
Comprehensive Industry Document on Dairy Industry (only foreword available for free)	n.a.	n.a.
Comprehensive Industry Document on Glass Industry (not available online)	n.a.	n.a.
Comprehensive Industry Document on Starch and Glucose (Maize Processing) Industry (only foreword available for free)	n.a.	n.a.
Comprehensive Industry Document on Ceramic Industry (only foreword available for free)	n.a.	n.a.
Comprehensive Evaluation of Treatment Technology for Cement Industry (not available online)	n.a.	n.a.
Comprehensive Industry Document on Fertilizer Industry (only foreword available for free)	n.a.	n.a.
Comprehensive Industry Document on Spent Pot Lining Waste from Aluminium Industry (only foreword available for free)	n.a.	n.a.
Comprehensive Industry Document on Soft Drink Manufacturing Unit, Bakeries and Confectioneries (not available online)	n.a.	n.a.
Comprehensive Industry Document on Rice Mills (only foreword available for free)	n.a.	n.a.
Comprehensive Industry Document on Fruit and Vegetable Processing Industry (not available online)	n.a.	n.a.
Comprehensive Industry Document on Asbestos Products Manufacturing Industry (not available online)	n.a.	n.a.
Comprehensive Industry Document on Textile Industries	n.a.	n.a.
Comprehensive Industry Document on Coffee Processing Industry	n.a.	n.a.
Comprehensive Industry Document on Ginning Industry (not available online)	COINDS/63/2006-07	n.a.
Comprehensive Industry Document Khandsari (Sugar Industry) (only foreword available for free)	n.a.	n.a.

Source: CPCB, n.d.b

5.2.3. Information collection and evaluation of techniques

MINAS

When a sector has been prioritised for development or revision of a MINAS, CPCB constitutes an industry-specific Task Force of about 20 members, consisting of representatives from CPCB, the Ministry of Environment, Forests and Climate Change (MoEF&CC) and other concerned ministries, SPCBs, the relevant industry, academic institutes and think tanks. Instructed by the Task Force, the concerned division(s) of CPCB develops a draft of the new or revised MINAS. At this stage, CPCB often takes support from an external expert or research institute for the preparation of a background document which includes an analysis of the level of enforcement of existing MINAS and issues driving the revision of these. The external consultant also assesses the availability of new technologies, reviews international standards and practices and proposes standards for the draft MINAS.

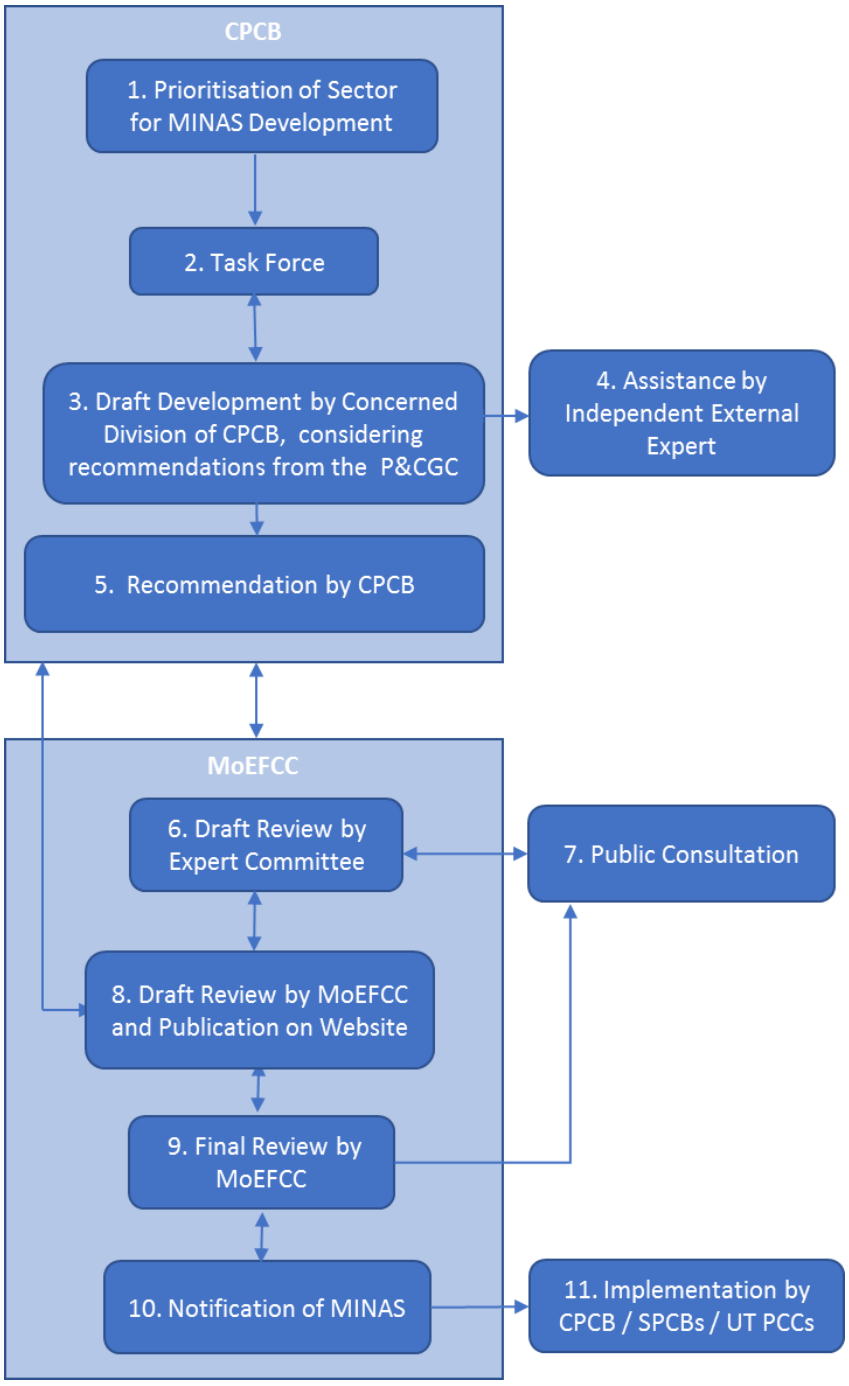
Subsequently, the Task Force meets and discusses the draft, taking into consideration all aspects and its expected benefits in terms of pollution control, environmental impacts, and economic costs to the industries. The draft is also shared with the Peer and Core Group Committee (P&CGC), a separate expert group established by CPCB, which reviews the draft and provides feedback and recommendations. The members of the P&CGC are from academic and research institutions, MoEF&CC, CPCB, and representatives from industries and business organisations, relevant ministries, and independent consultants including medical doctors and health professionals. While the Peer Group is sector-specific, just like the Task Force, the Core Group spans across multiple sectors, enabling its members to ensure the harmonisation of MINAS pertaining to different industries.

Based on recommendations provided by the P&CGC, the Task Force reviews the draft MINAS once more, before sending the document to MoEF&CC, where it is examined by the Control of Pollution Division. Once the Ministry approves the draft, the document is uploaded on the Ministry's website for 30-60 days of public consultation. All stakeholders, including the common public, are invited to submit their comments and observations on the draft. The feedback received during the public consultation is examined by the Ministry's Expert Committee, comprising representatives of MoEF&CC and other relevant ministries, CPCB, industry associations, including the Confederation of Indian Industry (CII), the Bureau of Indian Standards (BIS) and others, before being forwarded to CPCB for final revision.

After CPCB's final amendments of the draft MINAS, the document is once again reviewed by the MoEF&CC's Expert Committee. As soon as all their comments are addressed, the draft MINAS is approved by the MoEF&CC and sent to the Law Ministry for vetting.

Figure 1 illustrates the development process for the MINAS, as described above. The model is inspired by Ricardo et al. (2016), who have reviewed and described the processes for setting of emission standards in India in detail.

Figure 1. Procedure for setting of MINAS



Source: Developed by the authors, inspired by Ricardo et al., 2016

COINDS

The collection of information and evaluation of techniques for the development of the COINDS is overseen by CPCB; these processes may be (partially) integrated into those for the setting of MINAS. The means used for information collection for the COINDS may include sector-specific questionnaires, stakeholder meetings and literature review, including of BAT documents from other countries and regions, such as the EU BAT Reference Documents. In some cases, CPCB and SPCB officials carry out inspections of industrial facilities in order to gather information pertaining to products manufactures, processes involved in manufacturing, identification of pollution sources, including monitoring of emissions or discharge, pollution control technologies and equipment installed in the facilities as well as good practices for pollution control. Data may also be gathered from other environmental and administrative officers, business operators, industry associations, companies, technology suppliers and – as and when required – NGOs.

Furthermore, CPCB seeks assistance from an external expert or agency, such as a research institute or a think tank, as and when required, for the collection of background information, the development of relevant sector-specific studies, and drafting of the COINDS. For example, Punjab State Council for Science & Technology assisted in the development of the Comprehensive Industry Document for the electric arc and induction furnaces industry (CPCB, 2010), M/S Consulting Engineering Services assisted in the development of the Comprehensive Industry Document for the rubber products manufacturing industry (CPCB, 2007), the National Productivity Council assisted in the development of the Comprehensive Industry Document on stone crushers (CPCB, 2009), and the Federation of Indian Chambers of Commerce and Industry assisted in the development of the comprehensive industry document for siting of rice shellers/mills, handling and storage of rice husk and handling, storage and disposal of ash generated in boiler using rice husk as fuel (CPCB, 2012).

The development of the COINDS does in many cases include the assessment of advanced and well-known techniques, although not in a standardised manner. This is done by CPCB and relevant experts nominated by CPCB. The following criteria are normally considered when assessing the techniques, with reference to each other so that a balance is maintained:

Technical aspects

When assessing techniques, technical aspects are considered the most important. The implementation and operation of the technique must be techno-economically feasible under the Indian conditions.

Economic aspects

Economic aspects are also considered, notably the cost of introducing the techniques to industry operators. However, it is expected from the industry operators that they adopt suitable techniques for control and prevention of chemical pollution regardless of any economic burden incurred, as per criteria prescribed under the MINAS.

Environmental benefits

When assessing the environmental benefits of various techniques, both a top-down approach (i.e. starting from a general list of aspects and pollutants for all industrial sector

and selecting those that are most relevant) and a bottom-up approach (i.e. selecting relevant aspects and pollutants for a certain sector based on monitoring and experiences), in addition to expert judgement, are considered.

Quality aspects

Stakeholders reported that plant size, capacity, quantity and type of products manufactured, climate conditions and type of fuels and raw materials all may be taken into account in the assessment of techniques. Safety is considered on a case-by-case basis, while no consideration is taken of animal welfare.

Social aspects

Social aspects are not considered as part of the development of the COINDS. However, during the consideration of environmental aspects, related social issues also get captured. But whenever a new industrial facility is established, an environmental impact assessment is carried out, involving public consultations. This allows for social issues to be brought up. Social issues may also be brought up during the development of the MINAS.

5.2.4. Data handling

The data considered for and used in the MINAS and the COINDS are collected, collated, and processed by the CPCB in consultation with SPCBs and other stakeholders.

5.2.5. Decision making process

CPCB finalises the draft MINAS, before submitting them to the MOEF&CC for approval. Subsequently, the documents are sent to the Law Ministry for vetting. After approval from the Law Ministry, the MINAS is notified in the Gazette of India, which is the public journal of the Central Government for the publication of authorised legal documents, and becomes legally binding. Implementation of the MINAS will subsequently take place, overseen by CPCB, the SPCBs and the UTPCCs. As for the COINDS, these are prepared and approved by CPCB, which has the authority to publish this document series.

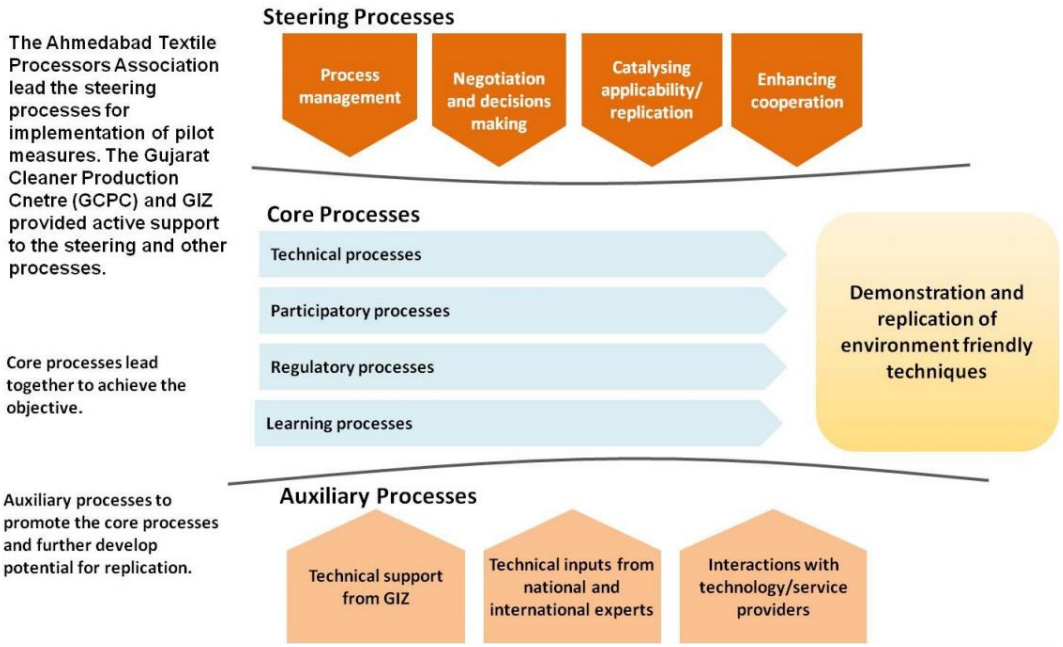
5.3. A local example of BAT development: The Indo-German Environment Partnership in Gujarat

The Indo-German Environment Partnership (IGEP) has initiated a BAT programme in the state of Gujarat. The programme is the result of a collaboration between the Gujarat SPCB, the German Federal Environment Agency and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), and is manifested in the Joint Declaration of Intent for Promotion of Best Available Techniques (BAT) not Entailing Excessive Cost (IGEP, n.d.). The Gujarat Cleaner Production Centre (GCPC) has also been involved in the partnership.

The IGEP programme for BAT has resulted in a set of guidelines, of various nature and for different industrial activities and sectors, including the dairy sector, ceramic sector, bentonites manufacturing industry, pulp and paper sector, textile sector and wastewater treatment. The documents can be accessed on the GCPC's website (http://gcpcgujarat.org.in/publication/).

The methodology for the determination of BAT under the IGEP programme is illustrated by Figure 2, using the example of the textile sector. In line with this methodology, GIZ establishes three stakeholder groups: key stakeholders, primary stakeholders and secondary stakeholders. Primary stakeholders include volunteering textile industries in Ahmedabad. Secondary stakeholders consist of international consultants of GIZ, experts of the German Federal Environmental Agency, service providers and technology providers to the textile industry as well as textile companies in the city of Surat. The leading industry (in this example, the Ahmedabad Textile Processors Association) is in charge of the steering processes. NGOs are not part of the process.

Figure 2. Steering process for the reference document on the textiles Industries under the IGEP programme



Source: Nukala et al., 2015

GIZ is responsible for the gathering of data on techniques for prevention and control of industrial emissions; this takes place at two levels: Desktop research is done by the consultant and different in-depth studies are done by the volunteering companies. In the example shown in Figure 2, the Ahmedabad Textile Processors' Association identified industries that volunteered to participate in the pilot activity and that were willing to implement pilot measures. A detailed study was undertaken by GIZ and GCPC in the representative units that volunteered. The GIZ team initially carried out preliminary investigations in representative textile industries of Ahmedabad and later attempts were made to achieve *material balance* in each of the industries, i.e. to identify material usage, wastes and waste water generated, the efficiency of unit operations, etc. However, as this was not easy to accomplish due to lack of proper monitoring systems, desk research was carried out to qualify and quantify the material balance.

Ahead of the data gathering process, a workshop, where representatives of the industry, the Government, technology providers, universities and research organisations are present, is organised. This workshop aims at identifying the core issues associated with

environmental improvements and identifying actions needed for enabling improved performance in the sector.

5.4. Other BAT-related initiatives

5.4.1. National Ambient Air Quality Standards (NAAQS)

The NAAQS were developed in 1984 and are divided into four area categories: industrial, residential, rural and others. As a result of the 2009 revision of the standards, the area categorisation was replaced by area demarcations, such as ecologically sensitive, incorporating separate norms for a few parameters (Gazette of India, 2009). The parameters included in the NAAQS are Sulphur Dioxide (SO2), Nitrogen Dioxide (NO2), Particulate Matters (PM10 and PM2.5), Ozone (O3), Lead (Pb), Carbon Monoxide (CO), Ammonia (NH3), Benzene (C6H6), Benzo(α)pyrene, Arsenic (As), and Nickel (Ni) with associated methods of measurement. CPCB oversees the testing of air quality and assists governments in their planning to meet the NAAQS. For setting or revising the NAAQS, CPCB engages an academic/research institute to carry out background work that involves review of criteria and standards, current levels of pollutants in ambient air, studies on health effects of air pollutants, etc. A steering committee consisting of experts from academia, research institutes, and others is set up to review the methodology and progress of the work in CPCB. The draft standards are circulated to NGOs, industry association, SPCBs, and other stakeholders for public opinion. The standards draft is also uploaded on the CPCB's website. The Steering Committee discusses the comments and incorporates them in the draft of standards. Prior to notification, draft standards are again reviewed by the P&CGG.

5.4.2. Continuous Emission Monitoring Systems

CPCB has recently established the Continuous Emission Monitoring System (CEMS) and Continuous Effluent Quality Monitoring Systems (CEQMS) for real-time pollution monitoring and reporting for 17 highly polluting industries, including aluminium, cement, chlor-alkali, copper, distilleries, dye and dye-intermediates, fertilisers, iron and steel, oil refineries, pesticides, petrochemical, pharmaceutical, power plant, pulp and paper, sugar, tanneries and zinc (CPCB, n.d.c). Real-time monitoring is also mandated in common pollution treatment facilities like solid and hazardous waste incinerators, bio-medical waste incinerators, Common Effluent Treatment Plants (CETP), etc. The grossly polluting industries, generating 100 kg or more biochemical oxygen demand (BOD) per day and discharging into River Ganga, have also been mandated to install CEQMS. The CPCB and respective SPCBs are receiving real-time monitoring data at the control room situated in their premise. If the concentration of pollutants exceeds the discharge/emission limit, the industry operator receives an SMS alert. If the number of SMS'es exceeds a certain number, CPCB and SPCB pay a visit to the concerned industrial facility for inspection of functions of emission control equipment and treatment facilities.

5.4.3. Corporate Responsibility for Environmental Protection

MoEF&CC launched the Charter on Corporate Responsibility for Environmental Protection (CREP) (CPCB, 2003) in 2003 with the purpose of going beyond compliance with regulatory norms for prevention and control of pollution through various measures including waste minimisation, in-plant process control and adoption of clean technologies. However, the CREP is not a legally binding but more of a mutual agreement between industries and regulatory bodies. The Charter has defined targets

concerning conservation of water, energy, recovery of chemicals, reduction in pollution, elimination of toxic pollutants, processing and management of residues that are required to be disposed of in an environmentally sound manner. The Charter listed action points for pollution control for various categories of highly polluting industries. An industry-specific task force has been constituted to monitor the progress of the implementation of the action points.

5.4.4. Comprehensive Environmental Pollution Index (CEPI) and categorisation of industries

CPCB launched the Comprehensive Environmental Pollution Index (CEPI) in 2009. The index, which was revised in 2016, is based on a nation-wide environmental assessment of industrial clusters. CEPI assigns a number between 0 and 100 to all industrial clusters, characterising the environmental quality of their operations, i.e. their impact on air, water, land, health and ecology, and colour-code them based on their score: red for facilities scoring between 60 and 100; orange for those scoring between 30 and 59; green for those scoring between 21 and 40; and white for those scoring under 21 (ENVIS, 2016). Using CEPI, CPCB assessed the pollution levels in 88 industrial clusters and identified 43 critically polluted areas in 2010. These areas were banned for new industrial set-up or expansion until the respective SPCBs prepare a mitigation action plan for improvement of the environmental quality.

5.5. Attributes and limitations

5.5.1. Attributes

Stakeholders report that a key success factor of the current system is that only the MINAS are legally binding, while the COINDS simply constitute guidelines, allowing industrial facilities to choose the pollution abatement techniques that are best suited to their conditions.

5.5.2. Limitations

Stakeholders report that as a result of the focus on emission/discharge standards, rather than on abatement techniques, industrial facilities primarily have an end-of-pipe approach to emissions reduction, and that process-integrated techniques often are neglected. Some stakeholders suggested that India should have more load-based standards for more sectors.

Further challenges include inadequate and poor data, lack of intensive monitoring and little information about new techniques is available to industry operators.

There is a general understanding of the need to develop BAT among Indian environmental policy makers. However, stakeholders suggested that if BAT are to be developed in India in the near future, these should not be legally binding, but remain guidelines given that compliance with emission standards continues being a legal requirement.

Notes

1 The Water (Prevention and Control of Pollution) Act, 1974, formed the Central Government's first real attempt to address environmental issues, setting out to "provide for the prevention and control of water pollution and the maintaining or restoring of wholesomeness of water". Furthermore, it included a provision to establish the Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs). The Water (Prevention and Control of Pollution) Cess Act, 1977, (MOEF&CC, 1977) was passed in order to ensure the collection of a cess on water consumption from industries, as a means to provide increased resources to CPCB and SPCBs.

2 The Air (Prevention and Control of Pollution) Act, 1981, sets out to ensure the prevention, control and abatement of air pollution, including by setting National Ambient Air Quality Standards (NAAQS). The Act was amended in 1987.

3 The Environment Protection Act (EPA), 1986, empowers the Central Government to establish authorities with the mandate to prevent environmental pollution in all its forms and to tackle specific environmental problems that are peculiar to different parts of the country. EPA oversees the handling of hazardous substances.

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Chapter 6. The People's Republic of China: A standardised methodology to identify available technologies

This chapter presents the People's Republic of China's standardised approaches to elaborate sector-specific Guidelines on Available Technologies of Pollution Prevention and Control (GATPPCs) and environmental standards, including emission limit values. These approaches are currently being introduced. Furthermore, the chapter explores the features of the Chinese government's Integrated, Intelligent and International Platform for Environmental Technologies (3iPET), in addition to a few other selected BAT-related initiatives.

6.1. Introduction

In the People's Republic of China (hereafter 'China'), the policies to prevent and control industrial emissions are based on legally binding environmental standards, in addition to a series of non-binding Guidelines on Available Technologies of Pollution Prevention and Control (GATPPCs), currently available for close to thirty industrial sectors. These guidelines include information both on emission limit values (ELVs) and on available techniques for pollution prevention and control. The ELVs are also presented in separate documents.

Before 2006, Best Practicable Technologies (BPTs) were examined all across China. Under the Eleventh Five-Year Plan, in effect during the period 2006-2010, the country established its Environmental Technology Management System. As a result, the Ministry of Ecology and Environment (MEE) (previously the Ministry of Environmental Protection) set up a BAT determination system (Liu and Wen, 2012). The development of BAT was piloted in sectors such as thermal power, iron and steel industries. Several government departments carried out research on foreign environmental technologies, especially from the Unites States and the European Union. An extended stakeholder consultation was carried out to identify the status of environmental protection technologies nationwide.

Despite these efforts, experts concluded that the technical information collected was not comprehensive enough and pointed out that there was a lack of mechanisms to promote innovative technologies. Therefore, the BAT screened out at that time were not effective in guiding technology development (Wang et al., 2013).

For these reasons, the Government now focuses on enforcing legally binding environmental standards, rather than specific techniques. The Environmental Protection Law[1] introduces two types of national standards: ambient environmental quality standards and discharge or emission limit values (ELVs). Quality standards are defined as maximum allowable concentrations of pollutants in air, water or soil. Emission or discharge limit values are defined as maximum allowable concentrations of pollutants in industrial emissions or discharges. In addition, both the specific Law on Prevention and Control of Water Pollution[2] and the Atmospheric Pollution Prevention and Control Law[3] foresee ELVs that take into account quality standards and economic and technological conditions. Under the Law on Prevention and Control of Water Pollution, state quality standards for the water environment and for the discharge of water pollutants shall be established at the central and local level by the competent authorities. As of 2008, industry-specific discharge limit values under this law apply generally, replacing the general set of water pollutant discharge standards from the Integrated Waste Water Discharge Standard of 1996.

Under the Thirteenth Five-Year Plan (2016-2020), there is also a focus on promoting, demonstrating and facilitating the application of pollution prevention and control technologies. As a consequence, BAT non-enforceable guidelines – the GATPPC – and accompanying support documents have been, and are currently being, developed. The GATPPCs serve as technical input towards ensuring compliance with the ELVs. The main purpose of the guidelines is to promote the implementation of the country's technical basis for a discharge permit system (Wang, 2016), accelerate the development of the Environmental Technology Management System, promote the technological progress of pollution prevention and control in relevant industries, take more evidence-based environmental management decisions as well as to guide the development of the

environmental protection industry. There is a general perception that the GATPPCs provide an indication of whether a defined ELV is achievable.

Until recently, China did not have an approved, standardised methodology for the procedure of evaluation of techniques and selection of techniques for the GATPPCs. However, as of 2017, the Government seeks to enhance and standardise the development of GATPPCs as well as of environmental standards. The Administrative Regulations for Revisions of Environmental Protection Standards (MEE, 2017a) entered into force in February 2017, replacing a set of similar regulations from 2006 (MEE, 2006), and provides a framework for the administrative procedures to set up and amend environmental standards, including ambient environmental quality standards and discharge or emission limit values, as well as managerial and monitoring standards. The Development Guideline for Guidelines on Available Techniques of Pollution Prevention and Control (MEE, 2018), which was adopted in January 2018, applies specifically to the GATPPCs and outlines a procedure for the development of these guidelines, consisting of three phases. Both documents were developed based on the Environmental Protection Law, Standardisation Law, Air Pollution Control Law and Water Pollution Control Law. The enforcement of the procedures described in the documents is taking place gradually.

Other existing initiatives of relevance to BAT include the eco-product certification spearheaded by the China Environmental Protection Industry Association as well as the Environmental Technology Verification organised by the Chinese Society for Environmental Sciences.

6.2. Guidelines on Available Technologies of Pollution Prevention and Control

6.2.1. Key features of the GATPPCs

The GATPPCs are non-binding guidelines providing technical guidance aimed at facilitating the enforcement of ELVs. All the GATPPCs are published in Chinese and are not available in any other language. The documents can be accessed through MEE's website (http://websearch.mep.gov.cn/was5/web/search?searchscope=&timescope=&orderby=&timescopecolumn=&s_time_1=&s_time_2=&e_time_1=&e_time_2=&channelid=233948&andsen=&total=&orsen=&exclude=&templet=&token=&searchword=%E6%9C%80%E4%BD%B3%E5%8F%AF%E8%A1%8C%E6%8A%80%E6%9C%AF). The MEE's website in English (http://english.sepa.gov.cn/Resources/standards/others1/) contains information on the GATPPC for the pulp and paper industry as well as on other environmental standards.

The structure of the GATPPCs varies according to the sector. In general, the guidelines present ELVs pertaining to the concerned sector as well as a list of available technologies for pollution prevention and control. Eight out of 19 finalised GATPPCs use the term BAT, while the remaining 11 simply refer to available technologies. For some industrial sectors, e.g. the pulp and paper and cement industries, the currently available draft for comments is entitled "Best Available Technologies" while the final version is entitled "Available Technologies". All the GATPPCs include a list of evaluation criteria, or indicators, used to identify BAT or available technologies; these also vary across sectors. The enforcement of the Development Guideline for GATPPCs is expected to lead to a standardisation of the content of development of GATPPCs across sectors. For example, the Development Guideline states that the information on the available technologies for pollution prevention and control should include the following elements:

i. Mechanism, operation and effectiveness of the technique (with respect to technical parameters and quantities of emission);
ii. industries to which it can be applied;
iii. rate and amount of emission reduction, in relation to ELVs (i.e. specify how the technique can help achieve emission standards);
iv. environmental impacts of the technique, such as any pollutants generated; and
v. cost of the technique.

Furthermore, the Development Guideline presents an outline for the content of the GATPPCs to be developed over the period 2018-2019 (see table 10). The outline distinguishes between techniques for pollution control, BAT and new techniques.

Table 10. Contents of Guidelines of Available Technologies for Pollution Prevention and Control

No.	Chapter
1	Title page
2	Table of contents
3	Abstract
4	Scope
5	Laws/regulations/documents in compliance with the guidelines
6	Terminologies
7	Manufacturing process and pollutants released
8	Techniques for pollution control
9	Best Available Techniques
10	New techniques
11	Informative appendix
12	Normative appendix
13	References

Many GATPPCs also contain an overview of the association between ELVs and available techniques for pollution prevention and control. Table 11 provides an example of this, showing an extract from the GATPPC on Thermal Power Plants (MEE, 2017b), listing ELVs associated with NO_x Removal Technologies.

Table 11. ELVs listed in the GATPPCs for thermal power plants

Method of combustion	Type of coal		Capacity of boiler (MW)	NOx ELV for furnace (mg/m3)	Available technologies to meet the ELV	
					Emission ≤200 mg/m3	Emission ≤100 mg/m3
Tangential combustion		Luster	All	950	SCR(2+1)	SCR(3+1)
		Lean coal		900		
	Bituminous coal	20%≤Vdat ≤28%	≤100	400	SCR(1+1) or +SNCR	SCR(2+1)
			200	370		
			300	320		
			≥600	310		
		28%≤Vdat ≤37%	≤100	320		
			200	310		
			300	260		
			≥600	220		
		37%<Vdat	≤100	310		
			200	260		
			300	220		
			≥600	220		
		Lignite	≤100	320		
			200	280		
			300	220		
			≥600			
Horizontal combustion		Luster				n.a.
		Lean coal	All	670	SCR(2+1)	SCR(3+1)
	Bituminous coal	20%≤Vdat ≤28%		470		
		28%≤Vdat ≤37%		400	SCR(1+1) or +SNCR	SCR(2+1)
		37%<Vdat		280		
		Lignite		280		
W-shape flame		Luster		1000	SCR(3+1)	SCR(4+1)
		Lean coal		850		
CFB		Bituminous coal/lignite		200		SNCR
		Luster/lean coal		150		

Note: CFB: Circulating fluidized bed; SCR: Selective Catalytic Reduction; SCR(1+1):ensures a 60% efficiency of removal of NOx; SCR(2+1): ensures a 75-85% efficiency of removal of NOx;SCR(3+1): ensures a 85% efficiency of removal of NOx; SNCR: Selective Non-Catalytic Reduction;SNCR-SCR: ensures a 55-85% efficiency of removal of NOx; Vdat: Volatile yield.
Source: MEE, 2018

6.2.2. Selection of sectors

Draft or final GATPPCs have been published for a total of 29 industrial sectors, as presented in Table 12. These include several that correspond to the three target sectors (see Annex A for more information on the target sectors). The table demonstrates the considerable variation across sectors in terms of the duration of the time between the release of the draft document and the final GATPPC: from nine months for the GATPPC on Thermal Power Plants, to almost six years for the GATPPC on Sintering and Pelletizing of Iron and Steel Industry.

Table 12. GATPPCs

Industrial sector/activity	Month/year of publication of draft document	Month/year of publication of final document
Thermal Power Plant	09/2016	06/2017
Copper Smelting Industry	09/2010	05/2015
Cobalt Smelting Industry	09/2011	04/2015
Nickel Smelting Industry	09/2011	04/2015
Secondary Lead Smelting	04/2014	02/2015
Enterprise Mobility Management	12/2013	08/2014
Sintering and Pelletizing Process of the Iron and Steel Industry	12/2008	08/2014
Cement Industry	07/2012	08/2014
Wood Pulping Process of Pulp and Paper Industry	04/2017	12/2013
Non-Wood Pulping Process of Pulp and Paper Industry	06/2011	12/2013
Recycled Fiber Pulping and Papermaking Process of Pulp and Paper Industry	n.a.	12/2013
Lead Smelting	10/2010	01/2012
Medical Waste Treatment and Disposal	03/2011	01/2012
Coking Process of the Iron and Steel Industry	10/2009	12/2010
Steel-making Process of the Iron and Steel Industry	10/2009	12/2010
Rolling Process of the Iron and Steel Industry	10/2009	12/2010
Mining and Mineral Processing of the Iron and Steel Industry	n.a.	03/2010
Treatment and Disposal of Sludge from Municipal Wastewater Treatment Plant	n.a.	03/2010
Coal-fired Power Plant Industry	12/2008	03/2010
Pharmaceutical Industry	01/2015	Forthcoming
Monosodium Glutamate Industry	09/2014	Forthcoming
Mercury-containing Waste Disposal	09/2014	Forthcoming
Coal to Methanol Industry	05/2014	Forthcoming
Rare Earth Metallurgical Industry	04/2014	Forthcoming
Dyeing and Finishing of Textile Industry	03/2014	Forthcoming
Tanning of Hides and Fur Industry	01/2014	Forthcoming
Electroplating Industry	08/2011	Forthcoming
Livestock and Poultry Farms	05/2011	Forthcoming
Township-villages	07/2010	Forthcoming

Source: MEE, n.d.

Adding to the list of existing GATPPCs, the Development Guideline for GATPPCs sets out to develop 15 new GATPPCs over the coming two years (2018-2019) (MEE, 2017c). These 15 sectors, which are presented in Table 13, have been selected because of their high level of energy consumption and emissions of pollutants.

Table 13. Selected industrial sectors for GATPPCs to be developed

Industrial sector	Planned year of publication
Sugar Industry	2018
Meat Industry	2018
Starch Industry	2018
Wood based panel Industry	2019
Furniture Industry	2019
Printing Industry	2019
Petroleum refining Industry	2018
Coking Industry	2018
PVC Industry	2019
Pesticide Industry	2018
Paint and Ink Industry	2019
Glass Industry	2018
Ceramics Industry	2018
Motor Vehicle Industry	2018
Industrial Boilers	2019

6.2.3. Information collection and evaluation of techniques

The process for determination GATPPCs is overseen by MEE or – in a few cases – other relevant ministries. Before the adoption of the Development Guideline for GATPPCs, the methods for collection of information on, and evaluation of, techniques were determined on a case-by-case basis. Nevertheless, some general tendencies were observed: the collection of information was generally done based on questionnaires disseminated to the industry, literature review, expert meetings or other means. The evaluation of techniques was carried out by technical working groups involving environmental officers, experts nominated by the ministries and industry associations. Stakeholders report that industries often took very active part in the development of GATPPCs, e.g. by initiating the development or revision of the documents, or by contributing to their content.

The public has so far generally not had access to information about the evaluation of techniques. However, public consultations have been carried out in some cases, in line with the Administrative Regulations for Revisions of Environmental Protection Standards from 2006 (MEE, 2006), which include a provision for "expert or public review of the draft standards". Public consultations will be used more systematically once the Development Guideline for GATPPCs takes full effect.

The full enforcement of the Development Guideline for GATPPCS will also lead to a more standardised procedure for the involvement of experts and industry, through sector-specific GATPPC Development Groups and surveys. The guideline outlines the three following phases of the assessment and selection of available techniques:

i. Preliminary selection: A sector-specific GATPPC Development Group conducts a preliminary data collection based on literature review, discussion amongst experts and information from national data management platforms, including the pollution discharge permit platform. Subsequently, the group distributes a questionnaire to industry operators in order to map widely used techniques. If the industry concerned has no more than 100 enterprises, all of them will generally be surveyed; if there are between 100 and 200 enterprises, no less than 100 should be surveyed; if there are between 200 and 1000 enterprises, at least 30%,

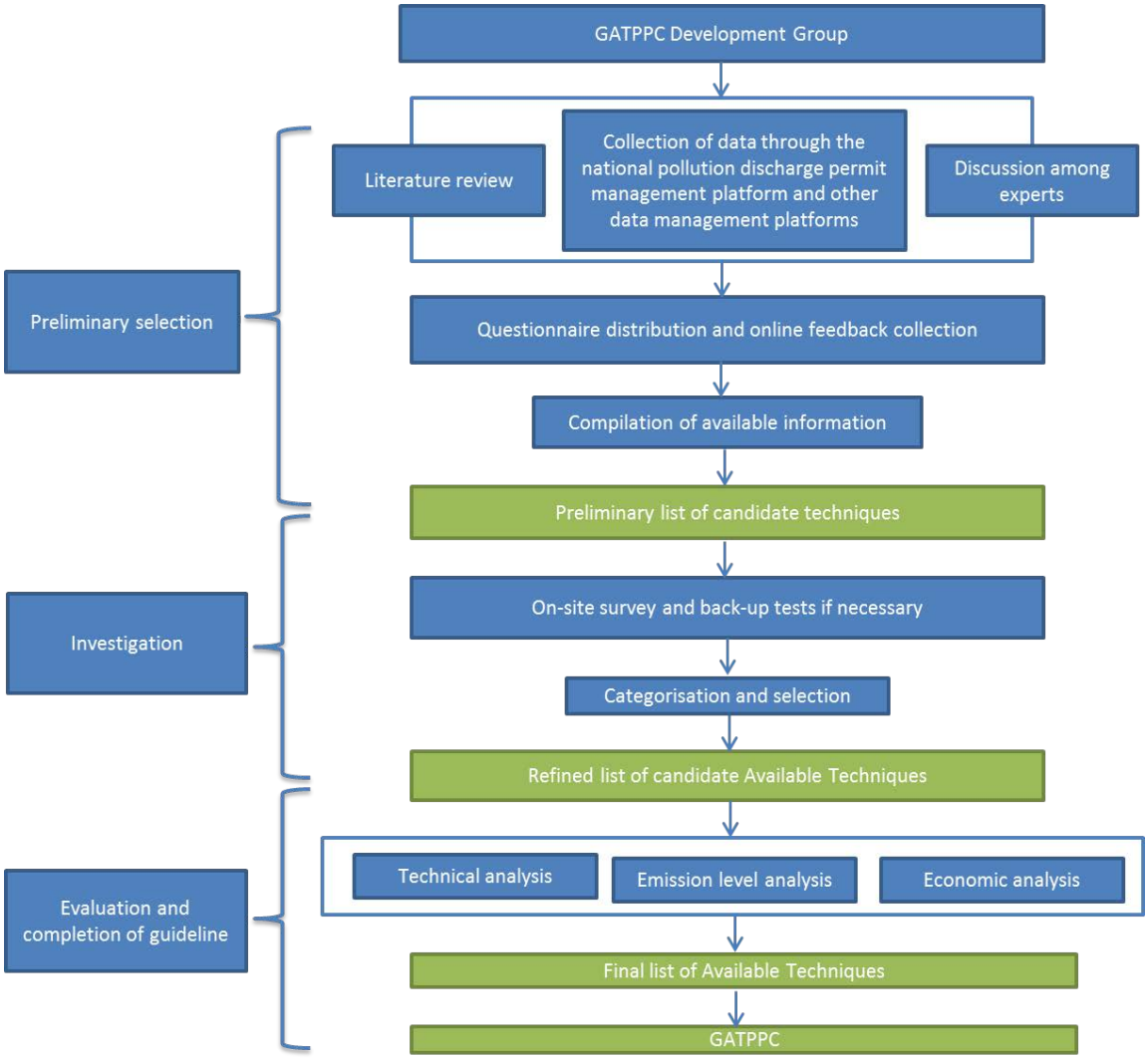
and no less than 100, should be surveyed; and if there are more than 1000 enterprises, at least 20%, and no less than 300, should be surveyed. The information collected during the first phase is compiled and presented as a preliminary list of candidate techniques.

ii. Investigation: As necessary, further investigations of the candidate techniques is carried out, based on on-site investigations and back-up tests aimed at obtaining quantitative information on the techniques. For each candidate technique, at least three cases, i.e. examples of industrial facilities that have implemented the technique considered to have met environmental standards should be selected, based on information from pollution discharge permits[4], data from environmental protection monitoring of construction projects, online monitoring data, etc. Each case should be assessed based on thorough information acquired through a comprehensive technical investigation. The second phase results in a refined list of candidate Available Techniques.

iii. Evaluation: The third phase consists of an evaluation of the candidate Available Techniques, aimed at assessing their technical, economic, environmental and management-related aspects, taking into account qualitative factors, e.g. through peer review, and quantitative factors, preferably by using the Analytic Hierarchy Process (AHP) to weigh indicators. The outcome of the third phase is a final list of Available Techniques and subsequently a GATPPC.

The three phases are illustrated by Figure 3.

Figure 3 The standardised procedure to develop GATPPCs



Source: Developed by the authors, based on MEE (2018)

The exact criteria for selection of techniques for the development of a GATPPC are determined on a case-by-case basis. However, the development of a GATPPC generally involves an integrated assessment of main varieties of raw materials, production processes, pollution prevention and control techniques, environmental management measures in the industry, as well as the overall development of the industry, its resource consumption level and pollution emission level, types of pollutants generated, and enterprises' performance in terms of meeting emission standards, etc. The criteria for the lead smelting industry (MEE, 2017e) and the dyeing and finishing of textile industry (MEE, 2014) are provided in Tables 14 and 15 as examples. It should be noted that the criteria are categorised in different manners in the two guidelines.

Table 14. Evaluation of water pollution prevention and control technologies for the lead smelting industry

Category	Indicators
Economic aspects	Construction cost
	Operational cost
	Revenue
Technical aspects	Production scale
	Effectiveness of pollutant removal
	Effectiveness in handling lead-containing materials
	Completeness of system configuration
	Advance in design
	Degree of automation
	Emergency response
	Provision of basic utilities (water, electricity, petroleum, etc.)
	Energy efficiency
	User-friendliness
Social aspects	Public perception
	Institutional capacity
	Geographical feasibility
	Technological capacity
Environmental aspects	Risk of producing toxic pollutants
	Risk of producing secondary pollutants
	Occupational health and safety
	Environmental impacts to nearby residents
	Ecological impact

Source: MEE, 2017e

Table 15. Evaluation criteria of water pollution prevention and control technologies for the dyeing and finishing of textile industry

Category	Indicators
Economic performance	Construction cost per unit
	Operation cost per unit
	Occupation area per unit
Technical performance	Resilience to shock
	Effluent COD
	Effluent BOD
	Effluent SS
	Effluent BOD5
	COD removal rate
	BOD5 removal rate
	SS removal rate
	Color removal rate
Operational management performance	Personnel qualification requirement
	Ease of operation
Environmental performance	Energy consumption level
	Production of sludge

Source: MEE, 2014

Based on the criteria of selection of techniques in all existing GATPPCs, the below sections sum up the technical, environmental, economic social and other aspects that usually are taken into account in the assessment of techniques.

Technical aspects

When doing the technical evaluation of techniques, the technological readiness level, the quality of the production process or products, the safety level and the applicability are taken into account. Applicability refers to whether the technique is applicable in new or existing plants, taking into account factors involved in retrofitting (e.g. plant size, capacity or load factor) and interactions with techniques already installed.

Other factors considered are the size, scale, capacity or load from the production lines in relation to the techniques, or the type of fuel or raw material used in the production process. Technical aspects can also cover features such as effectiveness of pollutant removal, advance in design, degree of automation, energy efficiency and user-friendliness.

In some GATPPCs, indicators such as unit design, scale, safety, system effectiveness, energy-saving performance, system reliability, etc., are classified as 'environmental desirability' rather than technical aspects. In other words, there is no standardised categorisation of the indicators.

Environmental aspects and pollutants

In general, environmental aspects are prioritised over economic aspects. There is not a general list of environmental aspects and pollutants which is applied to all sectors and all GATPPCs. Each guideline is developed with its own indices and criteria. For example, in case of lead smelting industries, the environmental aspects to be considered are the risk of producing toxic and secondary pollutants, occupational health and safety, environmental impacts to nearby residents and ecological impact. In case of medical waste disposal technologies, environmental desirability is related to the capacity of insuring public health and environmental safety.

Economic aspects

There is no standard economic assessment of techniques. The factors used for economic evaluation vary according to the sector, but are mostly related to the construction cost, operating cost and revenue. Even when economic effectiveness is to be considered, it mostly refers to comparing costs with revenues. It appears to be a need to further elaborate the criteria pertaining to the evaluation of the economic aspects of techniques in future GATPPCs.

Social aspects

Public perception, institutional capacity, geographical feasibility and technological capacity are among the social aspects considered in some of the GATPPCs currently being developed.

Other aspects

Administrative or management aspects are also considered when evaluating techniques. However, the interpretation of administrative diligence varies across the different guidelines. In case of medical waste treatment, the generation of toxic pollutants is classified under administrative diligence and not under environmental aspects. Governance is also taken into account in some GATPPCs.

6.3. Emission limit values associated with the GATPPCs

The Administrative Regulations for Revisions of Environmental Protection Standards outline the methodology applying to the development of various kinds of environmental standards, including ELVs that are associated with GATPPCs, and constitute a more overarching document than the Development Guideline for GATPPCs. The methodology is split into five stages, i.e. the initial stage, the proposal stage, the first draft stage, the second draft stage and the administrative examination stage, and a total of 22 steps. These are illustrated by Figures 4 and 5 (MEE, 2017a).

At the initial stage, the Project Management Unit (PMU) of MEE puts forward a project proposal for the ELV to be developed or revised (Step 1). MEE's Department of Science, Technology and Standards (DSTS) provides feedback on this proposal (Step 2), before inviting external institutes, such as universities and experts, to get involved in the project (Step 3). The institutes apply using the Application Form of Amending National Environmental Protection Standard (MEE, 2017d). The applications are assessed by experts from the relevant field (Step 4), based on the following eligibility criteria: (i) applicants should be experienced in environmental technologies and familiar with laws, policies and standards of environmental protection in China; (ii) applicants should be legal entities with solid human, technological, managerial and financial capacity; (iii) applicants should clarify the responsibility and financial roles of (not more than five) co-operation units; and (iv) applicants should currently be in charge of not more than ten projects and apply for not more than three projects. Furthermore, the institutes' applications should reflect a thorough understanding of the concerned project and relevant pollution control techniques in and outside China, including their environmental, economic and technical feasibility. The methodology as well as a budget for implementation of technologies must be included in the application; the budget should include expenses of trial experiments. Applicants have to defend their application with a 10-15 minutes presentation focusing on the proposed pollution control techniques and plans for implementation. Once the project rolls and responsibilities are defined by PMU and the institute is selected, a contract agreement between PMU and the selected institute is signed (Steps 5-6).

At the proposal stage, the selected institute will submit a proposal report (Step 7). The report is then reviewed by relevant MEE units and revised by the selected institute (Step 8). The PMU will invite at least seven experts to orally evaluate the proposal report (Step 9). In case the proposal report does not pass the evaluation, the selected institute will resubmit the report within 30 days, if the resubmitted report will not pass the evaluation again, the project is terminated (Steps 10-11).

At the first drafting stage (Steps 12-15), the selected institute will submit the first draft of the report, it is then reviewed and revised and seven experts from relevant MEE units are invited to evaluate the report. At the second drafting stage (Steps 16-18), the second draft version of the report is submitted by the selected institute, reviewed and revised and evaluated by experts in PMU as well as DSTS.

At the administrative examination stage (Steps 19-22), a final report is submitted, then it is reviewed, revised and examined by an expert committee and general committee underlying PMU and DSTS, respectively, and the report is then published and announced to the public for comments and consultation. The final documents are posted on MEE's website.

Figure 4. Flowchart of Procedures of Setting up/Revising Emission Standards (1/2)

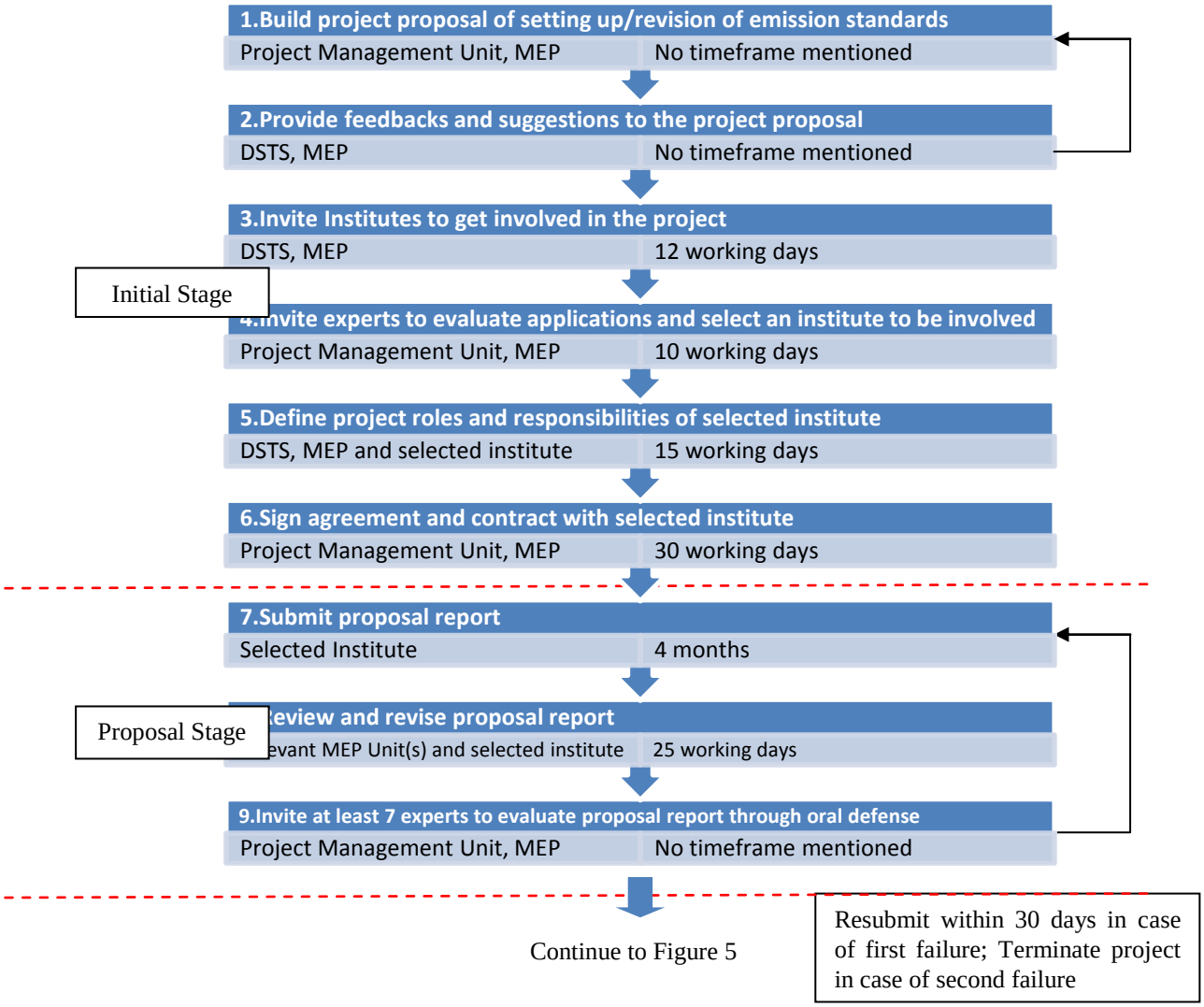
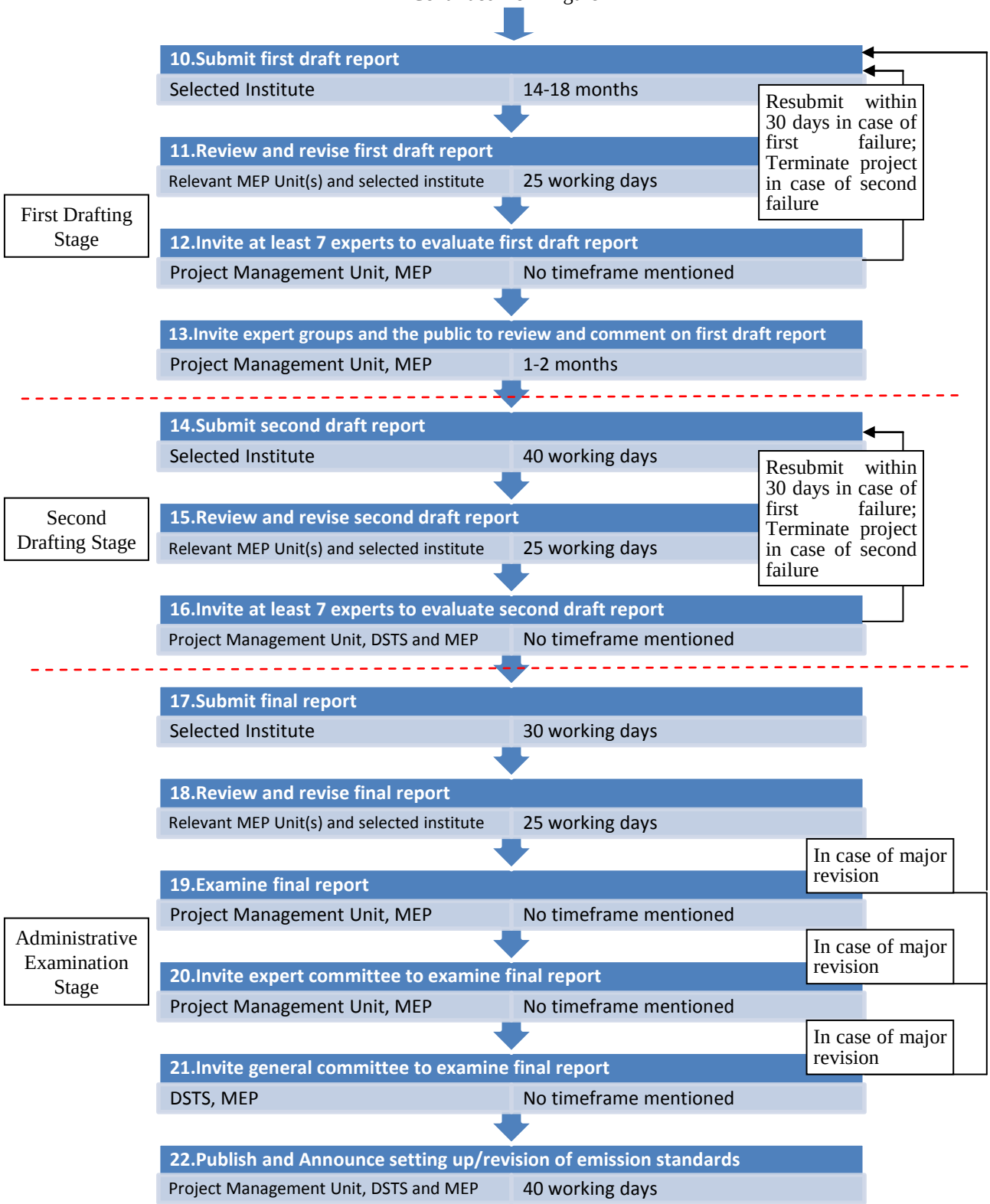


Figure 5. Flowchart of Procedures of Setting up/Revising Emission Standards (2/2)



6.4. Other BAT-related initiatives

6.4.1. The Integrated, Intelligent and International Platform for Environmental Technologies (3iPET)

Key features

Parallel to the GATPPC-based approach, the Foreign Economic Cooperation Office (FECO), underlying MEE, launched in 2017 for the third consecutive year, a call for proposals on environmentally sound technologies for prevention and control of pollutants to air, water and soil through the Integrated, Intelligent and International Platform for Environmental Technologies (3iPET) (FECO, n.d.). The objective of the platform is to promote environmental sustainability through technological innovation. The 3iPET is co-organised by the Chinese Research Academy of Environmental Sciences and supported by a number of other stakeholders[5].

Information on the 3iPET solicitation is publically available both in English and Chinese. Available documents include information on timeframe, scope of solicitation, application requirements, review process, support available to selected technologies, method of submission, contact information, organisers and supporters, application forms, and the evaluation criteria for the technologies.

Selection of sectors

Under 3iPET, no industrial sectors are selected over others; attention is rather given to the type of pollutant that the techniques can prevent and control. In 2017, the scope of the solicitation exercise was focused on, but not limited to: volatile organic compounds (VOCs) emission control, wastewater treatment in industrial parks, municipal solid waste treatment and disposal, industrial solid waste treatment, monitoring equipment for VOCs at sources of exhaust gas, and monitoring equipment for airborne VOCs (FECO, 2017).

Collection of information on techniques

FECO oversees the collection of data and evaluation of techniques. Data on both national and international technologies is collected through an annual solicitation activity on the online 3iPET platform. Chinese and foreign technology providers are invited to submit the 3iPET application form with information on techniques, over a time period of approximately three months. The application involves the submission of detailed information about the technique, including but not limited to technical rationale, innovation and advantages, technological processes, targeted key pollutants, technical indicators for pollution control, secondary pollution control, key economic indicators, ELVs that can be achieved with the help of the technique, intellectual property and technical appraisal.

The entities submitting an application for 3iPET must prove that they are the right holder of the technology proposed in their application, e.g. by referring to a patent or appraisal certificate of which they are the grantee. The applicants are also required to demonstrate their capacities with regards to the research, development, design, production and promotion of the technology concerned. Furthermore, the applicants must prove that the technologies submitted for consideration meet the following conditions:

i. Conforming to China's environmental policies and technical policies;
ii. with clear ownership of intellectual property or proprietary technical right;

iii. with mature process, advanced technicality and economical costing;
iv. three examples of large-scale implementation;
v. strong technical adaptability for extensive promotion and application; and
vi. mature technical processing, process unit or equipment/material/agent.

Finally, applicants are required to provide truthful information and will be held accountable for the authenticity of the submission. Applicants are also requested to present a Project Acceptance Report or a Performance Test/Evaluation Report issued by a qualified third party. The corresponding Monitoring Report shall be submitted as well.

Evaluation of the techniques and decision-making process

The process for evaluation and selection of techniques is divided into two stages. The first stage involves a large number of environmental technology experts from China and abroad and is carried out on an online platform. The experts assess the techniques based on clearly defined evaluation criteria, as listed in Tables 16-19, for each of the following categories of techniques:

i. Air pollution prevention and control;
ii. water pollution prevention and control;
iii. soil pollution prevention and control; and
iv. environmental monitoring.

The number of evaluation criteria for each category varies between twelve and fifteen. They cover aspects such as rationality, applicability, innovation, effectiveness in pollutant removal, stability, economic feasibility, energy and resource conservation. Since the 3iPET platform also aims to promote technology innovation, aspects such as market demand, promotion capability, and strength of the technology provider are also evaluated when selecting the technologies.

Each evaluation criterion corresponds to a maximum number of points. Techniques that reach a minimum score of 80 out of 100 are taken to the second stage of the evaluation process, which involves an assessment meeting with a group of five experts. The group seeks to reach a consensual decision; however, in cases where consensus is not achieved, a vote is carried out and a final decision is taken by the team leader. The techniques chosen by the expert group are not ranked, but presented as equally good alternatives.

Table 16. Evaluation Criteria for Air Pollution Prevention and Control Technologies

Indicator	Maximum Points	Marking criteria
Rationality of technological process	7	The process shall be short and complete, with high optimisation of component integration, and the process design shall be reasonable. Unreasonable processes will receive 0 points.
Applicability and effectiveness of technology	5	The technology shall be suitable for the treatment of industry-specific pollution and can effectively remove characteristic pollutants. Inapplicable technologies will receive 0 points.
Innovation and progressiveness of technology	15	The technology shall be technologically innovative partly or as a whole, with its innovations reaching an internationally advanced level. Out-dated or obsolete technologies will receive 0 points.
Effect on reducing pollutant emission	8	The technology shall have fair effects on removing characteristic pollutants and can meet the related standards steadily. Its total removal amount shall be higher than that of similar technologies. A technology without obvious effects will receive 0 points.
Effect on controlling secondary pollutions	3	In the process of pollution treatment, there shall be no transfer or diffusion of potential pollutants caused by the phase change or addition of substances. A technology that causes secondary pollution will receive 0 points.
Effect on solving industry-specific pollution	6	It can completely solve critical issues of an industry-specific pollution as a whole, and play a key role in industry-specific pollution treatment. A technology with poor effect will receive 0 points.
Maturity and practicality of technology	10	The technology has good industrialisation level of its technological achievements with extensive engineering applications, and its practicability has been proved through engineering practices. A technology without practical engineering applications will receive 0 points.
Economic feasibility	8	On a comparable basis, its overall unit construction cost and operating cost (expense) shall be relatively low, and its application shall be economically feasible. A technology that severely deviates from average market cost will receive 0 points.
Energy and resource conservation	5	Less construction space shall be occupied for the technology application, and less resources and energy shall be consumed during the facility operation. During the process of pollution treatment, the recycling or reuse of resources and energy can be realised. A technology that is incapable of energy and resource conservation will receive 0 points.
Stability of facility operation	5	The facility shall be in stable working operation, and shall be able to realise given parameters with minimal instability and failures. A technology that fails to operate stably will receive 0 points.
Usability of facility operation	5	The level of facility automation shall be high; the operations shall be simple, convenient and easy to control. A technology that has extremely complex operations and is difficult to be controlled will receive 0 points.
Market demand and prospect	7	The market demand of the technology shall be high, and it shall have a good market prospect for its application. It is a technology much needed currently by the market. A technology that has no market prospect for its application will receive 0 points.
Promotion of technology	9	The technology has been well promoted and widely used, and its owner has effective promotion strategy and decent promotion capabilities. A technology that cannot be promoted effectively will receive 0 points.
Comprehensive strength of the supporting institution	7	Supporting (owner) institution shall be a medium to large company, a listed company, or with well-rounded strengths in R&D, marketing, manufacturing, engineering and internal management. An institution that has no such basic strengths will receive 0 points.
Total points	100	Each expert will rate a given technology by adding up points from all indicators. A technology's final score will be an average of the total scores from all experts. A ranking of all technologies will then be done based on the final averaged scores.

Source: FECO, 2017

Table 17. Evaluation Criteria for Water Pollution Prevention and Control Technologies

Indicator	Maximum Points	Marking criteria
Rationality of technological process	5	The process shall be short and complete, with high optimisation of component integration, and the process design shall be reasonable. Unreasonable processes will receive 0 points.
Applicability and effectiveness of technology	5	The technology shall be suitable for the treatment of industry-specific pollution and can effectively remove characteristic pollutants. Inapplicable technologies will receive 0 points.
Innovation and progressiveness of technology	15	The technology shall be technologically innovative partly or as a whole, with its innovations reaching an internationally advanced level. Out-dated or obsolete technologies will receive 0 points.
Effect on reducing pollutant emission	8	The technology shall have fair effects on removing characteristic pollutants and can meet the related standards steadily. Its total removal amount shall be higher than that of similar technologies. A technology without obvious effects will receive 0 points.
Effect on controlling secondary pollutions	5	In the process of pollution treatment, there shall be no transfer or diffusion of potential pollutants caused by the phase change or addition of substances. A technology that causes secondary pollution will receive 0 points.
Effect on solving industry-specific pollution	6	It can completely solve critical issues of an industry-specific pollution as a whole, and play a key role in industry-specific pollution treatment. A technology with poor effect will receive 0 points.
Maturity and practicality of technology	10	The technology has good industrialisation level of its technological achievements with extensive engineering applications, and its practicability has been proved through engineering practices. A technology without practical engineering applications will receive 0 points.
Economic feasibility	8	On a comparable basis, its overall unit construction cost and operating cost (expenses) shall be relatively low, and its application shall be economically feasible. A technology that severely deviates from average market cost will receive 0 points.
Energy and resource conservation	5	Less construction space shall be occupied for the technology application, and less resources and energy shall be consumed during the facility operation. During the process of pollution treatment, the recycling or reuse of resources and energy can be realised. A technology that is incapable of energy and resource conservation will receive 0 points.
Stability of facility operation	5	The facility shall be in stable working operation, and shall be able to realise given parameters with minimal instability and failures. A technology that fails to operate stably will receive 0 points.
Usability of facility operation	5	The level of facility automation shall be high; the operations shall be simple, convenient and easy to control. A technology that has extremely complex operations and is difficult to be controlled will receive 0 points.
Market demand and prospect	7	The market demand of the technology shall be high, and it shall have a good market prospect for its application. It is a technology much needed currently by the market. A technology that has no market prospect for its application will receive 0 points.
Promotion of technology	9	The technology has been well promoted and widely used, and its owner has effective promotion strategy and decent promotion capabilities. A technology that cannot be promoted effectively will receive 0 points.
Comprehensive strength of the supporting institution	7	Supporting (owner) institution shall be a medium to large company, a listed company, or with well-rounded strengths in R&D, marketing, manufacturing, engineering and internal management. The institution that has no such basic strengths will receive 0 points.
Total points	100	Each expert will rate a given technology by adding up points from all indicators. A technology's final score will be an average of the total scores from all experts. A ranking of all technologies will then be done based on the final averaged scores.

Source: FECO, 2017

Table 18. Evaluation Criteria for Soil (Including Solid Waste) Pollution Prevention and Control Technology

Indicator	Maximum Points	Marking criteria
Innovation and progressiveness of technology	15	The technology shall be technologically innovative partly or as a whole, with its innovations reaching an internationally advanced level. Out-dated or obsolete technologies will receive 0 points.
Maturity of technology	8	The technology has good industrialisation level of its technological achievements with extensive engineering applications, and its practicability has been proved through engineering practices. A technology without practical engineering applications will receive 0 points.
Stability of facility operation	5	The facility shall be in stable working operation, and shall be able to realise given parameters with minimal instability and failures. A technology that fails to operate stably will receive 0 points.
Usability of facility operation	5	The level of facility automation shall be high; the operations shall be simple, convenient and easy to control. A technology that has extremely complex operations and is difficult to be controlled will receive 0 points.
Effect on solving industry-specific pollution	5	It can completely solve critical issues of an industry-specific pollution as a whole, and play a key role in industry-specific pollution treatment. A technology with poor effect will receive 0 points.
Treatment effect	9	The technology shall have fair effects on removing characteristic pollutants. Its total removal amount shall be higher than that of similar technologies. A technology without obvious effects will receive 0 points.
Validation of treatment effect	9	The effectiveness and stability standards of the treatment of characteristic pollutants shall be fully validated. A technology without validation will receive 0 points.
Effect on controlling residual risks/secondary pollutions	7	In the process of pollution treatment, there shall be no transfer or diffusion of potential pollutants caused by the phase change or addition of substances. A technology that causes residual risks or secondary pollution will receive 0 points.
Economic feasibility	8	On a comparable basis, its overall unit construction cost and operating cost (expense) shall be relatively low, and its application shall be economically feasible. A technology that severely deviates from average market cost will receive 0 points.
Energy and resource conservation	4	Less construction space shall be occupied for the technology application, and less resources and energy shall be consumed during the facility operation. During the process of pollution treatment, the recycling or reuse of resources and energy can be realised. A technology that is incapable of energy and resource conservation will receive 0 points.
User acceptance	5	The treatment technology shall be accepted by users and obtain positive evaluation from more than 3 users. A technology without user evaluation will receive 0 points.
Public acceptance	5	The treatment process and effectiveness shall be recognised by the public. A technology that is strongly opposed by the public will receive 0 points.
Market demand	5	The market demand of the technology shall be high, and it shall have a good market prospect for its application. It is a technology much needed currently by the market. A technology that has no market prospect for its application will receive 0 points.
Promotion of technology	5	The technology has been well promoted and widely used, and its owner has effective promotion strategy and decent promotion capabilities. A technology that cannot be promoted effectively will receive 0 points.
Comprehensive strength of the supporting institution	5	Supporting (owner) institution shall be a medium to large company, a listed company, or with well-rounded strengths in R&D, marketing, manufacturing, engineering and internal management. An institution that has no such basic strengths will receive 0 points.
Total points	100	Each expert will rate a given technology by adding up points from all indicators. A technology's final score will be an average of the total scores from all experts. A ranking of all technologies will then be done based on the final averaged scores.

Source: FECO, 2017

Table 19. Evaluation Criteria for Environmental Monitoring Technologies

Indicator	Maximum Points	Marking criteria
Rationality of technological process	7	The process shall be short and complete, with high optimisation of component integration, and the process design shall be reasonable. Unreasonable processes will receive 0 points.
Applicability and effectiveness of technology	7	The technology shall be suitable for the monitoring of industry-specific pollution and can effectively monitor characteristic pollutants. Inapplicable technologies will receive 0 points.
Innovation and progressiveness of technology	15	The technology shall be technologically innovative partly or as a whole, with its innovations reaching an internationally advanced level. Out-dated or obsolete technologies will receive 0 points.
Reliability of monitoring technology (equipment)	7	The technology shall have fair effects on monitoring characteristic pollutants and can meet the related standards continuously and steadily. It is more reliable than similar technologies (equipment). A technology that cannot meet the related standards continuously and steadily will receive 0 points.
Solution to major technological issues in this field	10	It can solve major technological issues in this field as a whole, and play a key role in the progress of monitoring technologies in this field. A technology that cannot solve major technological issues will receive 0 points.
Maturity and practicality of technology	9	The technology has good industrialisation level of its technological achievements with extensive engineering applications, and its practicability has been proved through engineering practices. A technology without practical engineering applications will receive 0 points.
Economic feasibility	9	On a comparable basis, its overall unit construction cost and operating cost (expense) shall be relatively low, and its application shall be economically feasible. A technology that severely deviates from average market cost will receive 0 points.
Stability of facility operation	7	The facility shall be in stable working operation, and shall be able to realise given parameters with minimal instability and failures. A technology that fails to operate stably will receive 0 points.
Usability of facility operation	7	The level of facility automation shall be high; the operations shall be simple, convenient and easy to control. A technology that has extremely complex operations and is difficult to be controlled will receive 0 points.
Market demand and prospect	6	The market demand of the technology shall be high, and it shall have a good market prospect for its application. It is a technology much needed currently by the market. A technology that has no market prospect for its application will receive 0 points.
Market promotion capability of the product	6	The technology has been well promoted and widely used, and its owner has effective promotion strategy and decent promotion capabilities. A technology that cannot be promoted effectively will receive 0 points.
Comprehensive strength of the supporting institution	10	Supporting (owner) institution shall be a medium to large company, a listed company, or with well-rounded strengths in R&D, marketing, manufacturing, engineering and internal management. An institution that has no such basic strengths will receive 0 points.
Total points	100	Each expert will rate a given technology by adding up points from all indicators. A technology's final score will be an average of the total scores from all experts. A ranking of all technologies will then be done based on the final averaged scores.

Source: FECO, 2017

6.4.2. Eco-Product Certification

For many years, the China Environmental Protection Industry Association has carried out eco-product certification. China's Environmental Protection Product Certification has established standardised methods for certification, assessment of equipment and equipment production capacity for air pollution control products, waste water, monitoring instrument products, etc. The specific method is to assess the production capacity of industrial facilities and of products according to relevant national norms and standards, including product inspection, factory quality system inspection, etc.

6.4.3. Environmental Technology Verification

The Chinese Society For Environmental Sciences organises the use of Environmental Technology Verification (ETV) methods to promote the screening and evaluation of technologies and set up a technology evaluation coalition. ETV is committed to helping the market absorb technologies that are innovative, especially those that are significantly better than current technologies, and ultimately achieve the goal of environmental protection through such measures as development, publicity and guidance. At present, some technical evaluations have been carried out on related technologies in the fields of waste water, waste gas and other waste. As a systematic evaluation method, this method has been adopted by all countries in the world. Both of these approaches can be considered as an important method for screening and evaluating BAT.

6.4.4. The Action Plan of Air Pollution Prevention and Control

The Action Plan of Air Pollution Prevention and Control was officially issued by the Chinese State Council. The Plan sets out to improve overall air quality across the nation over five years, reduce heavy pollution by a large margin and ensure considerable improvements of air quality in the Beijing-Tianjin-Hebei Province, the Yangtze River Delta and the Pearl River Delta. To achieve the above objectives, the Action Plan defines ten measures, including, amongst others:

i. increasing efforts of comprehensive control and reduction of emissions of multi-pollutants;
ii. optimising the industrial structure and promoting industrial restructure;
iii. accelerating the technology transformation and improving the innovation capability; and
iv. adjusting the energy structure and increasing the clean energy supply.

6.5. Attributes and limitations

6.5.1. Attributes

Stakeholders point out that despite the fact that the GATPPCs are not binding, the guidelines are expected to lead to a decrease in industrial emissions. The application of BAT can constitute a useful indication to industries and to regulators of whether ELVs are achievable or not. Therefore, stakeholders see it as important to strengthen the linkage between BAT and enforceable ELVs for all industrial sectors, especially coal-fired power plants, metal, pulp and paper, cement and petrochemical industries.

6.5.2. Limitations

Some stakeholders report that there is a lack of transparency in the process for selection of BAT and development of GATPPCs, and that this may be a barrier to industries' willingness to get engaged in the process. Furthermore, some point out that as many of the GATPPCs still are under development, conflicting information is sometimes found within the same document.

As regards the use of BAT as a policy tool more generally, some stakeholders fear that having industries relying on the techniques presented in the GATPPCs could impede their capacity and creativity in terms of developing better solutions to pollution control.

Besides, MEE seems to be slightly reluctant to promote GATPPCs due to accountability issues, seeing as there is a general concern that an industry may not reach the ELVs and fail to obtain operational permits while applying a recommended technique.

Notes

1 The Environmental Protection Law sets out to protect and improve the environment, to prevent and control pollution, to safeguard human health, and to promote modern development. The Law provides for: (i) the integration of environmental protection into development planning; (ii) the promotion of environmental education; (iii) the obligation of the individuals and units to protect the environment; (iv) the responsibilities of government bodies at central, provincial, regional and municipal levels, in respect of supervision and administration of environmental protection activities. As in the section on ELVs, the Environmental Protection Law introduces two types of national standards.

2 The Law on Prevention and Control of Water Pollution aims to prevent and control the pollution of rivers, lakes, canals, irrigation channels, reservoirs and other surface water and groundwater bodies. The Law also encourages and supports implementation of advanced, clean technologies and the elimination of backward techniques and equipment.

3 The Atmospheric Pollution Prevention and Control Law provides for the prevention and control of air pollution and for the protection and improvement of the living and ecological environment, including by encouraging and supporting the implementation of advanced, clean technologies and elimination of backward techniques and equipment.

4 The Chinese pollution discharge permit system is scheduled to be implemented in 82 different industries by 2020 (Yi, 2017).

5 The supports of 3iPET include ZMExpo MMI(Shanghai) Co., Ltd., China Environment Chamber of Commerce, Clean Air Initiative Centre, IVL Swedish Environmental Research Institute, Australian Trade and Investment Commission, Beijing Municipal Research Institute of Environmental Protection, Tianjin Academy of Environmental Sciences, Hebei Environment Federation;Jilin Province Association of Environmental Protection Industry (JLAEPI), Academy of Environmental Sciences of Liaoning Province, Shandong Province Environmental Protection Technology Service Centre, Beijing Inggreen Technology Co., Ltd., ALCLE Environmental Solutions Inc., Soil Environmental Remediation in China, International Technology Transfer Network (ITTN), Umore Cleantech Consulting and Ferrara Fiere/RemTech.

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Chapter 7. New Zealand: Procedures to establish best practical options

This chapter presents the key policy tools for implementation of New Zealand's performance-based environmental regulation, including National Environmental Standards, Best Practical Options and how these are applied in discharge permit conditions and under National Policy Statements. Furthermore, the chapter explores three series of guidance documents facilitating the prevention and control of industrial emissions.

7.1. Introduction

New Zealand has a performance-based environmental regulation – the Resource Management Act (RMA)[1] (Government of New Zealand, 1991) – which constitutes the principal framework to protect air, water and soil at the national, state and local level. The Ministry for the Environment (MfE) has devolved responsibility for the implementation of the RMA to local governments[2], which develop local plans for emission prevention and control, containing rules for discharges to air from industry and other activities. There would generally be one plan for each environmental medium (air, water and soil), although these could all be incorporated into one Natural Resource Management Plan. All newly established industrial facilities that may result in emissions to the environment must comply with the environment protection requirements of a local plan and comply with the conditions set by the local governmental authority.

However, MfE can impose rules through legally binding National Environmental Standards (NES) or specify objectives and policies through National Policy Statements (NPS) which local governments must comply with or give effect to. While the NES include no specific requirements to assess or improve the technological potential of polluters, the local governments may choose to apply Best Practical Options (BPO) as a means of compliance with the NES or where there is no applicable NES.

There is not one standard approach to determine BPO. The BPO are generally based on "good practice' or 'fit-for-purpose' techniques, rather than on BAT; stakeholders report that this appears to be a more flexible and cost effective approach, designed to ensure that outcomes are achieved, rather than prescribing more expensive BAT. The BPO can be expressed as treatment technologies, operating practices or performance standards. They apply to stationary sources, are not linked to thresholds and are generally determined for each facility in the conditions of their discharge permits (known as resource consents) or under the NPS.

Furthermore, in order to guide the local governments to meet their obligations under the RMA, MfE has developed a set of Good Practice Guides for air quality management. Together with a series Contaminated Land Management Guidelines as well as industry-specific guidelines developed by sectoral associations, these constitute key documents for the prevention and control of industrial emissions in New Zealand.

7.2. National Environmental Standards

The NES are legal regulations concerning contaminants, air quality, water quality, level or flow, and soil quality in relation to the discharge of contaminants. The NES for air quality were developed by MfE and consist of 14 separate, but interlinked, standards including:

i. seven standards banning activities that discharge significant quantities of dioxins and other toxics into the air, such as burning of wastes at landfills, tyres and coated wires, as part of meeting obligations under the Stockholm Convention on Persistent Organic Pollutants (UN, 2001); and
ii. five standards for outdoor air quality for maximum allowable levels of key pollutants carbon monoxide, nitrogen dioxide, ozone, sulphur dioxide and PM_{10} (MfE, 2017a, 2017b)

Local governments must ensure compliance with the NES. These apply as a minimum requirement in all regions, and local governments cannot provide for less stringent

standards for emissions. More stringent rules than the NES may be established through Regional Air Plans. Local governments may apply international emission limits in cases where these are not covered by the NES, e.g. benzene limits.

The NES for Air Quality's provision for exceptional circumstances allows local governments to apply to MfE to exclude an exceedance of the PM_{10} standard caused by exceptional circumstances. MfE uses the following five criteria to assess whether an exceedance was caused by exceptional circumstances:

i. Causation – whether the exceedance actually was caused by the reported events;
ii. control – the circumstances must be beyond the reasonable control of local governments;
iii. foreseeability – an assessment of whether the circumstances were able to be reasonably predicted and/or planned for;
iv. frequency and likelihood of reoccurrence – an assessment of how unusual the events were;
v. purpose of the RMA – whether a determination that circumstances were exceptional is consistent with the purpose of the RMA (MfE, 2017c).

Exceptional circumstances are assessed on a case-by-case basis. If the Minister concludes that an exceedance in fact was caused by exceptional circumstances, it is excluded when determining whether the standard for the relevant contaminant has been exceeded in the concerned air shed, i.e. areas where air quality is to exceed the standards. The local government is still required to give public notice of the exceedance.

7.3. Establishing BPO under environmental permits

7.3.1. Key features

Resource consents (discharge permits) are a requirement under the RMA unless a local plan makes the discharge a permitted activity. Industrial facilities can obtain a discharge permit by submitting a resource consent application to the local government. If available, BPO are usually mentioned in the consent applications; they may also be referred to in the consent conditions set by the local government as a means of management.

7.3.2. Collection of information on techniques

The RMA requires resource consent applications to be accompanied by an assessment of environmental effects (AEE), including the following elements:

i. a description of the nature of the discharge and the sensitivity of the receiving environment to adverse effects;
ii. any possible alternative methods of discharge, including discharge into any other receiving environment; and
iii. a description of the mitigation measures (including safeguards and contingency plans where relevant) to be undertaken to help prevent or reduce the actual or potential effect.

Consequently, the applicant must consider pollution control technologies, including alternatives, to show that discharges are managed so as to avoid, remedy or mitigate adverse effects. Operators usually mention BPO in their application if these are available. Local plans can require that facilities provide information on additional elements in their AEE; however, they cannot require any of the above elements to be left out.

7.3.3. Evaluation of the techniques

Resource consents are granted based on the information provided in the AEEs submitted by industrial facilities. The RMA states that a resource consent may contain a requirement for "the holder to adopt the BPO to prevent or minimise any actual or likely adverse effect on the environment of the discharge…". The term BPO is, however, rarely referred to in the conditions of a resource consent; rather, the conditions would require that the permit holder uses specific treatment technologies, adopts certain operating practices or meets defined performance standards. Notably, all resource consent conditions include a requirement to comply with the NES.

In cases where BPO are stated in the conditions of the resource consent, these are determined on a case-by-case basis by the local government, based on the circumstances, the activity and the standards/rules in the local plan, relevant technical, environmental, economic and, if necessary, cultural aspects, in addition to the mitigation measures indicated in the AEE and the demonstrable technological potential of the facility concerned. Furthermore, the RMA states that the selection of BPO to prevent or minimise the adverse effects on the environment shall take into account:

i. the nature of the discharge or emission and the sensitivity of the receiving environment to adverse effects;
ii. the financial implication, and the effects on the environment, of that option when compared with other options; and
iii. the current state of technical knowledge and the likelihood that the option can be successfully applied (Government of New Zealand, 1991).

7.4. Establishing BPO under National Policy Statements

7.4.1. Key features

The NPS are higher level instruments which state objectives and policies for matters of national significance. These must be considered and given effect to by local governments in developing plans and issuing resource consents. There are currently five NPS in place, including for freshwater management, urban development capacity, renewable electricity generation, electricity transmission and coastal policy (MfE, 2017d).

Policy A3(b) of the NPS on Freshwater Management (NPS-FM) (MfE, 2014) states that local governments should, where permissible, make rules requiring the adoption of BPO "to prevent or minimise any actual or likely adverse effect on the environment of any discharge of a contaminant into freshwater, or onto or into land in circumstances that may result in that contaminant (or, as a result of any natural process from the discharge of that contaminant, any other contaminant) entering freshwater". Furthermore, the guidance document accompanying NPS-FM (MfE, 2017e) recommends local governments to consider rules requiring the adoption of BPO by those seeking resource consents, i.e. assess local plans in order to determine whether additional BPO provisions are needed to prevent or minimise adverse effects on the environment.

7.5. Guidance documents for prevention and control of industrial emissions

7.5.1. Good Practice Guides for the management of air quality

Key features

MfE has developed different Good Practice Guides for the management of air quality, to help local governments meet their obligations under the RMA. These are available on the MfE's website (www.mfe.govt.nz/air/improving-air-quality/good-practice-guides-councils). The Good Practice Guides include, amongst others, reference methods for determination of PM_{10}, carbon monoxide, nitrogen oxides, sulphur dioxide and ozone. The Good Practice Guides for Assessing and Managing Odour and Dust, respectively, contain a chapter on the management and control of emissions. The documents also outline the associated monitoring, data quality, and environmental effects assessment aspects.

Selection of sectors

While the RMA covers all industrial and agricultural activities that emit pollutants to air, water and/or soil, the Good Practice Guides only address horizontal topics, notably related to air pollution, including for the management of odour and dust (MfE, 2016a). Table 20 lists the Good Practice Guides that have been developed.

Table 20. Available Good Practice Guides for the management of air quality

Title	Year of publication
Good Practice Guide on air quality monitoring and data management	2009
Good Practice Guide on assessing discharges to air from land transport	2008
Good Practice Guide on assessing discharges to air from industry	2016
Good Practice Guide on atmospheric dispersion modelling	2004
Good Practice Guide on assessing and managing odour	2016
Good Practice Guide on assessing and managing dust	2016
Good Practice Guide on monitoring and management of visibility in New Zealand	2001
Good Practice Guide on preparing emissions inventories	2001

Source: MfE, 2016a

7.5.2. Contaminated Land Management Guidelines

MfE has also developed a set of Contaminated Land Management Guidelines (MfE, 2016b), which provide best practice that can be applied to all industries and activities in respect to contaminated land. These are accompanied by a set of guidance documents that address contaminants from specific industries or activities, providing further refinement. Such guidelines are developed for five sectors, as listed in Table 21, and can be consulted on MfE's website (www.mfe.govt.nz/land/risks-contaminated-land/managing-contaminated-land/guidelines-address-contaminants-specific). There are no guidance documents available for the three target sectors (see Annex A for more information on the target sectors).

Table 21. Available guidance documents addressing contaminants from specific

Title	Year of publication
Health and Environmental Guidelines for Selected Timber Treatment Chemicals	1997
Guidelines for Assessing and Managing Contaminated Gasworks Sites in New Zealand	1997
Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand	1999; revised 2011
Environmental guidelines for water discharges from petroleum industry sites in New Zealand	1998
Identifying, Investigating and Managing Risks Associated with Former Sheep-dip Sites: A Guide for Local Authorities	2006

Source: MfE, 2015

7.5.3. Industry-specific guidance documents

There is also another set of guidance documents addressing specific industrial sectors, developed by sectoral associations, oftentimes in collaboration with the Government. These documents all use different terminologies. For example, the New Zealand Forest Owners' Association (NZFOA, 2007) speaks about Best Environmental Management Practices (BEPs), the dairy industry (FAR et al., 2015) uses the term Good Management Practices (GMP) and the New Zealand Green Shell Mussel Industry has an Environmental Code of Practice (Aquaculture New Zealand, 2007) and refers to the term Operator Management Practices (OMP). There is no common platform for the consultation of the Good Practice Guides.

An example of a Good Practice Guide developed by a sectoral association is the Water Accord (DELG, 2015), which constitutes a set of National Good Management Practice Benchmarks set by the dairy industry, aimed at strengthening the environmental performance of stationary sources in the dairy sector. Some of these benchmarks are based on technological potential, taking into account relevant research, quality nutrient management advice and proven cost effective solutions. The accord outlines the dairy industry's commitment to improving water quality in New Zealand, and includes commitments to targeted riparian planting plans, effluent management, comprehensive standards for new dairy farms and measures to improve the efficiency of water and nutrient use on farms.

7.6. Attributes and limitations

7.6.1. Attributes

The determination of BPO is often tempered by economic and efficiency criteria, allowing for a more flexible, 'fit-for-purpose' and cost effective approach, designed to ensure that things work and outcomes are achieved, rather than prescribing more expensive BAT.

Another attribute of the current process available under the RMA is that it allows review and amendments of the NES, including through stakeholder consultation and involvement of representatives from government, local government and industry.

7.6.2. Limitations

The use of BPO that often are tempered by economic and efficiency criteria can also be considered a limitation. For example, Policy A3(b) of the NPS on Freshwater Management is intended to be consistent with section 70(2) of the RMA, which sets out when a BPO may be imposed. The words "where permissible" in Policy A3(b) reflect section 70(2) which requires councils to be satisfied that including a rule which provides

for the use of a BPO is the most efficient and effective means of preventing or minimising adverse effects on the environment.

The performance-based approach under the RMA and the devolved nature of the implementation of this to local government can lead to a variation in standards of control across the country. However, offsetting this is the application of minimum standards and expectations through the imposition of nationally applying NES and NPS.

Furthermore, the process is not as prescriptive as in other parts of the world. The RMA and the associated NES provide national guidance. For some areas, such as contaminated soils, stakeholders' interpretation and implementation have been inconsistent. The information to monitor and evaluate if the processes in place are improving the environmental, economic or health are not substantial enough to make a determination. A more prescriptive and reproducible approach would be required to ascertain this.

In respect to the Good Practice Guides that address specific industries or activities, these target specific industries often as a response to national issues at the time. These guidelines are often superseded by other documents or not kept up to date with national or international technical information and can lead to stakeholder confusion or incorrect implementation. It requires significant resources to maintain these documents.

Notes

1 The RMA promotes *sustainable management* of air, water and soil, defined as managing the use, development, and protection of natural and physical resources in a way, or at a rate, that enables people and communities to provide for their social, economic and cultural well-being as well as for their health and safety while: (i) sustaining the potential of natural and physical resources, excluding minerals, to meet the reasonably foreseeable needs of future generations; (ii) safeguarding the life-supporting capacity of air, water, soil and ecosystems; and (iii) avoiding, remedying, or mitigating any adverse effects of activities on the environment.

2 The local government sector in New Zealand consists of 11 regional council, 61 territorial authorities (including 11 city councils and 50 district councils) and six unitary councils (territorial authorities with regional council responsibilities) (LGNZ, n.d.)

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Chapter 8. International BAT initiatives

This chapter presents selected international initiatives facilitating the establishment or implementation of BAT, including BAT guidelines developed under international conventions and by international organisations. Special attention is given to how these guidelines are developed.

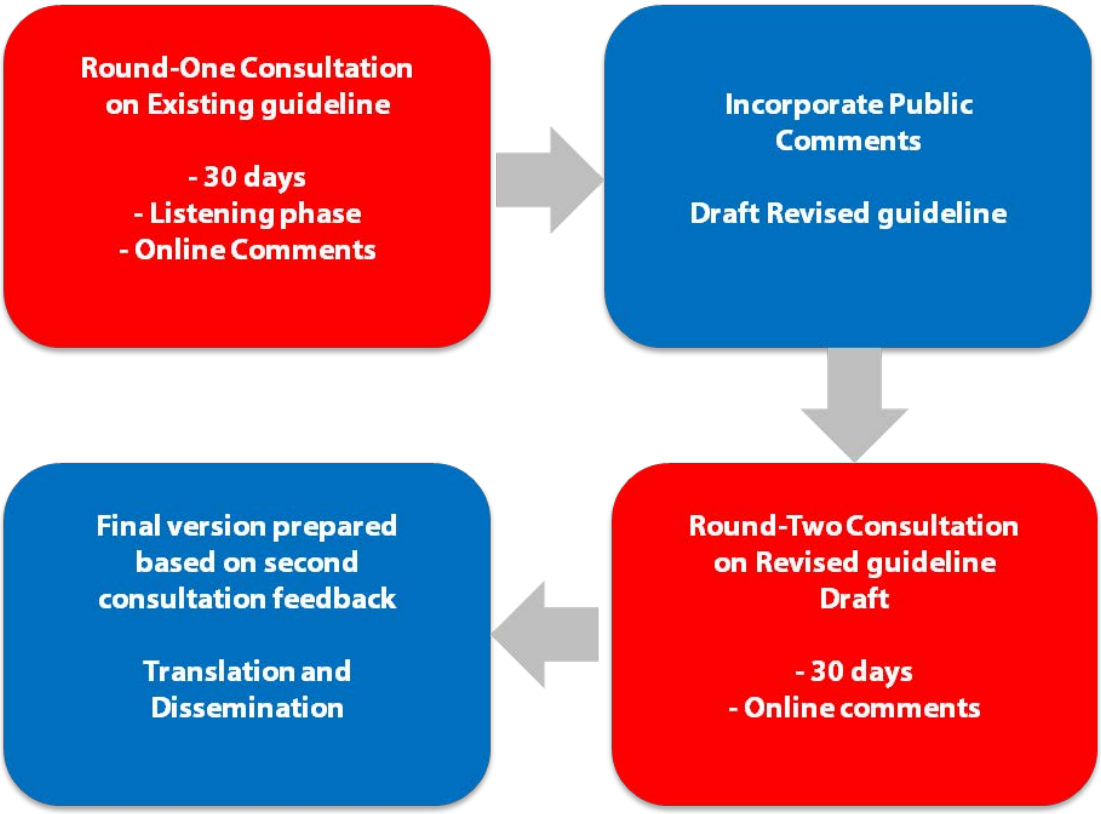
8.1. The World Bank Group's Industry Sector Guidelines

The World Bank Group (WBG)'s International Finance Corporation (IFC) has published a set of General Environment, Health and Safety (EHS) Guidelines for Industry. The WBG EHS Guidelines are developed by the IFC, in consultation with the World Bank (International Bank for Reconstruction and Development and International Development Association) and the Multilateral Investment Guarantee Agency (MIGA), and are used by WBG's clients. The guidelines address environmental matters and other issues that potentially apply to all industrial sectors, including community and occupational health and safety, construction and decommissioning. They are based on performance levels and measures that the IFC considers to be generally acceptable to the IFC and that are deemed achievable in new facilities at reasonable costs by existing technology (IFC, n.d.a). The guidelines present examples of general and industry-specific practices complying with IFC's definition of Good International Industry Practice (GIIP) as defined in IFC's Performance Standard 3: Resource Efficiency and Pollution Prevention (IFC, 2012). The EHS Guidelines have become a global standard, freely and publicly available, that serves to enhance scale and impact of good EHS practices globally. Over the past decade, an estimated USD 4.5 trillion in investments across emerging markets have adhered to these guidelines, or principles inspired by them.

The EHS Guidelines serve as technical reference documents for projects financed by IFC, including for the environmental assessment of projects, as described in IFC's Environmental and Social Review Procedures Manual (IFC, 2016). The guidelines can be used to form site-specific requirements for performance levels and measures as well as associated timelines. These requirements will apply even if they are more stringent than those defined by regulations in the host country of the project, unless the actors involved find that less stringent performance levels or measures are necessary due to the specific project circumstances, and submit a detailed justification demonstrating that their proposed alternative performance levels comply with the IFC's Performance Standard 3 on Resource Efficiency and Pollution Prevention (IFC, 2012). In cases where the requirements defined by regulations in the host country are more stringent than those set by the EHS Guidelines, the former apply (IFC, 2012, n.d.a).

The EHS Guidelines were first developed in 2007. A revision process was initiated in 2012, involving two rounds of online stakeholder consultations, each of them lasting for 30 days. The first one aims at gathering comments from stakeholders on the original 2007 guidelines, based on which a revised version is prepared and made available for the second round of consultations (IFC, n.d.b). The procedure is illustrated in Figure 6.

Figure 6. Procedure for revision of the IFC's EHS Guidelines for Industry



Source: IFC, n.d.b

The General EHS guidelines are accompanied by an extensive set of Industry Sector Guidelines (IFC, n.d.a), covering 61 sectors, grouped in eight categories, as presented in Table 22. The list includes guidelines that correspond to the three target sectors (see Annex A for more information on the selection of target sectors). All the guidelines are available on the IFC's website (www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/ehs-guidelines/), most of them in all the six official languages of the UN.

Table 22. The World Bank Group's EHS Industry Sector Guidelines

	Industrial sector/activity	Year of publication
Agribusiness/Food Production	Annual crop production	2016
	Aquaculture	2007
	Breweries	2007
	Dairy processing	2007
	Fish processing	2007
	Food and beverage processing	2007
	Mammalian livestock production	2007
	Meat processing	2007
	Perennial crop production	2016
	Poultry processing	2007
	Poultry production	2007
	Sugar manufacturing	2007
	Vegetable oil production and processing	2015
Chemicals	Coal processing	2007
	Large volume inorganic compounds manufacturing and coal tar distillation	2007
	Large volume petroleum-based organic chemicals manufacturing	2007
	Natural gas processing; nitrogenous fertilizer manufacturing	2007
	Oleochemicals manufacturing	2007
	Pesticides formulation, manufacturing and packaging	2007
	Petroleum refining	2016
	Petroleum-based polymers manufacturing	2007
	Pharmaceuticals and biotechnology manufacturing	2007
	Phosphate fertilizer manufacturing	2007
Forestry	Board and particle-based products	2007
	Forest harvesting operations	2007
	Pulp and paper mills	2007
	Sawmilling and wood-based products	2007
General Manufacturing	Base metal smelting and refining	2007
	Cement and lime manufacturing	2007
	Ceramic tile and sanitary ware manufacturing	2007
	Construction materials extraction	2007
	Foundries	2007
	Glass manufacturing	2007
	Integrated steel mills	2007
	Metal, plastic, rubber products manufacturing	2007
	Printing	2007
	Semiconductors and electronics manufacturing	2007
	Tanning and leather finishing	2007
	Textiles manufacturing	2007
Infrastructure	Airlines	2007
	Airports	2007
	Crude oil and petroleum product terminals	2007
	Gas distribution systems	2007
	Health care facilities	2007
	Ports, harbors and terminals	2017
	Railways	2007
	Retail petroleum networks	2007
	Shipping	2007
	Telecommunications	2007
	Toll roads	2007
	Tourism and hospitality development	2007

	Waste management facilities	2007
	Water and sanitation	2007
Mining	Mining	2007
Oil And Gas	Liquefied natural gas (LNG) facilities	2017
	Offshore oil and gas development	2015
	Onshore oil and gas development	2007
Power	Electric power transmission and distribution	2007
	Geothermal power generation	2007
	Thermal power	2008
	Wind energy	2015

Note: The hyperlinks in the document link to the English version of the documents.
Source: IFC, n.d.a

8.2. BAT and BEP guidance under the Minamata Convention on Mercury

A guidance document on BAT and best environmental practices (BEP) for the implementation of the Minamata Convention on Mercury was adopted in 2017, as called for in the Convention's Article 8. The document is available in six languages on the website of the Convention (www.mercuryconvention.org/Implementationsupport/Formsandguidance/tabid/5527/language/en-US/Default.aspx). The document consists of several sections addressing different industrial sectors and activities potentially emitting mercury as well as techniques that may be used to control or reduce such emissions. The different sections are listed in Table 23.

Table 23. BAT/BEP guidance documents under the Minamata Convention

Industrial sector/activity or technique	Year of publication
Common Techniques	2016
Monitoring	2016
Coal-fired power plants and coal-fired industrial boilers	2016
Smelting and roasting processes used in the production of non-ferrous metals (lead, zinc, copper and industrial gold)	2016
Waste incineration facilities	2016
Cement clinker production facilities	2016
New and emerging techniques	2016

Source: MCM, n.d.a

In October 2013, the Parties to the Convention established and mandated a Group of Technical Experts on Air Emissions, consisting of 31 technical experts from all regions, in addition to eight observers, so as to develop the BAT/BEP guidance called for in the Convention's Article 8 (MCM, n.d.). In developing the guidance, the expert group was required to pay attention to the need to minimise cross-media effects as well as to address other issues relevant to emissions (UNEP, 2015).

The expert group met four times over the period 2014-2015 and elaborated a draft guidance document for public consultation. After having addressed the comments received during the public consultation phase, the expert group submitted the document to the Intergovernmental Negotiating Committee on Mercury, which adopted the document, at a provisional basis, at its seventh session in 2016. The document was formally adopted at the first meeting of the Conference of the Parties in 2017 (MCM, n.db, UNEP, 2015).

The Convention's Article 8 requires the Parties to use BAT to control and, where feasible, to reduce emissions for new sources. BAT is also described by the Convention as one of many measures that may be used for existing sources. While the BAT/BEP guidance developed under the Convention does not impose any legal requirements on the Parties, these are obliged to take the guidance into account when determining BAT as well as to contribute to its review and update as appropriate through the Conference of the Parties (UN Environment, 2016).

In order to determine BAT, each Party is expected to assess its national circumstances in accordance with the definition of BAT contained in the Convention's Article 2. This definition provides for a consideration of economic and technical elements for a given Party or a given facility within its territory. As a consequence, the BAT/BEP guidance describes a range of potential BAT and is generally less conclusive than e.g. the EU BAT Conclusions. The Convention recognises that some of the control measures described in the guidance documents may not be available to all parties for technical or economic reasons. Financial support, capacity building, technology transfer or technical assistance is made available, as stated in the Convention's Articles 13 and 14 (UN Environment, 2016).

The process for selecting BAT at the national level under the Convention could be expected to include the following five general steps:

i. Establish information about the source, or source category, including on associated processes, input materials, feedstocks or fuels, actual or expected activity levels, including throughput, in addition to, where relevant, information on the expected life of the facility and any requirements or plans for controlling other pollutants;
ii. identify all optional techniques, and combinations of techniques, for emission control of relevance for the source of concern, including the common techniques and techniques for specific source categories described in the BAT/BEP guidance;
iii. among the full range of options, identify the control techniques that are technically viable, taking into account whether the techniques are applicable to the type of facility within the sector, in addition to any physical limitations which may influence the choice of certain techniques;
iv. select which of these options that are the most effective in terms of controlling and, where feasible, reducing emissions of mercury, taking into consideration the performance levels referred in the BAT/BEP guidance, and in terms of achieving a high general level of protection of human health and the environment as a whole; and
v. determine which of these options that can be implemented under economically and technically viable conditions, taking into account associated costs and benefits and whether they are accessible to the operator of the facility as determined by the party concerned. The techniques selected may differ for new and existing facilities. The need for maintenance and operational control of the techniques should also be taken into account in determining BAT, in order to ensure the achieved performance over time (UN Environment, 2016).

8.3. BAT guidelines under the Stockholm Convention on Persistent Organic Pollutants

The Stockholm Convention's Guidelines on Best Available Techniques and Guidance on Best Environmental Practices (SSCPOP, 2008) provide the necessary guidance called for in paragraph C of Article 5 of the Convention. This paragraph calls for parties to "promote the development and, where it deems appropriate, require the use of substitute or modified materials, products and processes to prevent the formation and release of the chemicals listed in Annex C, taking into consideration the general guidance on prevention and release reduction measures in Annex C and guidelines to be adopted by decision of the Conference of the Parties" (SSCPOP, 2008).

The guidance document describes the chemicals listed in the Convention's Annex C, i.e. polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans, polychlorinated biphenyls and hexachlorobenzene, and outlines key provisions and associated requirements under the Convention as well as how these relate to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal. The document also provides guidance for the consideration of alternatives in the application of BAT, including a checklist for the application of BAT to new sources. Furthermore, the document includes general guidance, principles and considerations applying to multiple source categories, in addition to specific guidelines for each of the source categories listed in Table 24. For each of the categories, the guidelines contain a process description, primary and secondary measures, performance levels, performance reporting and case studies. The guidelines are designed so as to serve a range of actors involved in the implementation of the Stockholm Convention at the national level, including policy makers, regulatory authorities, engineers, other technical users, other stakeholders and interested parties (SSCPOP, 2008).

Table 24. BAT guidelines under the Stockholm Convention on Persistent Organic Pollutants

Industrial sector/activity
Waste incinerators
Cement kilns firing hazardous waste
Production of pulp using elemental chlorine or chemicals generating elemental chlorine
Thermal processes in the metallurgical industry
Open burning of waste, including burning of landfill sites
Thermal processes in the metallurgical industry not mentioned in Annex C
Residential combustion sources
Fossil fuel-fired utility and industrial boilers
Firing installations for wood and other biomass fuels
Specific chemical production processes releasing chemicals listed in Annex c
Crematoria
Motor vehicles
Particularly those burning leaded gasoline
Destruction of animal carcasses
Textile and leather dyeing (with chloranil) and finishing (with alkaline extraction)
Shredder plants for the treatment of end-of-life vehicles
Smouldering of copper cables
Waste oil refineries

Note: The hyperlinks in the document link to the English version of the documents.
Source: SSCPOP, 2008

8.4. UNIDO's work on BAT implementation in developing countries

The United Nations Industrial Development Organisation (UNIDO) is carrying out a number of BAT/BEP projects in emerging countries in various industrial sectors. The interventions include capacity building to raise awareness of these concepts as well as targeted technical assistance and demonstrations for achieving a wide adoption of the BAT/BEP approaches.

Sectors targeted include metallurgical, textile and power industries as well as the waste sector in various regions. In Asia, UNIDO has introduced BAT/BEP approaches in Cambodia, Indonesia, Mongolia, the Lao People's Democratic Republic, Philippines and Thailand. The projects in these countries also involved guidance and awareness raising programmes on BAT and BEP as well as ensuring the incorporation of these concepts in the curricula at universities in all the countries (UNIDO, 2015).

From 2011 to 2016, UNIDO carried out projects in various African countries, assisting the implementation of BAT/BEP under the Stockholm Convention by organising workshops and awareness raising campaigns for government officials and private companies. The organisation has also supported the implementation of BAT/BEP in several countries in the Caribbean (UNIDO, 2015).

8.5. BAT projects in the EECCA region

In addition to the extensive BAT work carried out by the Government of the Russian Federation, a number of other BAT projects have been conducted in the Russian Federation and other countries in Eastern Europe, Caucasus and Central Asia (EECCA). This was highlighted by the United Nations Economic Commission for Europe (UNECE) during their 2016 Workshop to Promote the Understanding and Implementation of BAT across the Entire UNECE Region with focus on Countries in the EECCA Region (UNECE, 2016). For example, the Swedish Environmental Protection Agency has conducted projects in collaboration with environmental ministries in the Russian Federation and Belarus, involving activities using the GAINS model, which is a scientific tool to combat air pollution and climate change, to analyse emissions, effects and costs associated with wider BAT implementation. The EU and the governments of Sweden, Norway and the Netherlands have also financed trainings on the use of the GAINS model in EECCA countries (Yaramenka, 2016).

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Chapter 9. Key insights

This chapter presents key insights on the approaches that different governments have adopted to establish BAT or similar concepts aimed at preventing and controlling industrial pollution. It provides a number of good practices for the effective design and implementation of procedures to establish BAT by discussing the main similarities and differences across countries. The chapter also contains a summary table (Table 25), providing an overview of key components of national approaches to establish BAT.

9.1. BAT terminology and reference documents

The EU, Korea and the Russian Federation all operate with the term BAT, while the term Best Techno-Economically Available Techniques is more widely used in India, and Best Practicable Options (BPO) in New Zealand. In China, the most prevalent term is available techniques; however, BAT are referred to in some guidance documents. The US operates with a set of different terms, including Best Available Control Technology, Reasonably Available Control Technology and Maximum Achievable Control Technology.

All the countries examined have some variation of official reference documents for BAT or similar concepts. These are in most cases developed for individual industrial sectors (*vertical* BAT documents), but examples of horizontal BAT documents, i.e. thematic documents applying to all industrial sectors, are found in New Zealand, the Russian Federation, the EU and the US. The BAT documents in the EU, the Russian Federation and Korea are called BAT reference documents, or BREFs, while they are named Guidelines on Available Techniques of Pollution Prevention and Control in China. All of the above present a list of techniques identified as BAT, while the Indian equivalent – COINDS – are rather guidelines highlighting the advantages and disadvantages of various available techniques.

The US does not have one standardised format for BAT documents; different documents apply under each of the performance standard programmes, including New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants, in addition to Control Technique Guidelines providing recommendations for the determination of Reasonably Available Control Technology. New Zealand also has several different kinds of BAT-related documents, including governmental Good Practice Guides addressing local governments and industry-specific guidelines developed by sector associations, while the most relevant document for information on BPO in fact is discharge permits.

9.2. The legal status and function of BAT versus ELVs

All seven countries have some variation of BAT embedded in their environmental legislation, with a key function for the setting of emission limit values (ELVs) and other permit conditions. While ELVs are legally binding in all the countries, application of BAT is not mandatory by law in any of them. The BAT rather serve as technical guidance, helping industrial operators to design, operate, maintain and decommission their installations in compliance with the ELVs, i.e. to prevent or control emissions to air, soil and water.

The order of development of BAT and ELVs, respectively, varies across the countries. In the EU, the Russian Federation and Korea, ELVs are set based on already determined BAT. A similar procedure takes place in India; however, there are also cases where the Indian BAT documents (known as COINDS) are developed after the ELVs. In China, the setting of ELVs and identification of available techniques can be integrated into the same procedure. In New Zealand, BAT (usually termed BPO) is an optional policy tool that local governments may choose to apply as a means to enforce compliance with nationally defined ELVs. In the US, the procedure varies depending on the specific performance standard programme.

9.3. Procedures to determine BAT

The EU, the Russian Federation, Korea and China have a standardised methodology to establish BAT in place. India has a standardised procedure for the development of ELVs, which includes the consideration of available techniques; however, the procedure allows for methodological flexibility with regards to the latter. The US and New Zealand do not have one standardised methodology, as the procedures vary across policy programmes and regions.

In most of the countries, the selection of industrial sectors for development of BAT is based on a more or less formalised assessment of the environmental impact of the sectors. In the Russian Federation and the EU, the list of the sectors, or the criteria for selection of these, is embedded in the legislation. In Korea, the assessment of the sectors is based on advanced statistical analysis of environmental performance indicators. In New Zealand, the BPO may apply to any sectors, as these are defined for single industrial facilities in their discharge permit conditions, and in India, it depends – in part – on the availability of technologies for pollution prevention and control in each sector.

All countries have a procedure to establish BAT that involves an initial collection of information on techniques for the prevention and control of industrial emissions. This is primarily done through questionnaires and stakeholder meetings, and in some cases interviews, online registration points and literature research. The stakeholders involved in the information collection typically include representatives of governmental environmental authorities, i.e. ministries of environment or environmental protection agencies, and of the industry, i.e. industry associations and single operators. Depending on the country, the stakeholder group may also involve representatives of other ministries, such as for industry, business and trade, in addition to NGOs, research institutes and technique suppliers. In Korea, the Russian Federation, the EU and China, the stakeholders are grouped into sectoral Technical Working Groups or Development Groups. In India as well as under some of the BAT identification systems in the EU, an independent consultant or institute is given the mandate to collect information from stakeholders and available literature. In China, independent institutes are usually involved in the development of environmental standards.

Once the information on techniques is gathered, an evaluation procedure takes place. Generally, the same stakeholders oversee the evaluation and the information collection. In India and New Zealand, the characteristics of the evaluation procedure may vary across sectors, and does not necessarily result in the identification of certain techniques as BAT. In the EU, Korea, the Russian Federation and China, the procedure is more formalised, and a preselection of techniques is carried out prior to the primary evaluation procedure. In all the countries examined, technical and environmental aspects are taken into account as part of the evaluation of techniques, and in most cases also economic aspects. In a few cases, social aspects or other factors, such as biodiversity, are also considered. In some countries, notably Korea, emissions monitoring data constitutes a key source of information for the assessment of environmental aspects of techniques. Furthermore, scientific literature and industrial entities constitute important data sources.

In Korea, a third formal step is part of the procedure to establish BAT: following the identification of BAT, these are categorised based on the installation time or the type of fuel or raw materials used. None of the other countries have a formalised categorisation or prioritisation procedure. However, the EU operates with a hierarchy of techniques, giving priority to preventive techniques over end-of-pipe measures when selecting BAT.

9.4. Attributes and limitations

The countries' BAT policies are highly divergent in nature and were implemented at very different points in time. This restricts the ability to compare the attributes and limitations of the procedures to establish BAT. However, there are certain similarities between the strengths and drawbacks reported by stakeholders from the different countries. Those most frequently stressed by stakeholders are discussed below.

9.4.1. A BAT-based approach to emission limit values

In all countries, the evaluation of techniques and/or identification of BAT are part of, or a means to, the setting of legally binding ELVs. Stakeholders from many countries report that a BAT-based approach to the setting of legally binding ELVs appears to be beneficial for the prevention and control of industrial emissions. Notably, several national experts highlight the advantages of leaving industrial facilities with the freedom to choose their preferred means to achieve the ELVs, using BAT as a guiding – rather than prescriptive – policy tool. However, some stakeholders also point to the potential downsides of only ELVs – and not BAT – being legally binding, as this may lead industrial operators to neglect preventive measures and solely adopt end-of-pipe solutions. To avoid this tendency, some countries have integrated mechanisms for prioritisation of preventive techniques in their procedures for BAT establishment. Another suggested solution to this challenge is to develop ELVs based on load rather than on concentration.

9.4.2. A multi-stakeholder process

In all the countries, the BAT documents and the ELVs associated with BAT are the result of a comprehensive stakeholder process, often involving governmental experts, representatives of single industries or industry associations, members of NGOs and research institutes. The objective of this is to allow for a variety of perspectives to be taken into account in the steps to identification of BAT, thus providing a solid base for the determination of ELVs. Yet, some stakeholders report that the BAT determination procedure in their country is opaque. It appears that stakeholders can sometimes have difficulties obtaining information on the rationale behind the determination of BAT, ELVs or elements of these.

Another concern raised by stakeholders from several countries is that although all interested stakeholders in theory are entitled to participate in the BAT determination process, this is not always the case in practice, as representatives of smaller companies or industrial associations often do not have the resources to take part. In other cases, some groups of stakeholders – even if they have the resources – are not willing to share essential perspectives or information, such as economic data. This potentially prevents crucial elements from being taken into consideration when determining BAT.

9.4.3. An evidence-based process

In some countries, the determination of BAT is based on an in-depth analysis of monitoring data, allowing for a strengthened outcome. An adequate emissions monitoring system with high quality data seems to be highly beneficial to BAT determination and some of the countries that do not have advanced monitoring systems experience this as a drawback.

As stated above, an impediment to the adequate determination of BAT is in many cases the lack of access to data on the economic aspects of techniques. Although some of the

stakeholders involved, e.g. industrial operators and sector associations, possess such data, they are often not willing to share this information due to strategic reasons.

9.4.4. A time-consuming process

A weakness of the approach of many of the countries is the extensive time needed to identify BAT and finalise BAT documents – between one and six years, depending on the country. This stands in stark contrast to the fast technological evolution in many industrial sectors. Some country experts state that the lack of strict timelines is experienced as a drawback for the process. Moreover, some point out that the procedures for BAT establishment often are highly resource-intensive. On the other hand, stakeholders in countries with a short lead time per BAT document state that a tight schedule also may have a negative impact on the quality of the documents.

Table 25. Approaches to establishing BAT in the Russian Federation, Korea, the US, the EU, India, People's Republic of China and New Zealand

	Russian Federation	Korea	United States	European Union	India	People's Republic of China	New Zealand
Environmental legislation in which the BAT policy is embedded	Federal Law on Environmental Protection and related acts	Act on the Integrated Control of Pollutant-Discharging Facilities ('IPPC Act')	Clean Air Act (CAA); Clean Water Act; Pollution Prevention Act	Industrial Emissions Directive (IED); Eco-Management and Audit Scheme (EMAS) Regulation; Mining Waste Directive; Medium Combustion Plant Directive	Environmental Protection Act; Water (Prevention and Control of Pollution) Act; Air (Prevention and Control of Pollution) Act	Environmental Protection Law; Atmospheric Pollution Prevention and Control Law; Law on Prevention and Control of Water Pollution	Resource Management Act (RMA)
Predominant BAT terminology	BAT	BAT	Best Available Control Technology, Reasonably Available Control Technology, Maximum Achievable Control Technology, etc.	BAT	Best Techno-Economically Available Technology	Available Technologies of Pollution Prevention and Control	Best Practical Options (BPO)
Documents presenting or reflecting BAT	BREFs and lists of BAT-AELs	BREFs	Various technology-based performance regulations; Control Technique Guidelines (CTG) for volatile organic compounds; etc.	BREFs and BAT Conclusions; Sectoral Reference Documents and Best Practice Reports	Minimal National Standards (MINAS) and Comprehensive Industry Document Series (COINDS)	Guidelines on Available Technologies of Pollution Prevention and Control (GATPPCs), including ELVs	Horizontal guidance document and a few industry-specific guidelines; however, BPO are rather contained in discharge permits conditions, defined for each facility.
Legal status of BAT and associated emission limit values	BAT are not legally binding, but form the basis for legally binding BAT-AELs.	BAT are not legally binding, but form the basis for legally binding BAT-AELs.	Technology-based performance standards are legally binding; specific techniques are generally not legally	BAT are not legally binding, but form the basis for legally binding BAT-AELs.	The MINAS are legally binding, while the COINDS are guidance documents.	Only the ELVs are legally binding, and not the technologies presented in the GATPPCs.	BPOs are not legally binding, but can be used to enforce compliance with legally binding ELVs through discharge

			binding.				permits.
Standardised methodology to determine BAT	Yes, defined by the Federal Law on Standardisation.	Yes, defined by the IPPC Act.	No; there are several methodologies for the setting of technology-based performance standards, varying across sectors, environmental media and areas.	Yes, known as the *Seville Process* and defined by the IED. Variations of the *Seville Process* apply under other directives, regulations and for certain sectors.	There is a commonly used procedure for the setting of the MINAS. The development of COINDS is often part of this procedure, but can also happen later.	Yes, defined by the Development Guideline for Guidelines on Available Techniques of Pollution Prevention and Control. The Administrative Regulations for Revisions of Environmental Protection Standards prescribe the development of associated ELVs.	No, the methodologies are determined by the local governments.
Year of entry into force of the methodology	2018	2017	Varies across programmes.	BREFs developed since 1997; *Seville Process* adopted under the IPPC Directive (2008); BAT Conclusions introduced under the IED (2010)	n.a.	2018	1991
Time period required to develop documents presenting or reflecting BAT	One year	Three years	n.a.	Four years	Setting the MINAS usually takes two to three years; COINDS may be developed as part of this.	Varies from case to case	Varies from case to case
Selection of sectors for determination of BAT	Based on the list of installations falling into Category I, as defined by the Government Decree on Setting	Based on a statistical method relying on a system of Environmental Performance Scores,	Varies across programmes, but is generally based on the level of environmental concern, taking into	Based on the list of polluting industries that are within the scope of the IED, listed in its Annex I;	Based on the sectors' growth or pollution potential, i.e. their pollution contribution or impacts, and the	Based on the level of energy consumption and pollutant emissions, and defined in the	As BPO are defined as part of discharge permit conditions, they may apply to any industrial activities

	Criteria to Categories I, II, III and IV of Installations Causing Negative Environmental Impacts.	allowing identifying the sectors with the highest environmental impact. Production levels are taken into account.	account thresholds linked to potential emission levels.	however, industries for which there is limited pan-European benefit in reaching a consensual agreement on BAT are excluded .	availability of better production and pollution control techniques.	Development Guideline for Guidelines on Available Techniques of Pollution Prevention and Control.	emitting contaminants to air, water or soil.
BAT documents (or equivalent) available for the three target sectors							
Pulp and paper	Yes	In progress	Yes	Yes	Yes	Yes	No
Non-ferrous metals	Yes	Yes	Yes	Yes	Yes	Yes	No
Textiles	Yes	In progress	Yes	Yes	Yes	Draft available	No
Actors in charge of information collection and evaluation of techniques	Ministry of Industry and Trade; the BAT Bureau, and industry-specific TWGs.	The Integrated Permit System Division and the National Institute of Environmental Research, underlying the Ministry of Environment, and industry-specific TWGs.	The Environmental Protection Agency (EPA) for programmes applying nationally; state, local and tribal agencies for programmes applying at the corresponding levels.	The European IPPC Bureau (EIPPCB) and industry-specific TWGs. External contractors are involved in the information collection under the EMAS Regulation, the Medium Combustion Plant Directive and for the Hydrocarbons BREF.	The Ministry of Environment, Forests and Climate Change (MoEF&CC) and the Central Pollution Control Board (CPCB), assisted by external consultants, industry-specific Task Forces and the Peer and Core Group Committee (expert group).	The Ministry of Ecology and Environment (MEE); sector-specific GATPPC Development Groups; the MEE's Department of Science, Technology and Standards (DSTS) and Project Management Unit (PMU); appointed external institutes.	Local governments
Means/sources of collection of information on techniques	Questionnaires for industry operators, tailored to each sector.	Emissions monitoring data; questionnaires for industry operators; literature review, incl. of BAT documents from other countries.	Literature review; questionnaires for industry operators; information from trade associations; emission sources tests; information from permits, etc.	Industry-specific questionnaires for operators; information gathered by TWG members.	Background study by external consultants; stakeholder meetings, literature review, incl. of BAT documents from other countries; questionnaires.	Questionnaires for industry operators: literature review: expert discussions; national data management platforms; information from pollution discharge permits; monitoring data; on-site investigations and back-up tests. .	Information included in applications for discharge permits.

Procedure for evaluation of techniques, including criteria considered	Includes a procedure of preselection. Based on five criteria defined in the Government Decree on the procedure to determine technologies as BAT: environmental impact; economic efficiency: resource use; time required for implementation; at least two Russian cases of successful introduction. Public consultation included.	Includes a procedure of preselection. Based on analysis of the data gathered, notably the emissions monitoring data, and includes an evaluation of environmental, economic and technical aspects.	Varies across programmes. The CAA and regulations developed to implement the CAA dictate the specific factors to be considered and criteria for stringency for programmes applying to air emissions.	Includes a procedure of preselection. Based on the procedure to determine BAT Conclusions (listed in each BREF) and the criteria for determination of BAT defined in Annex III of the IED. Main criteria include industry-specific Key Environmental Issues, economic viability and technical aspects.	Based on the evaluation of technical, environmental, economic and quality aspects, through a series of exchanges between the actors involved. Public consultation included.	Includes a procedure of preselection. Based on criteria listed in each GATPPC, generally involving an integrated assessment of raw materials, production processes, techniques, environmental management measures, levels of resource consumption and emissions, types of pollutants, and industry operators' compliance with ELVs. Public consultation included.	Evaluation is carried out on a case-by-case basis, as part of the procedure to define permit conditions for each facility, taking into account specific circumstances, standards defined by the local government, the measures proposed in the permit application, the likelihood of successful implementation of a technique, in addition to its financial implications and environmental effects.
Steps to official approval and publication	The TWGs and the Ministry of Industry and Trade make the final decision on BAT. BAT-AELs shall be officially approved by the Government no later than six months after the official adoption of the BREFs, and become legally binding upon official publication by the Government or the Ministry for Natural Resources and Environment.	The Central Environmental Policy Committee makes the final decision on the BREFs. The BAT in the BREFs are categorised based on their time of installation, the type of fuel or raw materials used.	Proposed performance standards and supporting information are made available for public review. Comments are considered in finalising standards. National standards are published in a regulatory docket and initially in the Federal Register (the US Government Journal), before being officially codified in the "Code	BREFs are published by the European Commission and the BAT Conclusions are published as Commission Implementing Decisions in the Official Journal of the European Union.	MINAS are approved by the Law Ministry and COINDS by CPCB; both documents are notified in the Gazette of India (the public journal of the Central Government).	The Development Groups make the final decision on the GATPPCs. PMU and DSTS (MEE) are in charge of decision-making concerning environmental standards. The final documents are posted on MEE's website.	The BPO are approved as part of the definition of the permit conditions for each facility by the local government; however, many permits do not make reference to BPO.

			of Federal Regulations".				
Attributes of the methodology	Stakeholder involvement, objective selection of technologies.	Restriction system which ensures that confidential data only can be accessed by TWG members	Performance standards are generally applied in the form of quantified emission limits, giving companies flexibility to decide the best way to achieve the ELVs, considering costs and other factors.	The methodology is tried and trusted, robust and ensures environmental improvement.	Because MINAS are legally binding, while the COINDS are guidelines only, industrial operators have the flexibility to choose the techniques best suited to their conditions.	BAT can help ensure the achievement of ELVs.	The determination of BPO is tempered by economic and efficiency criteria, allowing for a more flexible, fit-for-purpose and cost-effective approach, rather than prescribing more expensive BAT.
Limitations of the methodology	Short time to develop BAT documents, not all the stakeholders are willing to participate, small companies are less involved.	The configuration of the TWG; data collection through field surveys, comprehensive data analysis.	n.a.	Limited resources availability; long response time to rapid technological developments; assessment is not based on life cycle thinking.	Due to the MINAS being legally binding, industrial facilities tend to focus on end-of-pipe solutions; thus, process-integrated techniques are often neglected.	Perceived lack of transparency, concerns regarding accountability for ELV achievement if BAT fail.	The performance-based approach under the RMA and the devolved nature of the implementation of the Act to local governments can lead to variation in standards of control across the country.

Annex A. Selection of target industrial sectors

Selected target sectors

The following target sectors were selected for Activity 2:

i. Processing of non-ferrous metals;
ii. pre-treatment (operations such as washing, bleaching, mercerisation) or dyeing of textile fibres or textiles; and
iii. Production of pulp and paper.

The target sectors were chosen based on the following criteria:

i. The number of countries in which the sector is subject to the implementation of BAT;
ii. the sector's relevance regarding emission reductions of chemicals in the environment, e.g. emissions into air, water, etc.; and
iii. the sector's willingness' to participate in the project.

The sections below provide details about how the three criteria were used to assess potential target sectors.

Criterion 1: The number of countries in which the sector is subject to the implementation of BAT

Based on the outcome of Activity 1 and literature research, the following sectors for which BAT are defined were identified.

Table 26. Sectors for which BAT reference documents (BREFs) are available in at least four countries

	EU	US	NZ	Russia	India	China
Combustion of fuels in installations	X	X		X	X	
Production of pig iron or steel (primary or secondary fusion) including continuous casting	X	X		X	X	X
Processing of non-ferrous metals	X	X		X	X	
Production of cement, lime and magnesium oxide	X	X		X	X	X
Manufacture of glass including glass fiber	X	X		X	X	X
Manufacture of ceramic products by firing, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain	X	X		X	X	X
Production of organic chemicals	X	X		X	X	
Production of inorganic chemicals	X	X		X		X
Production of phosphorous-, nitrogen- or potassium-based fertilizers (simple or compound fertilizers)	X	X		X	X	X
Production of pharmaceutical products including intermediates	X	X			X	X
Production of rubber		X	X	X	X	X
Disposal or recovery of waste in waste incineration plants or in waste co-incineration plants	X	X		X		
Production of pulp and paper	X	X	X	X	X	X
Pre-treatment (operations such as washing, bleaching, mercerisation) or dyeing of textile fibers or textiles	X	X		X	X	X
Treatment and processing, other than exclusively packaging, of the following raw materials, whether previously processed or unprocessed, intended for the production of food or feed	X	X	X		X	X
Intensive rearing of poultry or pigs	X	X	X	X	X	X
Preservation of wood and wood products with chemicals	X	X	X	X	X	X
Independently operated treatment of waste water	X	X	X	X	X	(X)

Table 27. Sectors for which BREFs are available in three countries

	EU	US	NZ	Russia	India	China
Refining of mineral oil and gas	X	X		X	X	
Gasification or liquefaction of coal and other fuels	X			X		(X)
Processing of ferrous metals	X	X		X	X	
Production of asbestos or the manufacture of asbestos-based products	X	X			X	
Production of plant protection products or of biocides	X	X			X	
Disposal of non-hazardous waste	X	X		X		

Note: Some of the BREFs used for the above assessment are more than ten years old.

Criterion 2: The sector's relevance regarding emission reductions of chemicals in the environment

Based on Yin, Zheng and Li (2016) and EU (2014), a list of industries emitting pollutants to air, soil and water was defined (as presented in Tables 26 and 27, considering the quantity and characteristics (hazardous, toxic, etc.) of the emissions from each sector as well as the sectors' potential for emissions reduction, including some where this has already been achieved. However, the categorisation of sectors in Tables 26 and 27 differs slightly from that of Yin, Zheng and Li (2016) and the EU (2014). The categorisation used in the studies is presented below.

i. Iron and steel industry;
ii. non-ferrous metals industry;
iii. production of industrial and other chemicals;
iv. pulp and paper industry;
v. non-metallic mineral production;
vi. production and supply if electrical power, steam and hot water;
vii. petroleum refineries;
viii. wood production;
ix. food production;
x. miscellaneous petroleum, coal production;
xi. leather production;
xii. textile industry;
xiii. beverages; and
xiv. rubber production.

Criterion 3: The sector's willingness' to participate in the project

During the Expert Group on BAT's First Meeting (November 2016) and teleconference (14 March 2017), participants discussed the sectors' willingness to participate in the project. Based on the discussions, the following list of sectors, in which one or more countries showed an interest, was made:

i. Processing of non-ferrous metals;
ii. pre-treatment (operations such as washing, bleaching, mercerisation) or dyeing of textile fibres or textiles;
iii. combustion of fuel;
iv. cement;
v. pulp and paper production;
vi. production of ferrous metals; and
vii. waste management.

References

EU (2014), "Contribution of industry to pollutant emissions to air and water", AMEC Environment & Infrastructure UK Limited in partnership with Bio Intelligence Service, Milieu, IEEP and REC, https://circabc.europa.eu/sd/a/c4bb7fee-46df-4f96-b015-977f1cca2093/Contribution%20of%20Industry%20to%20EU%20Pollutant%20Emissions-AMEC%20Final%20Report%2013298i5.pdf

Yin, J., M. Zheng and X. Li (2016), "Interregional transfer of polluting industries: a consumption responsibility perspective", *Journal of Cleaner Production*, Vol. 112/5, vol. 4318–4328.

Annex B. Questionnaire for Activity 2

OECD BAT project
Activity 2 on methodologies and criteria used in developing BAT

Contact information

Organization

Name:

.....

Country:

.....

Contact person

Name:

.....

Email:

.....

Phone number:

.....

Background and Scope

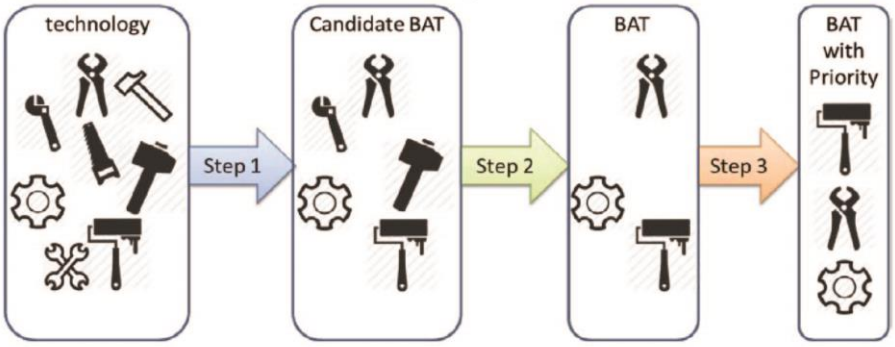
In view of the OECD's Best Available Techniques (BAT) project , the OECD would like to collect information on the methodologies and criteria used in developing BAT policy.
Generally speaking, there are two main steps in developing BAT. In some cases a third step is part of the methodology;

1) collecting wide range of techniques and making a list of candidate BAT,

2) evaluating each technique from various aspects (e.g. technical, environmental, economic) by experts, categorizing as BAT or not, and making a BAT list, and – in some cases:

3) ranking or prioritizing individual techniques within the BAT list.

The picture below is an illustration of the three steps.



Considering these procedures, this section seeks information on the methodologies and criteria used, in each step, to be applied in developing specific BATs.

When responding to this questionnaire, the non-ferrous metals and pulp and paper industries should be kept in mind as examples. The questionnaire does not seek answers on methodologies to determine or evaluate generic techniques applied in a wide range of sectors, nor on methodologies to determine BAT for one specific pollutant.

General information

01 For which policy instrument on selecting and evaluation BAT the questionnaire will be filled in. Please, fill in the paragraph number of the BAT policy instrument as presented the Activity I report.

In case the report on Activity I is not available, this question will ask for the name of the policy.

02 Is there a standardized methodology and/or a rule for the procedure of selection and evaluation of techniques to develop BAT?

☐ Yes ☐ No

03 Is the approach the same for the selection and evaluation of BAT for different environmental compartments (e.g. air, water, soil, etc.)?

☐ Yes ☐ No

04 Is the approach the same for the selection and evaluation of BAT for different sectors?

☐ Yes ☐ No

05 In case you only make BAT-evaluations for certain sectors:

- Why are these sectors selected?
- How are these sectors selected?
- Do you take into account certain thresholds on production levels, on emission levels or on volume of raw materials used?

06 Please mark which steps (related to the figure above) are part of your approach for nominating BAT.

- Step 1
- Step 2
- Step 3

07 How long does it typically take to develop a BAT sector report?

14 Who is involved in the collection of environmental friendly techniques?

☐ Environmental administration ☐ Economic Affairs administrations ☐ Business operators
☐ Experts nominated by one or more administrations ☐ Expert nominated by industrial associations
☐ Industry associations ☐ Companies ☐ NGOs ☐ Technique suppliers
☐ Business operators ☐ Others, please specify

15 In case different stakeholders are involved, how is the information exchange organized? Indicates if this is done in a formal or informal way.

☐ by means of technical working groups ☐ ad hoc consultation
☐ questionnaires and written consultation ☐ Others, please specify

16 When candidate BAT are evaluated to become BAT, which criteria are taken into account?

☐ Technical aspects ☐ Environmental benefit ☐ Economic aspects
☐ Social aspects ☐ Other, please describe

17 Technical aspects, which elements are taken into account?

> Technological readiness level? > Safety? > Type of technology
o Preventive, process integrated, end-of-pipe?
> Quality? Applicability e.g.

☐ an indication of the type of plants or processes within the sector to which the technique cannot be applied,
☐ constraints to implementation in certain generic cases, considering, e.g.:
☐ whether it concerns a new or an existing plant, taking into account factors involved in retrofitting (e.g. space availability) and interactions with techniques already installed,
☐ plant size, capacity (large or small) or load factor,
☐ quantity, type or quality of product manufactured,
☐ type of fuel or raw material used,
☐ animal welfare,
☐ climatic conditions.
☐ Other, please specify

Which monitoring data or information are used for the assessment of candidate BAT in relation to the technical aspects?

☐ from suppliers ☐ from one individual company ☐ from a group of companies
☐ from sector associations ☐ from research companies or research papers ☐ Other

18 Environmental benefit

> 1. Are there relevant environmental aspects or issues selected for a certain sector, on which techniques have to have an impact to become BAT?
> In case of yes, how are "relevant" environmental aspects nominated to take into account in the assessment?

☐ Relevant environmental aspects and pollutants are selected for a certain sector and used for the evaluation of all the candidate BAT in that sector

- Top – down method (starting from a general list of aspects and pollutants for all industrial sectors and selecting the one which are relevant for the non-ferrous metal or pulp and paper sector)
- Bottom up method (based on monitoring and experience, selecting the relevant aspects and pollutants for a certain sector)
- Combined methodology, …
- Other approach, …

☐ Relevant environmental aspects and pollutants are defined on the level of a candidate BAT

> 2. How are the positive and negative environmental effects (cross-media) of a technique assessed? Is there a method?

- Description (based on multi-criteria analysis, expert-judgement, other).
- Reference
- Link

> 3. Which monitoring data or information are used for the assessment of candidate BAT in relation to the environmental benefits?

☐ from suppliers ☐ from one individual company ☐ from a group of companies
☐ from sector associations ☐ from research companies or research papers ☐ Other

19 Economic aspects

- When is a technique considered economically viable?
- Which economic tools are used?
- How do you evaluate affordability?
- How do you evaluate cost-effectiveness?

> 1. Which data or information are used for the assessment of candidate BAT in relation to the economic aspects?

☐ from suppliers ☐ from one individual company ☐ from a group of companies
☐ from sector associations ☐ from research companies or research papers ☐ Other

20 Social aspects

> 1. Which criteria are taken into account?

21 Other aspects

1. Which aspects and criteria are taken into account?

Step 3: Prioritisation of BAT

22 How the prioritisation of BAT is done?

- ☐ stakeholder meetings
- ☐ expert analysis
- ☐ public consultations
- ☐ Other

> 1. Is the approach documented? If yes: please provide the reference and/ or of the link to the document.
> 2. If BAT are ranked, what criteria are taken into account?

Decision making and data handling

23 Decision making

> 1. Who is responsible for the final decision on the evaluation of the technique?

24 Data handling

> 1. Who is responsible for the checking the quality of data, and how is it validated?
> 2. How is data (e.g. on economic or technical issues) confidentiality dealt with?

Lessons learned

> 1. What do you consider to be the 3 best attributes of your system for identifying BAT?
> 2. What do you consider to be the 3 main limitations of your system for identifying BAT?

Annex C. Experts consulted for the development of this report

Country	Name	Organisation
Korea	Youn Jung Bae	Seoul National University
	Jaewoong Lee	National Institute of Environmental Research
	Yeon-joung Bae	Research Institute of Green Eco Engineering
	Yong-Hwan Cho	Ministry of Environment
Russian Federation	Ksenia Bagrintceva	CIS Centre
	Vladimir Maksimov	Ministry of Economic Development
	Tatiana Guseva	Russian BAT Bureau
United States	Steve DeVito	US EPA
	Gail Lacy and colleagues	US EPA's Office of Air and Radiation
European Union	Alex Radway	DG Environment, the European Commission
	Ian Hodgson	DG Environment, the European Commission
	Stefan Drees	European Chemical Industry Council (Cefic),
	Serge Roudier	Joint Research Centre, European IPPC Bureau, the European Commission
	Annalisa Bortoluzzi	BIAC
	Annika Månsson	Swedish Environmental Protection Agency
India	Manoranjan Hota	MoEF&CC
	J. S. Kamyotra	CPCB
	V. P. Yadav	CPCB
	P.K. Mishra	CPCB
	Nazimuddun, Divya Sinha	CPCB
	D.C. Jakhwal	CPCB
	Kamlesh Singh	CPCB
	Reena Satavan	CPCB
	Sumit Sharma	The Energy and Resources Institute (TERI)
	Sourabh Manuja	The Energy and Resources Institute (TERI)
	Nivit Kumar Yadav	Centre for Science and Environment (CSE)
	Sanjeev Kumar Kanchan	Centre for Science and Environment (CSE)
	Amit Jain	IRG System South Asia Private Limited
	Deepshikha Sharma	Innovation Centre Denmark Embassy of Denmark, New Delhi
	Purnima Dhall	Delhi University
	Paresh Misra and colleagues	Shahi Exports Private Limited
People's Republic of China	Fei Weiliang	FECO, MEE
	Chen Xinying	FECO, MEE
	Hao Zhao	Ministry of Water Resources
	Li Yun Cheng	Ministry of Water Resources
	Shen Kejun	Ministry of Water Resources
	Guan Chenghua	Capital Institute of Science and Technology Development Strategy
	Zhao Zheng	Capital Institute of Science and Technology Development Strategy
	Bai Ying	Capital Institute of Science and Technology Development Strategy
	Yuan Xiangfei	Capital Institute of Science and Technology Development Strategy

	Cai Guangzhi	Capital Institute of Science and Technology Development Strategy
	Jianxin Zhu	Chinese Academy of Science
	Chen Yang	Chinese Academy of Science
New Zealand	Peter Dawson	New Zealand Environmental Protection Authority
	Owen Cox	New Zealand Environmental Protection Authority
	Rachel Rait	Ministry for the Environment
	Rapunzel De Leon	Ministry for the Environment

Best Available Techniques (BAT) have emerged as a key policy tool to prevent and control the emission of industrial pollutants, and thereby to ensure the protection of human health and the environment. BAT are the state of the art of processes, facilities or methods of operation which indicate the practical suitability of a particular measure for limiting emissions. This report presents the first comprehensive analysis of approaches to establishing BAT and similar concepts around the world, including in OECD Members and Partners as well as under international conventions.

The report demonstrates the key characteristics of more than nine methodologies to establish BAT and similar concepts, providing governments with good practice insights on how to effectively design or review their approach to determining BAT. It also presents a unique, international compilation of existing BAT documents, allowing interested stakeholders to seek guidance from already identified BAT.

www.oecd.org/chemicalsafety/risk-management/best-available-techniques.htm