Official Journal of the European Union

L 174

English edition

Legislation

Volume 59

30 June 2016

Contents

II *Non-legislative acts*

DECISIONS

(1) Text with EEA relevance

EN

Acts whose titles are printed in light type are those relating to day-to-day management of agricultural matters, and are generally valid for a limited period.

The titles of all other acts are printed in bold type and preceded by an asterisk.

II

(Non-legislative acts)

DECISIONS

COMMISSION DECISION (EU) 2016/1031

of 6 November 2015

on the measures SA.35956 (13/C) (ex 13/NN) (ex 12/N) implemented by Estonia for AS Estonian Air

and

on the measures SA.36868 (14/C) (ex 13/N) which Estonia is planning to implement for AS Estonian Air

(notified under document C(2015) 7470)

(Only the English text is authentic)

(Text with EEA relevance)

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union, and in particular the first subparagraph of Article 108(2) thereof,

Having regard to the Agreement on the European Economic Area, and in particular Article 62(1)(a),

Having regard to the decisions by which the Commission decided to initiate the procedure laid down in Article 108(2) of the Treaty, in respect of the aid SA.35956 (13/C) (ex 13/NN) (ex 12/N) [1] and in respect of the aid SA.36868 (14/C) (ex 13/N) [2],

Having called on interested parties to submit their comments pursuant to the provisions cited above and having regard to their comments,

Whereas:

1. **PROCEDURE**

1.1. **The rescue case (SA.35956)**

(1) By letter dated 3 December 2012, Estonia notified the Commission of its plans to provide rescue aid in favour of AS Estonian Air ('Estonian Air' or 'the airline') as well as of several capital injections carried out in the past. A meeting with the Estonian authorities took place on 4 December 2012.

(2) Following those pre-notification contacts, by SANI notification number 7853 of 20 December 2012, Estonia notified to the Commission the planned provision of rescue aid to the airline in the form of a loan facility amounting to EUR 8,3 million.

(3) On the basis of the information provided by the Estonian authorities, it appeared that the first tranche of the rescue loan was disbursed to Estonian Air on 20 December 2012. For this reason, the Commission registered the case as non-notified aid (13/NN) and informed Estonia of the reclassification of the case by letter of 10 January 2013. Furthermore, the Commission requested additional information by letter of 10 January 2013, to which Estonia replied by letter of 21 January 2013.

(1) OJ C 150, 29.5.2013, p. 3 and 14.
(2) OJ C 141, 9.5.2014, p. 47.

(4) By letter dated 20 February 2013, the Commission informed Estonia that it had decided to initiate the procedure laid down in Article 108(2) of the Treaty in respect of the rescue aid amounting to EUR 8,3 million and the measures granted in the past.

(5) By letter dated 4 March 2013, Estonia informed the Commission of its decision of 28 February 2013 to increase the rescue loan granted to Estonian Air by EUR 28,7 million. By letter dated 16 April 2013, the Commission informed Estonia that it had decided to extend the procedure laid down in Article 108(2) of the Treaty to the additional rescue aid (jointly with the decision referred to in recital 4, 'the rescue aid opening decisions').

(6) Estonia submitted comments on the rescue aid opening decisions by letters dated 9 April and 17 May 2013. The Commission requested additional information from Estonia by letter of 8 April 2013, which Estonia replied to on 18 April 2013.

(7) The rescue aid opening decisions were published in the *Official Journal of the European Union* on 29 May 2013 ([3]). The Commission invited interested parties to submit comments on the measures. The Commission received comments from two interested parties, namely International Airlines Group ('IAG') and Ryanair. The Commission forwarded them to Estonia, which was given the opportunity to react; Estonia's observations were received on 5 August 2013.

1.2. **The restructuring case (SA.36868)**

(8) Following informal contacts with the Commission, Estonia notified a restructuring plan — including a recapitalisation of the airline amounting to EUR 40,7 million — on 20 June 2013, by SANI notification number 8513. The notification was registered with number SA.36868 (13/N).

(9) The Commission requested additional information by letters dated 16 July and 28 October 2013, to which the Estonian authorities replied by letters dated 28 August and 25 November 2013. Estonia submitted additional information by e-mail of 22 December 2013.

(10) In addition, the Commission received a complaint from Ryanair dated 23 May 2013 concerning Estonia's plans to increase the capital of Estonian Air as well as a sale-and-lease-back agreement between Estonian Air and Tallinn Airport regarding an office building owned by Estonian Air. On 25 June 2013, the Commission forwarded the complaint to Estonia. Estonia's comments were submitted by letter dated 5 August 2013 ([4]).

(11) By letter dated 4 February 2014, the Commission informed Estonia that it had decided to initiate the procedure laid down in Article 108(2) of the Treaty in respect of the notified restructuring aid ('the restructuring aid opening decision') ([5]).

(12) Estonia submitted comments on the restructuring aid opening decision by letter dated 19 March 2014. A meeting with the Estonian authorities and Estonian Air took place on 7 May 2014, followed by a telephone conference on 30 June 2014. In addition, a meeting with the Estonian authorities and their legal representative took place on 28 August 2014, after which Estonia provided additional information by e-mail on 10 September 2014.

(13) On 31 October 2014, the Estonian authorities submitted a modified restructuring plan. Following that, meetings with the Estonian authorities were held on 23 November, 11 December and 19 December 2014 and additional information was submitted by the Estonian authorities on 3, 10 and 19 December 2014.

(14) Additional information was submitted by the Estonian authorities on 14, 27 and 28 January, 13 February, 11 March, 8 and 30 April, 27 May, 17 July and 26 August 2015. In addition, meetings with the Estonian authorities were held on 14 and 15 January, 27 March, 21 April (telephone conference), 7 May (telephone conference), 28 May and 15 September 2015.

([3]) See footnote 1.

([4]) Given that the complaint was submitted on 23 May 2013, before Estonia notified Estonian Air's restructuring plan on 20 June 2013, the complaint was registered under the rescue case, i.e. SA.35956. However, given that the complaint partly related to the plans of the Estonian authorities to recapitalise the airline, it was assessed in the context of the opening decision on the restructuring case, i.e. SA.36868.

([5]) The restructuring aid opening decision was corrected by Commission decision C(2014) 2316 final of 2 April 2014.

(15) The restructuring aid opening decision was published in the *Official Journal of the European Union* on 9 May 2014 ([6]). The Commission invited interested parties to submit their comments on the measures. The Commission received comments from two interested parties, namely Ryanair and an interested party who does not wish its identity to be disclosed. The Commission forwarded them to Estonia, which was given the opportunity to react; Estonia's observations were received on 15 August 2014.

(16) By letter dated 8 October 2015, Estonia informed the Commission that they exceptionally accept that this Decision be adopted and notified in English, thereby waiving its rights deriving from Article 342 of the Treaty in conjunction with Article 3 of Regulation 1 ([7]).

2. THE ESTONIAN AIR TRANSPORT MARKET

(17) The main airport of Estonia is Tallinn Airport, which in 2013 served 1,96 million passengers down from 2,21 million passengers in 2012, that is to say, a decrease of 11,2 %. In 2013, 13 different airlines performed scheduled flights to and from Tallinn and a total of 20 routes were operated all year round ([8]). In 2014, Tallinn Airport served 2,02 million passengers, an increase of 3 % compared to 2013. In total 15 different airlines operated 20 routes on a year-round basis ([9]).

(18) Estonian Air carried 27,6 % of the passengers flying via Tallinn in 2013, down from 40,2 % in 2012, although it maintained its leader position. Also in 2013, Ryanair and Lufthansa carried 15,1 % and 10,5 %, respectively, of passengers travelling to/from Tallinn, closely followed by Finnair and airBaltic ([10]). In 2014, Estonian Air's share of total passengers further decreased to 26,6 %, followed by Lufthansa with 13,4 % and Ryanair with 11,5 % of the total passengers ([11]).

(19) Due to the stability of the Estonian economy in 2013, passenger demand for air transport remained high, which presented other airlines an opportunity to increase their supply and market share ([12]). In 2013, Turkish Airlines started to operate flights to/from Istanbul and Ryanair added seven new routes, while Lufthansa and airBaltic increased their frequencies. In 2014, new airlines started operating scheduled routes from Tallinn, such as for example TAP Portugal (to/from Lisbon) and Vueling (to/from Barcelona) ([13]).

(20) According to the manager of Tallinn Airport, the whole of Estonia can be deemed the catchment area of this airport. At the same time, most of Estonia is also located within the catchment area of other international airports such as Helsinki, Riga and Saint Petersburg ([14]).

3. THE BENEFICIARY

(21) Estonian Air, a stock company under Estonian law, is the flag carrier airline of Estonia, based in Tallinn Airport. Currently, the airline has around 160 employees and operates a fleet of seven aircraft.

(22) Estonian Air was formed as a State-owned company after the independence of Estonia in 1991 from a division of the Russian airline Aeroflot. After privatisation efforts and subsequent changes in the airline's shareholding structure, Estonian Air is currently owned by Estonia (97,34 %) and the SAS Group ('SAS') (2,66 %).

([6]) See footnote 2.
([7]) Regulation 1 determining the languages to be used by the European Economic Community (OJ 17, 6.10.1958, p. 385/58).
([8]) The other airports in Estonia (Tartu, Pärnu, Kuressaare and Kärdla regional airports and Kihnu and Ruhnu airfields) carried 44 288 passengers in 2013. In 2013, Tartu was the only regional airport in Estonia with a scheduled international flight to Helsinki. Source: 2013 annual report of AS Tallinna Lennujaam, manager of Tallinn Airport, available at http://www.tallinn-airport.ee/upload/Editor/Aastaaruanded/Lennujaama%20aastaraamat_2013_ENG.pdf
([9]) Source: 2014 annual report of AS Tallinna Lennujaam, manager of Tallinn Airport, available at http://www.tallinn-airport.ee/upload/Editor/Ettevote/Lennujaama%20aastaraamat_ENG_2014_23.5.15.pdf
([10]) Source: Estonian Air's consolidated annual report for 2013, available at http://estonian-air.ee/wp-content/uploads/2014/06/ESTONIAN-AIR-ANNUAL-REPORT-2013.pdf
([11]) Source: Estonian Air's consolidated annual report for 2014, available at https://estonian-air.ee/wp-content/uploads/2014/04/Estonian-Air-Annual-Report-2014-FINAL-Webpage.pdf
([12]) Source: 2013 annual report of AS Tallinna Lennujaam, see footnote 8.
([13]) Source: web page of Tallinn Airport (http://www.tallinn-airport.ee/eng/).
([14]) See footnote 12.

(23) Estonian Air participates in one joint venture: Eesti Aviokütuse Teenuste AS (51 % share), which provides refuelling service to aircrafts at Tallinn Airport. Estonian Air also participated in the joint venture AS Amadeus Eesti (60 % share), which provides Estonian travel agencies with booking systems and support, but in early 2014 it sold its stake to Amadeus IT Group, SA ([15]). Estonian Air also had a 100 %-owned subsidiary, AS Estonian Air Regional, which operated commercial flights to neighbouring destinations in cooperation with Estonian Air. This subsidiary was sold in June 2013 to Fort Aero BBAA OÜ, a private jet operator ([16]).

(24) Estonian Air has made heavy losses since 2006. More than half of the airline's equity disappeared between 2010 and 2011. In that period, the airline lost more than one quarter of its capital.

(25) Despite capital injections in 2011 and 2012, the airline's financial situation continued to deteriorate in 2012. In May 2012, a monthly loss of EUR 3,7 million was incurred, above the budgeted loss of EUR 0,9 million. By the first half of 2012, the losses of Estonian Air had reached EUR 14,9 million ([17]). In June 2012, Estonian Air revised its forecast for 2012 and estimated EUR 25 million in operational losses for the year (the original budget forecasted an annual loss of EUR 8,8 million). By the end of July 2012, Estonian Air had reached a state of technical bankruptcy under Estonian law. In the financial year 2012, the airline made a loss of EUR 49,2 million.

(26) The net loss of Estonian Air in 2013 amounted to EUR 8,1 million ([18]). In 2014, its net loss reached EUR 10,4 million ([19]).

4. DESCRIPTION OF THE MEASURES AND THE RESTRUCTURING PLAN

(27) This section provides a description of the measures under assessment both as regards the rescue case (SA.35956), that is to say, measures 1 to 5, and the restructuring plan notified under the restructuring case (SA.36868).

4.1. The 2009 capital increase (measure 1)

(28) Tallinn Airport and the airline were a single company until 1993, when the airline became an independent entity. In 1996, Estonia privatised 66 % of the shares of the airline. After privatisation, the shares were held as follows: 49 % by Maersk Air, 34 % by the Ministry of Economic Affairs and Communications of Estonia, and 17 % by Cresco Investment Bank ('Cresco'), a local investment bank. In 2003, SAS bought the 49 % stake of Maersk Air, while the other shareholdings remained the same.

(29) According to the information provided by Estonia, the airline sought new capital from its shareholders in 2009 for two main reasons. First, at the beginning of 2008, Estonian Air made a down payment in cash of EUR […] (*) million to acquire three new Bombardier regional jets in order to upgrade the fleet to more efficient aircraft. Secondly, the business model did not work under the stress of the financial crisis and the airline faced liquidity problems at the end of the year.

(30) In February 2009 all the shareholders increased the airline's capital by EUR 7,28 million in proportion to their shareholdings. Estonia injected in cash EUR 2,48 million, while Cresco provided EUR 1,23 million also in cash. SAS injected a total of EUR 3,57 million, of which EUR 1,21 million in cash and EUR 2,36 million in the form of a loan-to-equity conversion. The shareholding structure of Estonian Air did not change as a result of measure 1.

4.2. The sale of the ground handling section in 2009 (measure 2)

(31) In June 2009, Estonian Air sold its ground handling business to the State-owned Tallinn Airport at a price of EUR 2,4 million. At the time of the sale, Tallinn Airport was 100 % owned by Estonia.

(15) See http://www.baltic-course.com/eng/transport/?doc=86191
(16) See http://www.aviator.aero/press_releases/13003. At the time of the sale, AS Estonian Air Regional was dormant and had no aircraft, no employees, and no assets.
(17) Source: Estonian Air's review of performance for the first half of 2012, available at http://estonian-air.ee/wp-content/uploads/2014/04/ENG-1H-2012.pdf
(18) See footnote 10.
(19) See footnote 11.
(*) Business secret

(32) The Estonian authorities explained that no open, transparent and unconditional tender took place. Also, the sale price was not based on an expert opinion but it was based on the book value of the assets for sale. Depreciated assets were taken into account by adding value. According to the Estonian authorities, the price was established in direct negotiations between Tallinn Airport and Estonian Air.

4.3. **The 2010 capital injection (measure 3)**

(33) On 10 November 2010, Estonia injected EUR 17,9 million (EEK 280 million) in cash into the capital of Estonian Air while SAS carried out a loan-to-equity conversion for an amount of EUR 2 million. At the same time, SAS acquired Cresco's 17 % stake in the airline in exchange for a EUR […] loan write-off that Cresco held with SAS and thus Cresco ceased to be a shareholder.

(34) The decision to acquire the majority ownership of the airline was based on a business plan dating from 2010 ('the 2010 business plan'). At the same time, Estonia wanted to ensure long-term flight connections between Tallinn and the most important business destinations and saw gaining control of the airline through a capital injection as the best way to reach this objective.

(35) The capital was apparently used for pre-payments of USD […] million for three Bombardier CRJ900 aircraft which were delivered in 2011, as well as to cover part of the net loss in 2011 amounting to EUR 17,3 million.

(36) As a result of the 2010 capital injection, Estonia became majority owner with 90 % of the shares of Estonian Air, while SAS's participation was diluted to 10 %. As indicated in recital 33, Cresco — which held 17 % of the shares of Estonian Air since the airline's privatisation in 1996 — ceased to be a shareholder and decided not to inject more money into the airline ([20]).

4.4. **The 2011/2012 capital increase (measure 4)**

(37) In November 2011, Estonia decided to inject EUR 30 million in capital into Estonian Air and to increase its stake to 97,34 %. The capital injection was carried out in two tranches of EUR 15 million each, one on 20 December 2011 and the other on 6 March 2012. SAS did not participate to this capital injection and its shareholding was diluted from 10 % to 2,66 %. Since then, the shareholding structure of Estonian Air has not changed.

(38) The capital injection was apparently carried out on the basis of a business plan dated October 2011 ('the 2011 business plan'). The 2011 business plan was based on the assumption that a bigger network and more frequencies would improve the airline's competitiveness. It was considered that a good hub structure (hub-and-spoke network) would attract passengers and allow flexibility to reallocate traffic through a hub to counter seasonality or sudden changes in demand. In addition, the hub volumes were considered to allow the lowering of seat cost by utilising bigger aircraft. The regional network model was considered to allow the airline to grow in size and reduce risks. The 2011 business plan also implied an increase of connections to and from Estonia, of the fleet and consequently an increase of staff to handle more round trips.

(39) According to the 2011 business plan, Estonian Air would require EUR 30 million from its shareholders and loan from the private bank […]. Although the Estonian branch of the bank allegedly approved the loan through its credit committee, the loan was in the end refused by the highest credit committee of […] in November 2011. Notwithstanding this refusal, Estonia decided to provide EUR 30 million to Estonian Air.

4.5. **Rescue loan facility (measure 5)**

(40) In view of the bad mid-2012 results of Estonian Air (losses of EUR 14,9 million), it became clear to the management of the airline that the hub-and-spoke strategy of the 2011 business plan had not succeeded. In this context, Estonia decided to provide additional support to the airline in the form of rescue aid.

([20]) See Baltic Reports of 7 June 2010, *Government sets bailout deal for Estonian Air*, http://balticreports.com/?p=19116

(41) The rescue measure consisted of a loan amounting to EUR 8,3 million provided by the Ministry of Finance of Estonia with an annual interest rate of 15 %. A first instalment of the loan of EUR 793 000 was already disbursed on 20 December 2012, the second instalment of EUR 3 000 000 on 18 January 2013 and the remaining EUR 4 507 000 on 11 February 2013 ([21]). Estonia committed to communicate to the Commission a restructuring plan or a liquidation plan or proof that the loan had been reimbursed in full not later than six months after the first implementation of the rescue aid measure, namely by 20 June 2013.

(42) On 4 March 2013, the Estonian authorities informed the Commission of their decision dated 28 February 2013 to increase the rescue loan facility by EUR 28,7 million on the basis of a request of Estonian Air setting out its liquidity needs. Of that amount, EUR 16,6 million were granted to the airline on 5 March 2013 after signing an amendment to the previous loan agreement, while the remaining EUR 12,1 million of the rescue aid facility were provided to Estonian Air on 28 November 2014 ([22]). The terms of the additional rescue loan were the same as those of the original rescue loan, namely the loan had to be originally reimbursed at the latest by 20 June 2013 (reimbursement was then postponed following the notification of the restructuring case) and an interest of 15 % p.a. would be charged.

(43) The total amount of the rescue loan facility was thus of EUR 37 million and it has been all discharged to Estonian Air in several tranches as described in recitals 40 and 41.

(44) On 5 December 2013, at the request of Estonian Air, Estonia decided to lower the interest rate of the rescue loan from the initial 15 % to 7,06 % as from July 2013. According to the Estonian authorities, the reason for this decision was that the airline's risk profile had changed since the rate was set in December 2012.

4.6. **The notified restructuring aid and the restructuring plan (measure 6)**

(45) On 20 June 2013, Estonia notified restructuring aid of EUR 40,7 million to Estonian Air in the form of an equity injection, on the basis of a restructuring plan ('the restructuring plan') covering a five-year restructuring period from 2013 to 2017.

4.6.1. *Return to viability by 2016*

(46) The restructuring plan aims at restoring Estonian Air's long-term viability by 2016. The restructuring plan assumes that it will be possible to turn around the existing level of losses from earnings before taxes ('EBT') of EUR – 49,2 million in 2012 to break-even level by 2015 and to profitability by 2016. According to the restructuring plan's assumptions, Estonian Air will generate EBT of EUR 1,3 million by 2016.

Table 1

Profit and loss 2009-2017

(in EUR million)

	2009	2010	2011	2012	2013(f)	2014(f)	2015(f)	2016(f)	2017(f)
Revenues	62,759	68,583	76,514	91,508	71,884	73,587	76,584	78,790	80,490
EBITDA ([1])	2,722	3,181	(6,830)	(10,037)	6,510	8,454	9,918	10,000	10,813
EBT	(4,434)	(2,617)	(17,325)	(49,218)	(7,052)	(1,577)	(0,002)	1,296	2,031
EBT margin	(7 %)	(4 %)	(23 %)	(54 %)	(10 %)	(2 %)	(0 %)	2 %	3 %
Total equity	7,931 ([2])	23,958	36,838	(14,683)	18,964	17,387	17,385	18,681	20,712

([1]) Earnings before interest, taxes, depreciation and amortisation.
([2]) Exchange rate EUR 1 = EEK 15,65.

(47) Concerning profitability, the restructuring plan aims at achieving a return on capital employed ('ROCE') of 6,2 % and a return on equity ('ROE') of 6,9 % by 2016, and of 9,8 % and 8,9 % respectively by 2017.

([21]) See also http://www.e24.ee/1106240/estonian-airile-makstakse-valja-kolm-miljonit-eurot/
([22]) See Estonian Air's consolidated annual report for 2014, available at https://estonian-air.ee/wp-content/uploads/2014/04/Estonian-Air-Annual-Report-2014-FINAL-Webpage.pdf as well as press article 'Estonian government approves of last loan payment to Estonian Air' of 20 November 2014: http://www.baltic-course.com/eng/transport/?doc=99082

Table 2

Forecasted ROE and ROCE 2013-2017

(%)

	2013	2014	2015	2016	2017
ROE	(37,2)	(9,1)	(0,0)	6,9	9,8
ROCE	(6,6)	0,8	7,1	6,2	8,9

4.6.2. *Restructuring measures*

(48) To achieve those results, the restructuring plan envisages a number of key actions. For instance, Estonian Air decreases the size of its fleet, passing from 11 aircraft in December 2012 to 7 planes as of August 2013. The airline also rationalises the fleet: from the initial aircraft mix (including four Embraer E170, three Bombardier CRJ900, three Saab 340 and one Boeing 737), Estonian Air aims at having a single- type fleet of seven CRJ900 by the end of 2015. Of these seven aircraft, five would be used to serve the airline's route network and the remaining two would be wet-leased or chartered.

(49) Estonian Air has downsized its route network, passing from 24 routes available in 2012 to 12 routes, of which two are seasonal ([23]). The airline thus discontinued 12 routes, which are designated as compensatory measures (see Table 4). The downsizing of the route network entails a capacity reduction of 37 % in terms of ASK ([24]) and 35 % in terms of seats offered (in 2013 figures compared to 2012). Furthermore, Estonian Air reduced by 23 % the ASK in those routes maintained as core.

(50) Estonian Air has already reduced its headcount from 337 employees in April 2012 to 197 in March 2013 and around 160 at present, beyond the original plan to reduce staff down to 164 employees. Furthermore, Estonian Air sold to Tallinn Airport an office building and a hangar.

(51) According to the restructuring plan, Estonian Air also plans to implement a new pricing model (fewer booking classes/price groups and fare regulations, as well as product disaggregation aimed at generating higher levels of ancillary income) and a number of measures to improve the quality of its services, including the channels through which they are sold. In particular, Estonian Air intends to increase the revenues resulting from marketing campaigns — mainly through digital channels — from EUR [200-500 thousand] in 2013 to EUR [1,5-2,5] million in 2017. Also, the new online service fee will increase revenues from EUR [200-500 thousand] in 2013 to EUR [1-2] million in 2017. Those measures should increase revenues by EUR [10-20] million in the next five years.

(52) In addition, according to the restructuring plan, Estonian Air plans to implement a number of measures to reduce costs, including the signing of a collective agreement regarding pay scale increases, vacation and pilot utilisation; the introduction of a multifunctional employee concept, especially in back office staff; increased fuel efficiency via improved flight operations, including reduced take off power and fine tuning, reduced distribution and commission costs; efficiencies from the single type fleet; and contractual renegotiations such as ground handling, catering and airport charges. Those measures should yield EUR [20-30] million in the next five years.

(53) Furthermore, the restructuring plan envisages the reorganisation of the airline's senior management team.

4.6.3. *Compensatory measures*

(54) As part of its restructuring, Estonian Air discontinued a total of 12 routes, which are designated as compensatory measures. The restructuring plan also highlights that the slots given up in London Gatwick (LGW), Helsinki (HEL) and Vienna (VIE) should be counted as compensatory measures since these are coordinated (capacity constrained) airports.

([23]) The restructuring plan maintains the following 10 'core' routes: Amsterdam (AMS), Stockholm (ARN), Brussels (BRU), Copenhagen (CPH), Kiev (KBP), Saint Petersburg (LED), Oslo (OSL), Moscow Sheremetyevo (SVO), Trondheim (TRD) and Vilnius (VNO). The seasonal routes are Paris Charles de Gaulle (CDG) and Nice (NCE). However, it appears from press articles and public statements of Estonian Air that Estonian Air has operated — and intends to operate in the future — seasonal routes beyond the ones contained in the restructuring plan, namely Munich (MUC), Split (SPU) and Berlin (TXL). It also appears that as from 2015, Estonian Air intends to add Milan (MXP) to its offers of seasonal routes.

([24]) ASK stands for available seat kilometre (seats flown multiplied by the number of kilometres flown). ASK is the most important capacity indicator of an airline as employed by the air transport industry and by the Commission itself in previous restructuring cases in the air transport sector.

Table 3

Routes designated as compensatory measures

(%)

Destination	Load factor (2012)	Level 1 contribution [1] (2012)	DOC contribution [2] (2012)	Profitability margin (2012)	Capacity given up in ASK (% compared to total capacity pre-restructuring)
Hannover (HAJ)	66	82	− 18	− 67	2
Helsinki (HEL)	54	60	− 64	− 126	1
Joensuu (JOE)	60	77	− 35	− 111	0
Jyväskylä (JYV)	53	76	− 40	− 117	0
Kajaani (KAJ)	42	75	− 82	− 168	0
Riga (RIX)	45	59	− 143	− 310	1
London Gatwick (LGW)	80	85	− 1	− 36	5
Tartu (TAY)	42	62	− 100	− 183	1
Tbilisi (TBS)	76	84	− 27	− 89	4
Kuressaare (URE)	33	86	8	− 36	0
Venice (VCE)	87	84	10	− 35	1
Vienna (VIE)	71	84	− 13	− 59	3

(1) Level 1 contribution margin is defined as total revenue less passenger-related variable costs over total revenue.
(2) The plan defines DOC contribution as total revenue less passenger, round trip and fuel-related costs over total revenue.

4.6.4. *Own contribution*

(55) According to the restructuring plan the own contribution would consist of EUR 27,8 million from the planned sale of three aircraft in 2015, EUR 7,5 million from the sale of property, EUR 2 million from the sale of other non-core assets, and EUR 0,7 million from a new loan to be provided by […]. Given the total restructuring costs of EUR 78,7 million, the own contribution (totalling EUR 38 million) would correspond to 48,3 % of the restructuring costs. The remaining part of the restructuring costs would be funded by restructuring aid granted by Estonia in the amount of EUR 40,7 million in the form of equity, part of which would be used to repay the rescue loan.

4.6.5. *Risk and scenario analysis*

(56) The restructuring plan provides a scenario analysis including, beside the base case on which the restructuring plan is based, a best case ('high case') and a worst case ('low case') scenario. On the one hand, the high case assumes an annual GDP growth in Europe of 5 %, a growth in ancillary revenues of EUR 7 million resulting from improved product positioning and a 5 % average passenger increase. According to the restructuring plan, the high case would result in positive EBT already in 2014. On the other hand, the low case is based on the assumption that GDP growth in Europe will continue to be low until 2017 which will lead to a 12 % decrease in the number of passengers. The negative consequences of the fall in the number of passengers would however be mitigated by a number of management actions, namely a 10 % roundtrip frequency reduction, a 1 % increase in the price of tickets, an increase in the number of ancillary revenues from EUR 4,5 per passenger in 2015 to EUR 6,5 per passenger in 2017, a 10 % reduction in consulting costs and other department costs, and further reduction of crew (5 pilots and 5 cabin crew members between 2014 and 2016). Taking into consideration the mitigating management actions, the low case would result in slightly positive EBT in 2017 but still lead to negative net cash before financing. The restructuring plan claims that in none of the cases additional funding would be needed.

Table 4

Scenario analysis 2013-2017

(in EUR million)

		2013	2014	2015	2016	2017
High case	EBT	[(8)-(7)]	[0-1]	[3-4]	[6-7]	[9-10]
	Net cash before financing	[(10)-(9)]	[7-8]	[6-7]	[5-6]	[8-9]
Low case	EBT	[(8)-(7)]	[(4)-(3)]	[(3)-(2)]	[(1)-0]	[0-1]
	Net cash before financing	[(10)-(9)]	[2-3]	[1-2]	[(1)-0]	[(1)-0]

(57) The restructuring plan also provides a sensitivity analysis upon the base case which covers selected factors: 5 % or 10 % decrease in yield targets, 5 % decrease in the number of passengers, 5 % or 10 % increase in fuel costs, 5 % or 10 % decrease in the target sale price for the aircraft to be sold in 2015 (see recital 55 above) and 5 % appreciation and depreciation in the USD/EUR exchange rate. The restructuring plan considers the impact that each factor individually considered would have on the recovery of the airline and concludes that additional funding between EUR [1-10] million and EUR [30-40] million would be needed in all cases (except in case there is a 5 % USD/EUR exchange rate appreciation). In addition, in most of the cases, break-even would not be reached by the end of the planned restructuring period, namely 2017.

4.7. **The modified restructuring plan of 31 October 2014**

(58) On 31 October 2014, the Estonian authorities submitted a substantially modified restructuring plan. The modifications of the plan relate in particular to the following:

(1) Planned acquisition of Estonian Air by a private investor, the Estonian investment group Infortar ([25]), which is envisaged to acquire […] % shares from Estonia by […] 2015;

(2) Extension of the restructuring period from five to more than six years, with the start date moved backwards from 2013 to November 2010 and the end date moved from end 2017 to November 2016;

(3) A modified business plan, taking into account privatisation and envisaged synergies with the ferry operator Tallink, partly owned by Infortar, as well as additional adjustments due to recent developments (Ukraine crisis, lower than expected passenger numbers on some lines due to competition, etc.).

(59) By moving backwards the start date of the restructuring period to November 2010, the modified restructuring plan also captures as restructuring aid the capital injections of 2010 (measure 3) and 2011/2012 (measure 4). The total restructuring aid amount would thus increase from EUR 40,7 million as per the original restructuring plan to EUR 84,7 million.

(60) As a result of the extension of the restructuring period and the planned entry of a private investor in 2015, the modified restructuring plan covers three distinct business strategies based on separate contemporaneous business plans:

(1) 2011-April 2012: Strategy to expand and develop a regional hub-and-spoke operator (financed to a large part by the two State capital injections under measures 3 and 4 and based on a business plan prepared by the new management appointed after the State had acquired 90 % of Estonian Air shares in November 2010), involving among others:

([25]) Infortar is one of the largest private investment groups in Estonia with interests in shipping (including a 36 % stake in Tallink, a large passenger and cargo shipping company active in the Baltic Sea region), real estate, financial services, etc. In 2013, the Infortar group made a net profit of EUR 20 million and held assets worth EUR 432 million.

(a) expansion of the fleet from 8 to 11 aircraft (plus 2 additional on order);

(b) developing Tallinn into a regional hub with significantly increased number of routes operated (from 13 in March 2011 to 24 in September 2012);

(c) increased number of staff from 255 to 337.

(2) April 2012-2014: Strategy to reduce capacity and change business model to a point-to-point regional network carrier, focusing on a limited number of core routes. The measures included among others:

(a) reduction of the fleet from 11 to 7 aircraft;

(b) reduction of routes operated from 24 to 12 routes;

(c) reduction of the number of staff from 337 to 164;

(d) replacement of the previous CEO and the management team.

(3) 2015-2016: Strategy providing for the entry of a private investor, synergies with the ferry operator Tallink and additional adjustments taking into account weaker performance in 2014:

(a) continue focusing on [5-15] core routes but increase the number of seasonal routes from [1-5] to [5-10] by 2016;

(b) supplement the current 7 aircraft with […] small regional aircraft ATR42s (wet-leased) to service the additional seasonal routes;

(c) utilise revenue and cost synergies with the private investor and its subsidiaries (Tallink ferry, hotels, taxi services, etc.).

(61) The Estonian authorities argue that despite changing strategies, the restructuring period from November 2010 to November 2016, namely from the acquisition by the State of 90 % of the shares of Estonian Air until the airline returns to profitability according to the modified restructuring plan, can be considered as part of one 'restructuring continuum' with the single goal of making the airline profitable and economically sustainable. They claim that it is one long-term process with changing tactics of how to achieve the desired outcome — once it was found that the hub-and-spoke strategy did not function, it was abandoned and replaced by a different strategy but with the same desired goal of profitability and sustainability.

(62) The modified restructuring plan envisages return to viability by 2016, at the end of the 6-year restructuring period as shown in Table 5.

Table 5

Profit and loss 2011-2016

(in EUR million)

	2011	2012	2013	2014(f)	2015(f)	2016(f)
Revenues	76,514	91,508	72,123	68,463	81,244	97,098
EBITDA	(6,830)	(10,037)	6,943	5,735	11,907	21,715
EBT	(17,325)	(49,218)	(8,124)	(11,417)	(3,316)	3,874
EBT margin	(23 %)	(54 %)	(11 %)	(17 %)	(4 %)	4 %
Total equity	36,838	(14,683)	(22,808)	(32,406)	6,548	10,423

(63) Compared to the original restructuring plan, the airline should increase its focus on non-core routes and businesses (for example, adding further seasonal routes or expanding its wet-lease business). Further, the airline should take advantage of a number of synergies that it can develop both on revenue and costs side with Tallink. Therefore, the modified restructuring plan envisages much stronger revenue growth in 2015 and 2016 than the original restructuring plan.

(64) As regards own contribution, the modified restructuring plan envisages a total own contribution of EUR [100-150] million, representing [50-60] % of the restructuring costs. That amount includes — apart from the revenues from asset sales and a new [loan, already accounted for in the originally notified restructuring plan — financing provided in 2010 in equity and loans by SAS (EUR […] million), financing for the purchase of aircraft obtained in 2011 from Export Development Canada (EDC) and […] (EUR […] million), a planned equity contribution by Infortar in 2015 (EUR […] million) and an intra-group credit line to be provided by Infortar in 2015 (EUR […] million).

(65) The compensatory measures proposed in the modified restructuring plan include fleet downsizing, discontinuation of routes and resulting market share reduction. Between 2010 and 2016, the airline would have reduced its permanent fleet by one aircraft (from eight to seven). Compared to 2012, the reduction in 2016 would be down to four aircraft. Further, between 2010 and 2016, the modified restructuring plan envisages an overall reduction of routes from [20-25] to [15-20]. While the airline has given up eight routes (Athens, Barcelona, Dublin, Rome, Hamburg, London, Berlin and Kuressaare), three routes would be added (Gothenburg, Split and Trondheim). Overall, the capacity flown would remain stable with [1 000-1 200] million ASKs in 2016 compared to [1 000-1 200] million ASKs in 2011. As regards market share, the Estonian authorities argue that Estonian Air's market share dropped from 40,2 % in 2012 to 26,3 % in 2014.

(66) As regards the entry of a private investor, the modified restructuring plan envisages that Infortar would not pay anything to the State for its stake in Estonian Air. Instead, it would provide a capital injection of EUR […] million into Estonian Air (thereby acquiring by April 2015 between […] of its shares) plus an additional intra-group credit line of EUR […] million. Estonia would provide the remaining part of the rescue loan (up to EUR […] million) and then write-off a majority of its loans (up to EUR […] million […]) and give up its shareholding by agreeing to a reduction of the share capital to zero and then waiving its right to subscribe for the new capital increase, while possibly retaining up to […] % of Estonian Air shares.

(67) Infortar was not chosen on the basis of an open, transparent and unconditional tender but rather through direct negotiations with Estonia. The Estonian authorities argue that there was no time to organise a long tender process and that it actively approached a number of potential investors while others also had an opportunity to express their interests. Infortar was the only one to express a real interest backed by a contribution to the modified restructuring plan. In addition, the Estonian authorities argue that the value of Estonian Air was determined by an independent and reputed expert which concluded that the total equity value of Estonian Air as of 31 March 2015 from the perspective of a potential private investor would fall within a range of EUR […] million.

5. THE OPENING DECISIONS

5.1. The rescue aid opening decisions

(68) On 20 February 2013, the Commission decided to initiate the formal investigation procedure in respect of the measures granted in the past (measures 1 to 4) and the rescue loan facility. On 4 March 2013, the Commission extended the formal investigation procedure to the increase of the rescue loan facility.

(69) In the rescue aid opening decisions, the Commission highlighted that Estonian Air has continuously registered significant losses since 2006. In addition, the Commission noted that the airline showed some of the usual signs of a firm being in difficulty in the sense of the Community guidelines on State aid for rescuing and restructuring firms in difficulty [26] ('the 2004 R&R Guidelines') and that more than half of the airline's equity disappeared between 2010 and 2011. Also, by the end of July 2012, Estonian Air had reached a state of technical bankruptcy under Estonian law. On this basis, the Commission's preliminary view was that Estonian Air qualified as a firm in difficulty between 2009 and 2012.

[26] OJ C 244, 1.10.2004, p. 2.

(70) The Commission also expressed doubts as regards the measures under assessment and came to the preliminary conclusion that they entailed incompatible State aid. In relation to **measure 1**, although it appeared that it had been carried out on *pari passu* terms by the three shareholders of the airline at the time, the Commission observed that the new shares were paid in cash and through loan-to-equity conversion. Since the Commission had no detailed information on which shareholders had injected fresh money and which had accepted a loan-to-equity conversion, the Commission could not exclude the presence of an undue advantage to Estonian Air and thus took the preliminary view that measure 1 entailed unlawful State aid. As regards its compatibility with the internal market, the Commission noted that given the difficulties of the airline, only Article 107(3)(c) of the Treaty seemed applicable. However, the Commission came to the preliminary view that this was not the case since measure 1 did not meet several of the criteria of the 2004 R&R Guidelines.

(71) As regards **measure 2**, the Commission observed that, at the time of the sale, Tallinn Airport was 100 % owned by Estonia and that it lied within the jurisdiction of the Ministry of Economic Affairs and Communications, which seemed to indicate that the actions of Tallinn Airport could be deemed imputable to the State. In addition, since no open, transparent and unconditional tender had taken place, the Commission could not automatically exclude the presence of an undue advantage to Estonian Air and came to the preliminary view that measure 2 entailed unlawful State aid. It also preliminarily concluded that that aid was incompatible since the criteria of the 2004 R&R Guidelines were not met, including a possible breach of the 'one time, last time' principle.

(72) In relation to **measure 3**, the Commission first noted that it was not carried out on *pari passu* terms. It also highlighted that — as was the case for measure 2 — the contributions of the State and SAS had a different nature (fresh money from the State v conversion of debt from SAS) and were not of comparable amounts. As regards the 2010 business plan, the Commission doubted whether it could be regarded as sufficiently sound to conclude that a prudent private investor would have entered into the transaction in question on the same terms and also noted that Cresco had apparently disagreed with the plan and refused to inject additional money in the airline. Also, the Commission observed that Estonia had stated that the decision to increase capital in 2010 was taken in order to ensure the long-term flight connections to the most important business destinations and to gain control of the airline. On that basis, the Commission preliminarily concluded that measure 3 entailed unlawful State aid, which would be not be compatible with the internal market since it did not seem to respect the legal requirements of the 2004 R&R Guidelines, including a possible breach of the 'one time, last time' principle.

(73) The Commission also assessed whether **measure 4** would be in accordance with the market economy investor principle ('MEIP'). It first raised doubts as to whether the 2011 business plan was reliable and whether it was realistic to consider that only a bigger network and more frequencies, implying a capacity increase in terms of connections, fleet and staff, would improve the airline's competitiveness. The Commission also observed that the forecast growth prospect of the 2011 business plan seemed overoptimistic and the proposed hub-and-spoke strategy appeared extremely risky, something which appeared to be confirmed by the fact that neither the remaining private shareholder (SAS) nor any private creditor ([…]) was willing to participate in the transaction. In view of those considerations, the Commission came to the preliminary view that measure 4 entailed unlawful State aid and that it did not meet the criteria set out for rescue or restructuring aid under the 2004 R&R Guidelines.

(74) Finally, as regards the rescue loan facility (**measure 5**), the presence of aid was not disputed by Estonia. The Commission preliminarily noted that the aid seemed to fulfil most of the criteria of Section 3.1 of the 2004 R&R Guidelines concerning rescue aid. However, the Commission had doubts as to whether the 'one time, last time' principle had been respected in view of the fact that measures 1 to 4 could have entailed unlawful and incompatible aid. Since the Estonian authorities did not provide any justification allowing for an exception to the 'one time, last time' principle, the Commission came to the preliminary view that measure 5 could be regarded as unlawful and incompatible aid.

(75) For the part of the rescue loan not been disbursed at the time, namely EUR 12,1 million (see recitals 42 and 43 above), the Commission reminded Estonia of the suspensory effect of Article 108(3) of the Treaty. It added that Estonia should refrain from providing that amount to Estonian Air until the Commission had reached a final decision.

5.2. **The restructuring aid opening decision**

(76) On 20 June 2013, Estonia notified restructuring aid to Estonian Air of EUR 40,7 million in the form of equity on the basis of the restructuring plan (**measure 6**). The State-aid character of the measure was not disputed by Estonia, inter alia, given that the planned capital injection would come directly from the State budget and would exclusively benefit Estonian Air at conditions that a prudent market economy investor would normally not accept.

(77) The Commission then assessed the compatibility of measure 6 on the basis of the restructuring aid provisions of the 2004 R&R Guidelines. The Commission came to the preliminary opinion that Estonian Air would be eligible for restructuring aid since it would qualify as a firm in difficulty (see recital 69).

(78) The Commission then looked at whether the restructuring plan would allow Estonian Air to restore its long-term viability. The Commission observed that the scenario analysis and the sensitivity analysis of the restructuring plan showed significant weaknesses. In particular, it noted that in the low case scenario, Estonian Air would reach a slightly positive EBT in 2017. However, the net cash before financing would remain negative even after additional restructuring measures are adopted by the management of the airline (see Table 4). Moreover, the sensitivity analysis showed that relative minor changes in the assumptions would result, on a stand-alone basis, in the need for additional funding except in one case. On that basis, the Commission doubted whether the original restructuring plan provided a sound basis for restoring the long-term viability of Estonian Air.

(79) As regards compensatory measures, the Commission expressed doubts concerning the acceptability of the release of slots in a number of coordinated airports. Additional information on the capacity-constrained nature of the airports and economic value of the slots was necessary in order to assess whether these slots could be accepted as compensatory measures. As regards the discontinuation of 12 routes considered as compensatory measures (see recital 54 above), it was unclear to the Commission how the 'Level 1 contribution', 'DOC contribution' and the profitability margin of those routes had been calculated. The Commission noted that the difference between those profitability indicators was very pronounced and that it was unclear whether Estonian Air would have had to give up the routes in any event in order to return to viability. In particular, the Commission noted that all routes had a negative profitability margin. Also, if the Commission were to use the DOC contribution level to assess route profitability, only two routes — corresponding to a capacity decrease of around 1 % in terms of ASK — would have a DOC contribution level above 0 and would be acceptable.

(80) In relation to the proposed own contribution of Estonian Air of EUR 38 million (or 48,3 % of the total restructuring costs of EUR 78,7 million), the Commission noted that it appeared in principle acceptable. However, the Commission expressed doubts on the sale of three aircraft CRJ900 in 2015, the sale of AS Estonian Air Regional and the sale of Estonian Air's 51 % stake in Eesti Aviokütuse Teenuste AS. The Commission nonetheless considered that the sale of property, a new loan from […] and the sale of Estonian Air's 60 % stake in AS Amadeus Eesti could be accepted as own contribution.

(81) Finally, the Commission recalled its doubts in the rescue aid opening decisions as regards the compatibility of measures 1 to 5, which could lead to a breach of the 'one time, last time' principle.

(82) On that basis, the Commission doubted whether the notified restructuring measure complied with the 2004 R&R Guidelines and would be compatible with the internal market. It requested Estonia to submit comments and to provide all information as may help to assess the capital injection notified as restructuring aid.

(83) As regards the complaint received on 23 May 2013 regarding a sale-and-lease-back agreement between Estonian Air and Tallinn Airport (see recital 10 above), the Commission concluded that it did not entail an undue advantage to Estonian Air and thus excluded the presence of State aid.

6. **COMMENTS ON THE OPENING DECISIONS**

6.1. **Comments from Estonia**

(84) Estonia provided comments on the Commission's rescue aid opening decisions by letters of 9 April and 17 May 2013. As regards **measure 1**, Estonia is of the view that the investment was completed on the basis of a credible business plan and a positive valuation of the airline. Estonia indicates that SAS's contribution (which partly took

the form of a loan-to-equity conversion) is to be seen in a broader context in which SAS had provided loans to Estonian Air of USD […] million in 2008 and of EUR […] million in 2009. As regards the State's participation, Estonia explains that it based its decision on a valuation report produced by the Ministry of Economic Affairs and Communications according to which the value of the airline post-investment would exceed its pre-investment value. In addition, Estonia highlights that each shareholder carried out its own analysis of the operation and that they all decided to inject capital in proportion to their shareholdings, which would render measure 1 *pari passu*.

(85) Estonia first notes in relation to **measure 2** that the absence of a tender is in no way conclusive that State aid is present and that in any event the sale was based on a transaction value that reflected the true market price of the ground handling business of Estonian Air, which was moreover profit-making. According to Estonia, measure 2 consisted of the sale of the ground handling assets of the airline without employees or liabilities and the book value of the assets represented a floor price. In addition, Estonia is of the opinion that the transaction was comparable to similar ones. Estonia moreover emphasises that Tallinn Airport is an independent entity with no State interference and that all members of the management and supervisory boards are independent business people and not representatives or appointees of the State.

(86) Moreover, Estonia provides clarifications as regards the exact structure of **measure 3**, which it also considers aid-free. Estonia also claims that the participation of SAS amounts to EUR […] million, namely the EUR 2 million injected in cash plus the acquisition of Cresco's stake for EUR […] million. As regards the 2010 business plan, Estonia is of the opinion that that plan was based on sustainable growth and was based on positive expectations for the recovery and growth of the Estonian economy and of the international Air Transport Association's (IATA) expectations at the time for international traffic growth. According to Estonia, the 2010 business plan included all the drivers necessary for a prudent and credible investment decision. As regards the fact that the State took into account macroeconomic considerations, Estonia argues that these considerations were not the sole drivers of the State's investment decision. Estonia also provides a valuation of the airline by a senior economics analyst of the Ministry of Economic Affairs and Communications indicating the total value of equity of Estonian Air after the additional investment (on the basis of discounted forecasted cash flows) as EUR [0-10] million.

(87) As regards the State's decision to invest EUR 30 million in 2011/2012 (**measure 4**), Estonia first observes that in 2011 the Eastern European market was relatively stable in its growth prospects and that in the summer of 2011 the European aviation market was not yet in turmoil. Estonia moreover argues that SAS did not participate to measure 4 because it was facing severe financial difficulties at the time. As regards […] loan, which was supposed to be granted to the airline but which was not in the end, Estonia considers that it has to be seen separately from its equity investment. Estonia also highlights that the 2011 business plan was robust and credible, and that it included an expansionary strategy based on a solid and elaborate economic analysis of the aviation market of the region and the envisaged economic development of the surrounding countries. Estonia also claims that in 2011 the airline's equity was valuable both *pre* and *post* the capital injection. Although Estonia acknowledges that the 2011 business plan was not viable and was abandoned in mid-2012, it claims that at the time of deciding whether to carry out measure 4 the State believed that the airline would be able to restore its viability.

(88) In relation to the rescue loan facility (**measure 5**), Estonia is of the view that all the conditions of rescue aid of the 2004 R&R Guidelines were met. Estonia however considers that Estonian Air could be considered to be in difficulty only as of June/July 2012. Since it concludes that measures 1 to 4 did not entail State aid, the 'one time, last time' principle of the 2004 R&R Guidelines is not breached. Estonia nonetheless adds that if the Commission were to find a breach of the 'one time, last time' principle, it should take into account that Estonian Air serves only 0,17 % of the intra-European traffic and that there are no adverse spill-over effects on other Member States or any undue distortions of competition as a result of the aid.

(89) In its comments of 19 March 2014 on the restructuring aid opening decision (**measure 6**), Estonia reiterates the arguments in relation to the 'one time, last time' principle. As regards the restoration of Estonian Air's long-term viability, Estonia considers that the Commission should allow for the inclusion of mitigation actions by the management in the sensitivity analysis, since this is how normal businesses work.

(90) Estonia also provides some clarifications on how the Level 1 and DOC contributions and the profitability margin of the routes offered as compensatory measures were calculated (see recital 79). According to Estonia, Level 1 contribution defines the marginal revenue each passenger brings, not counting flying costs, while the DOC contribution defines the contribution a passenger brings including all the variable costs of flying but not aircraft-related costs or any other overheads. Estonia moreover claims that the routes are to be considered acceptable compensatory measures because they all had a positive contribution at Level 1 and refuses the Commission's argument that the abandoned routes would not be profitable under the new business model.

(91) In relation to own contribution, Estonia explains that the valuation report for the sale of the aircraft is realistic and provides details on the sale price of AS Estonian Air Regional and of Estonian Air's stake in AS Amadeus Eesti.

6.2. **Comments from interested parties**

(92) As regards the rescue aid opening decisions, the Commission received comments from IAG and Ryanair.

(93) IAG claims to be affected by the rescue aid to Estonian Air through its investment in FlyBe and its relationship with Finnair. IAG also notes that, in its view, the connectivity of Estonia would not be hampered if Estonian Air were to exit the market. IAG expressed concerns regarding the alleged breach of the 'one tine, last time' principle.

(94) Ryanair welcomes the Commission's formal investigation into the recue aid for Estonian Air, in particular in view of Estonian Air's inefficiency when compared to Ryanair. In relation to measures 1 to 5, Ryanair first notes that Cresco decided to give up its stake which is to be seen as a strong indication that the capital injections were not MEIP-compliant. Ryanair notes that low-cost carriers are a better alternative to national flag carriers such as Estonian Air and that EU law does not recognize the right of each Member State to have a flag carrier. Finally, Ryanair claims that its market position is directly and substantially affected by the State aid to Estonian Air and that this aid strongly distorts competition.

(95) Regarding the restructuring aid opening decision, two interested parties provided comments: an interested party who does not wish its identity to be disclosed and Ryanair.

(96) The interested party who does not wish its identity to be disclosed considers that Estonian Air's restructuring plan is neither credible nor achievable in view of the fact that its losses in 2012 were extraordinarily high, leading to a net margin below −50 %. As regards the restructuring of the fleet and the operations, the interested party is of the view that Estonian Air's plans to use two aircraft for charter flights are not viable in view of the very competitive nature of that market and criticises the mix of aircraft of the new fleet. The interested party also notes that the calculation of the profitability of the routes offered as compensatory measures shows that they are not acceptable and comes to the view that, overall, the restructuring aid should not be authorised. Finally, the interested party provides a case study of Hungary's connectivity after the collapse of Malév and comes to the conclusion that the market can compensate adequately for the loss of a flag carrier.

(97) Ryanair first notes that the Commission should assess whether Estonia had other options available (such as liquidation) rather than providing State aid. Ryanair also claims that the assumptions of the restructuring plan are extremely optimistic and that the plan is doomed to fail. For instance, Ryanair believes that it is unrealistic that Estonian Air will be able to sell some of its aircraft to raise capital. Ryanair also considers that the 12 routes cancelled by Estonian Air are non-profitable and cannot be deemed compensatory measures. Moreover, it notes that the conditions of the 2004 R&R Guidelines are not met, in particular the 'one time, last time' principle. Finally, Ryanair reiterates that the aid to Estonia Air harms its market position substantially.

6.3. **Observations from Estonia on the comments of interested third parties**

(98) Estonia addressed in detail the arguments raised by the interested parties. As regards the comments of IAG on the rescue aid opening decisions, Estonia notes that Estonian Air and FlyBe do not fly to the same airports and thus are not competing. As regards the connectivity of the country, Estonia considers that it would be affected if Estonian Air exits the market and argues that low-cost carriers do not provide the type of connectivity that is important to Estonia.

(99) In relation to Ryanair's comments on the rescue aid opening decisions, Estonia observes that the efficiency of low-cost carriers cannot be compared to that of regional carriers. As regards the rationale of the State to invest into the airline, Estonia observes that a profitable and sustainable airline is highly important as it provides Estonia with regular and dependable links to a number of countries that constitute Estonia's key economic trading partners, a role that is not fulfilled by the airline's main competitors. Finally, Estonia claims that low-cost carriers have failed in Estonia because of the small size of the market, not because of Estonian Air's presence and excludes competition between Ryanair and Estonian Air since they target different customer segments.

(100) Estonia also addressed the comments received in the context of the restructuring aid opening decision. As regards the comments of the interested party who does not wish its identity to be disclosed, Estonia does not provide observations on some of them arguing that it would submit a new restructuring plan and therefore that those comments were no longer relevant. Estonia nonetheless indicates that there is no overcapacity on the routes to and from Estonia and that there is no risk of undermining the internal market by shifting an unfair share of structural adjustments to other Member States. As regards the comparison with the case study of Hungary's connectivity, Estonia argues that Estonia is a small and isolated market and that the demise of Estonian Air would mean a loss on the quantity and quality of air connections, and claims its case to be more similar to that of Lithuania after the bankruptcy of its flag carrier FlyLAL, which — according to Estonia — lost 26 % of its mobility factor ([27]) compared to 4 % for Hungary.

(101) In relation to Ryanair's comments, Estonia reiterates that Ryanair's position would not be affected by the State aid granted to Estonian Air. In addition, Estonia considers that Ryanair's claim that Estonian Air should be liquidated is not supported by data. Finally, Estonia reiterates that there is no breach of the 'one time, last time' principle in relation to measures 1 to 3.

7. **ASSESSMENT OF THE MEASURES AND THE RESTRUCTURING PLAN**

(102) By virtue of Article 107(1) of the Treaty, any aid granted by a Member State or through State resources in any form whatsoever which distorts or threatens to distort competition by favouring certain undertakings or the production of certain goods shall, in so far as it affects trade between Member States, be incompatible with the internal market. The concept of State aid thus applies to any advantage granted directly or indirectly, financed out of State resources, granted by the State itself or by any intermediary body acting by virtue of powers conferred on it.

(103) To be State aid, a measure must stem from State resources and be imputable to the State. In principle, State resources are the resources of a Member State and of its public authorities as well as the resources of public undertakings on which the public authorities can exercise, directly or indirectly, a controlling influence.

(104) In order to determine whether the different measures assessed conferred an economic advantage to Estonian Air and therefore whether the measures involve State aid, the Commission will assess whether the airline received an economic advantage which it would not have obtained under normal market conditions.

(105) The Commission applies the MEIP test in its assessment. According to the MEIP test, no State aid would be involved where, in similar circumstances, a private investor of a comparable size to that of the bodies concerned in the public sector, operating in normal market conditions in a market economy, could have been prompted to provide to the beneficiary the measures in question. The Commission therefore has to assess whether a private investor would have entered into the transactions under assessment on the same terms. The attitude of the hypothetical private investor is that of a prudent investor whose goal of profit maximisation is tempered with caution about the level of risk acceptable for a given rate of return. In principle, a contribution from public funds does not involve State aid if it is *pari passu*, namely if it takes place at the same time as a significant capital contribution on the part of a private investor made in comparable circumstances and on comparable terms.

(106) Finally, the measures in question must distort or threaten to distort competition and be liable to affect trade between Member States.

(107) Inasmuch as the measures under assessment entail State aid within the meaning of Article 107(1) of the Treaty, their compatibility must be assessed in the light of the exceptions laid down in paragraphs 2 and 3 of that Article.

7.1. **Existence of State aid**

7.1.1. *Measure 1*

(108) The Commission will first assess the presence of aid in respect of the EUR 2,48 million capital injection of 2009 (measure 1). As explained in recital 105, it is considered that a contribution from public funds does not entail an undue advantage — and does not constitute aid — if it is carried out in *pari passu* terms.

([27]) Mobility factor is the number of air transport passengers divided by the country's population.

(109) In that respect, the Commission notes that measure 1 was carried out by the shareholders of Estonian Air at the time in proportion to their stakes, namely 34 % by Estonia (EUR 2,48 million), 49 % by SAS (EUR 3,57 million) and 17 % by Cresco (EUR 1,23 million). Estonia was confirmed that the State and Cresco injected cash only while SAS provided EUR 1,21 million in cash and EUR 2,36 million in the form of a loan-to-equity conversion. In addition, Estonia explained that SAS provided loans to Estonian Air of USD […] million in 2008 and of EUR […] million in 2009 (see recital 84).

(110) In the rescue aid opening decisions the Commission noted that the different nature of the contributions (fresh money increase v conversion of debt by SAS) was sufficient to create reasonable doubts about whether measure 1 was *pari passu*. However, the information provided by Estonia has allayed the doubts of the Commission, given that the capital contribution was carried out on clear *pari passu* terms at least with Cresco. Both the State and Cresco contributed rather significant amount of fresh money in cash in proportion to their shareholding. In addition, the overall contributions of Cresco and SAS in cash are significant and comparable to that of the State. Moreover, the loan-to-equity conversion of SAS is to be seen in the broader context of its previous loans to Estonian Air in 2008 and 2009, which demonstrate that SAS believed in the viability of the airline.

(111) A private participation of 66 % is clearly not negligible by comparison to the public intervention according to settled case-law ([28]). Moreover, nothing suggests that the decision of SAS and Cresco to invest into Estonian Air could have been influenced by the conduct of the State.

(112) In addition, the Commission observes that according to the 1994 Aviation guidelines ([29]) '[c]apital injections do not involve State aid when the public holding in a company is to be increased, provided the capital injected is proportionated to the number of shares held by the authorities and goes together with the injection of capital by a private shareholder; the private investor's holding must have real economic significance'. Therefore, it results that this is the case for measure 1.

(113) On that basis, the Commission considers that the decision Cresco to invest in Estonian Air was made *pari passu* with that of the State and that the investment of both Cresco and SAS was significant. In addition, the Commission has no reasons to doubt that SAS and Cresco decided to invest in Estonian Air for profit-seeking motives. The Commission therefore concludes that financing of Estonian Air through the EUR 2,48 million capital injection (measure 1) did not entail an undue advantage to Estonian Air and therefore excludes the presence of State aid, without it being necessary to assess further whether the rest of the cumulative conditions of Article 107(1) of the Treaty would be met.

7.1.2. *Measure 2*

(114) In June 2009, Estonian Air sold its ground handling business to the 100 % State-owned Tallinn Airport for EUR 2,4 million (measure 2). In order to determine the price, no open, transparent and unconditional tender took place and no valuation was carried out by independent valuators. Instead, the price was fixed through direct negotiations between Tallinn Airport and Estonian Air.

(115) The Commission observes that in the absence of a tender or an independent valuation it cannot exclude the presence of aid. Therefore, the Commission needs to assess the transaction and its context in detail to determine whether it provided Estonian Air with any undue advantage.

(116) Estonia clarified in the course of the formal investigation procedure that the ground handling business was profitable between 2005 and 2008, namely the years preceding the sale. In addition, the transaction took the form of an asset sale excluding liabilities and employees and other 'legacy costs'. In order to determine the price, the book value of the assets was established as a floor price. Furthermore, the Estonian authorities submitted their internal analysis demonstrating that the enterprise value-to-sales multiple (EV/sales) ([30]) for the transaction corresponds to multiples observed in several other transactions where a target company was a ground handling business. That would seem to suggest that the transaction took place on market terms.

([28]) Judgment of 12 December 1996, *Air France* v *Commission*, T-358/94, ECR, EU:T:1996:194, paragraphs 148 and 149.
([29]) Guidelines on the application of Articles 92 and 93 of the EC Treaty and Article 61 of the EEA Agreement to State aids in the aviation sector (OJ C 350, 10.12.1994, p. 5).
([30]) EV/sales multiple is valuation measure that compares the enterprise value of a company to the company's sales, giving investors an idea of how much it costs to purchase the company's sales.

(117) Moreover, Estonia claims that Tallinn Airport, despite being 100 % State-owned, is independent from the State and that the members of the management and supervisory boards are independent business people and not representatives of the State. In the rescue aid opening decisions, the Commission raised doubts as to whether the actions of Tallinn Airport could be deemed imputable to the State in view of the fact that the Ministry of Economic Affairs and Communications was the only shareholder of Tallinn Airport and that it came within the Ministry's jurisdiction.

(118) However, the Court of Justice of the European Union has consistently held that measures taken by public undertakings under State control are not *per se* attributable to the State. Indeed, the Court of Justice explained in *Stardust Marine* and subsequent case-law that in order to conclude on imputability it is necessary to 'examine whether the public authorities must be regarded as having been involved, in one way or another, in the adoption of [the] measures' ([31]). In relation to measure 2, the Commission cannot conclude that the decision of Tallinn Airport to invest in Estonian Air was imputable to the State. Also, the Commission did not find either any indirect evidence in this respect in the sense of the *Stardust Marine* case-law. For those reasons, the Commission considers that Tallinn Airport's decision to participate to measure 2 is not imputable to Estonia.

(119) Since Tallinn Airport's decision to participate to measure 2 was not imputable to the State and since the transaction seemingly took place on market terms, the Commission excludes the presence of State aid in relation to measure 2, without it being necessary to assess further whether the rest of the cumulative conditions of Article 107(1) of the Treaty are met.

7.1.3. *Measure 3*

(120) In relation to the 2010 capital injection (**measure 3**), Estonia explained in the course of the formal investigation procedure that the State injected EUR 17,9 million in cash while SAS converted into equity a EUR 2 million loan. At the same time, SAS acquired Cresco's stake in Estonian Air for EUR […] million (in exchange for a EUR […] million loan write-off that Cresco held with SAS). As a result, Cresco ceased to be a shareholder, the State's participation increased to 90 % and SAS's participation was diluted to 10 %. Estonia argues that its decision to invest again in Estonian Air was based on the 2010 business plan.

(121) The Commission first notes that the injections of the State and SAS took place under different forms and in amounts not in proportion to the shareholdings. An injection of EUR 17,9 million of fresh money by the State is not comparable to SAS' debt-to-equity swap of EUR 2 million, in particular since Estonia has not provided evidence that the loan was fully collateralised and thus that SAS would have assumed new risk by converting the loan into equity. As regards the debt write-off by SAS of a EUR […] million that Cresco held with SAS in exchange for Cresco's shares in Estonian Air, the Commission observes that this operation did not entail fresh money for Estonian Air. Moreover, it is uncertain whether SAS run new risk by accepting the debt write-off in exchange for Cresco's shares in Estonian Air. These elements are sufficient to allow the Commission to conclude that measure 3 was not carried out on *pari passu* terms.

(122) The Estonian authorities argue that measure 3 was MEIP-conform since it was adopted on the basis of the 2010 business plan, which they consider robust and credible. According to the plan, Estonian Air would break even already in 2013 if it changed the fleet in accordance with the plan, and would remain significantly profitable thereafter until at least 2020.

(123) The Commission acknowledges that the 2010 business plan analyses the situation of the airline, but it nonetheless has shortcomings that do not make it a reliable basis for a market-oriented investment decision. For instance, the financial forecasts are based on overly ambitious passenger growth numbers (average annual growth above 6 % for the period 2010-2020). Such growth prospects seem very much optimistic in view of the 2009 global economic and financial crisis. The 2010 business plan refers to IATA estimations of more than 5 % average growth for the next four years. However, IATA also indicates that this recovery will be very unevenly divided geographically and that a rapid recovery is not to be expected in Europe ([32]).

(124) Another shortcoming is that the sensitivity analysis of the 2010 business plan appears insufficient. As regards the risk of lower passenger numbers, the plan states that a 10 % decrease in the number of passengers would reduce by approximately EUR 6,4 million the net result for the first two years, which would more than double the negative net results expected for those two years. However, the 2010 business plan does not indicate the consequences for the overall period analysed and specific corrective actions to be taken.

([31]) Judgment in *France v Commission (Stardust Marine)*, C-482/99, EU:C:2002:294, paragraph 52.
([32]) See 2010 business plan, pages 16 and 17.

(125) The Commission also highlights that Cresco decided not to invest further in Estonian Air and instead decided to sell its stake to SAS. While Cresco may have had various reasons for doing so, it appears logical to consider that the 2010 business plan was not sufficient to reassure the private investor about its return on investment. A similar argument can be applied to SAS, who decided to participate in the 2010 capital injection but not in proportion to its stake and therefore was diluted to just 10 % from its previous 49 % stake.

(126) The Estonian authorities also argue that a valuation undertaken by the State in 2010 came to the conclusion that the airline would have positive value following the investment. This valuation calculated the value of equity based on discounted cash flow analysis taking into account expected cash flows in the years 2010-2019 plus a terminal value after 2019 of EUR [0-10] million (discounted) and deducting net debt of EUR [0-10] million. On this basis, the resulting total value of equity in a post-investment scenario would amount to EUR [0-10] million. Based on an alternative valuation method, it valued the airline by comparison with financial indicators for five smaller publicly-traded companies, resulting in a value of Estonian Air of around EUR [5-15] million.

(127) However, the Commission cannot consider this valuation as a valid basis for accepting the investment by a hypothetical private investor. First, the valuation itself points out substantial risks, uncertainties and sensitivity to the assumptions used and states that its forecasts should be regarded with caution ([33]). Further, some crucial assumptions underlying the valuation are not substantiated. In particular, the basis for establishing the substantial terminal value (representing more than 60 % of the resulting total discounted cash flow) is not indicated. Choosing a lower terminal value could even lead to a negative total value of equity. Secondly, the valuation states that the measures of the 2010 business plan may not be sufficient to solve some of the sustainability problems of Estonian Air (e.g. the loss-making operation of the turboprop aircraft Saab 340). Therefore, the cash-flow-based calculation assumes additional changes and thus deviates from the 2010 business plan which represents the basis for the investment. Thirdly, the valuation based on comparison with other airlines is extremely fragile. It compares Estonian Air with only five airlines, of which three have capacities several times bigger than Estonian Air's. Further, due to the bad financial situation of Estonian Air, the only reference basis that could realistically be used is the price-to-sales-revenue ratio whereas ratios based on other indicators give very different results. Fourthly, even accepting its results, the valuation does not explain why a private investor would have agreed to inject EUR 17,9 million in fresh capital to hold 90 % of the shares of a company whose total value of equity is estimated at only EUR [0-10] million (or as a maximum EUR [5-15] million). Finally, the Estonian authorities did not analyse any counterfactual situation to the capital increase in order to compare the expected return on their investment with results of possible alternative scenarios. While it might make economic sense for an existing shareholder to invest additional capital into an ailing company to safeguard its investment, such an investor would normally compare such investment to the costs/revenues of possible alternative scenarios, possibly including the liquidation of the company.

(128) In addition, the submission of the Estonian authorities of 9 April 2014 suggests that the capital increase was not motivated solely by the economic attractiveness of the investment. Estonia acknowledges that the objective of the 2010 business plan to secure long-term flight connections to important business destinations 'coincided with the State's own macroeconomic policy goals'. Although Estonia argues that these considerations were not the sole drivers of the State's investment decision, this suggests that the State was not solely taking into consideration profit-seeking motives. In this respect, it appears that members of the Estonian Government at the time of measure 3 stated that '[the Government's] stance has been that Estonian Air is a strategic company for the country and we are prepared to take a majority stake' ([34]) and that 'it's very important to have flights from […] Tallinn to some other important cities' ([35]), which do not appear to be concerns that a prudent market investor would take into consideration at the time of making an investment decision. In this respect, the Commission recalls that in the *Boch* judgement the Court indicated that 'the test is, in particular, whether in similar circumstances a private shareholder, having regard to the foreseeability of obtaining a return and leaving aside all social, regional policy and sectoral consideration would have subscribed the capital in question' ([36]).

(129) Overall, taking into account the absence of any private investor willing to invest fresh money into Estonian Air in a way similar to the State, the weaknesses of the 2010 business plan and the existence of macroeconomic objectives not relevant for any private investor, the Commission concludes that measure 3 was not MEIP-conform.

([33]) See internal valuation of Estonian Air prepared by the Estonian authorities 'Value assessment of AS Estonian Air', page 2.
([34]) See http://www.bloomberg.com/news/2010-04-22/estonia-government-nears-accord-on-buying-control-of-estonian-air-from-sas.html
([35]) See http://news.err.ee/v/economy/fe650a96-9daa-43e4-91eb-ab4396445593
([36]) Judgment *Belgium* v *Commission (Boch)*, C-40/85, EU:C:1986:305, paragraph 13. See also judgment of 21 January 1999, *Neue Maxhütte Stahlwerke GmbH* v *Commission*, T-129/95, T-2/96 and T-97/96, ECR, EU:T:1999:7, paragraph 132.

(130) In addition, for a measure to constitute State aid, it must stem from State resources and be imputable to the State. This criterion is not disputed in relation to the 2010 capital injection, given that it was the Ministry of Economic Affairs and Communication of Estonia, as shareholder of the airline, who injected the cash from the State budget.

(131) Finally, the Commission observes that the measure affects trade and threatens to distort competition between Member States as Estonian Air is in competition with other airlines of the European Union, in particular since the entry into force of the third stage of liberalisation of air transport ('third package') on 1 January 1993 ([37]). Measure 3 thus enabled Estonian Air to continue operating so that it would not have to face, as other competitors, the consequences normally deriving from its poor financial results.

(132) The Commission therefore concludes that measure 3 entailed State aid in favour of Estonian Air.

7.1.4. *Measure 4*

(133) As regards the EUR 30 million cash injection decided by Estonia in December 2011 (measure 4), Estonia is of the opinion that it did not entail State aid. No other investor participated in this capital injection, as a result of which SAS's stake was diluted from 10 % to 2,66 %, while the State's stake increased from 90 % to 97,34 %.

(134) The Commission remains unconvinced by the arguments provided by the Estonian authorities in the course of the formal investigation procedure. In the first place, the decision to invest was made by the State alone without any private intervention: SAS decided not to participate in this capital injection and the private bank […], who initially considered granting a loan to Estonian Air, refused to provide it in the end. Therefore, the investment cannot be deemed *pari passu*.

(135) In addition, the 2011 business plan, on the basis of which the investment decision was taken, foresees an expansionary strategy and a radical change of business model from point-to-point to hub-and-spoke on the basis of a regional network. Estonia has provided a presentation of the plan according to which the airline would acquire new aircraft (passing from seven planes in 2011 to 13 in 2013 and 2014) and make Tallinn a hub for Europe-Asia flights. According to this presentation, Estonian Air would require EUR 30 million from its shareholder and EUR […] million from a […] loan. Despite the fact that […] decided not to provide the loan in the end, the Commission highlights that Estonia granted EUR 30 million, without giving any kind of consideration to the impact that […] decision would have for the outcome of the 2011 business plan. This cannot be seen as the rational behaviour of an informed market operator.

(136) It also appears unrealistic to consider that Estonian Air would be able to almost triple its revenue in just 4 years and pass from EBT of EUR −15,45 million in 2011 to EUR 4,2 million in 2014, in particular in a context of economic and financial crisis. In this respect, the Commission recalls that according to the December 2011 financial forecast of IATA ([38]), profit margins in the airline industry in 2011 were squeezed as oil and fuel prices surged. For 2012, IATA foresaw that the European airline industry would face pressure due to the economic turmoil that would result from a failure of governments to resolve the euro area sovereign debt crisis. Considering that the European airlines were likely to be hit badly by recession in their home markets, IATA's 2012 forecast for European airlines was an earnings before interest and taxes (EBIT) margin of 0,3 %, with net losses after tax of USD 0,6 billion (namely EUR 0,46 billion).

(137) It also appears unrealistic to consider that Estonian Air would increase the number of seats from 1 million in 2011 to 2,45 million in 2014 while substantially increasing the load factor from 59,2 % to 72,3 % in the same period. The key risks also appear undervalued and the mitigation measures do not seem sufficiently assessed. The hub-and-spoke model was abandoned very rapidly by mid-2012 in view of the extremely negative results of the airline.

(138) In addition, the 2011 business plan explicitly takes into account various macroeconomic and political benefits to the State which are irrelevant from the perspective of a private investor. For instance, the plan indicates that the

([37]) The 'third package' included three legislative measures: (i) Council Regulation (EEC) No 2407/92 of 23 July 1992 on licensing of air carriers (OJ L 240, 24.8.1992, p. 1); (ii) Council Regulation (EEC) No 2408/92 of 23 July 1992 on access for Community air carriers to intra-Community air routes (OJ L 240, 24.8.1992, p. 8); and (iii) Council Regulation (EEC) No 2409/92 of 23 July 1992 on fares and rates for air services (OJ L 240, 24.8.1992, p. 15).

([38]) See http://www.iata.org/whatwedo/Documents/economics/Industry-Outlook-December2011.pdf benefits of the investment for Estonia are significant and explicitly states that 'the chosen network model is preferred taking into account current needs of business people and government directives'. In addition, the plan indicates that as a result of the investment, 2 000 jobs would be created and that Estonia would improve its position in global competitiveness rankings. Moreover, the Estonian authorities state that the proposed strategy fed into the Government Action Plan for 2011-2015 to develop direct air links to all major European business centres and to turn Tallinn Airport into a hub for Asia-Europe flights. For the reasons explained in recital 128, such considerations would not have been taken into account by a prudent market investor.

(139) Therefore, the Commission considers that measure 4 entailed a selective undue advantage to Estonian Air. For the same reasons stated in recitals 130 and 131, the Commission considers that measure 4 stems from State resources and is imputable to the State and that it affects trade and threatens to distort competition between Member States.

(140) The Commission therefore concludes that measure 4 entailed State aid in favour of Estonian Air.

7.1.5. *Measure 5*

(141) The Commission comes to the conclusion that the rescue loan facility should be considered State aid within the meaning of Article 107(1) of the Treaty since the loan, stemming from State resources, entails a selective advantage for Estonian Air which affects trade between the Member States and threatens to distort competition (see recital 131). In view of the financial situation of Estonian Air (it had been loss-making since 2006 and, by the end of July 2012, it had reached a state of technical bankruptcy under Estonian law — see details in Section 7.4.1), it was highly unlikely that a private creditor would be willing to provide any additional loans to cover the severe liquidity problems of Estonian Air. The Estonian authorities themselves regard this measure as State aid within the meaning of Article 107(1) of the Treaty since they claimed the fulfilment of rescue aid conditions of the 2004 R&R Guidelines.

7.1.6. *Measure 6*

(142) The decision of the Estonian authorities to inject EUR 40,7 million into Estonian Air in the form of equity should be considered State aid. The capital injection comes directly from the State budget and thus from State resources. Moreover, since it exclusively benefits one undertaking (namely Estonian Air) and is provided subject to conditions that a prudent market economy investor would normally not accept (financial difficulties of Estonian Air, investment not based on an appropriate analysis of return on the investment but on public interest considerations such as connectivity of Estonia and strategic importance of Estonian Air for the Estonian economy), the planned capital injection entails a selective advantage to Estonian Air. Moreover, the measure affects trade between Member States and threatens to distort competition (see recital 131). The measure in question thus enables Estonian Air to continue operating so that it does not have to face, as other competitors, the consequences normally deriving from its poor financial results. The Estonian authorities themselves regard this measure as State aid within the meaning of Article 107(1) of the Treaty since they claimed the fulfilment of restructuring aid conditions of the 2004 R&R Guidelines.

(143) The Commission therefore concludes that the notified restructuring measure constitutes State aid within the meaning of Article 107(1) of the Treaty. This is not disputed by the Estonian authorities.

7.1.7. *Conclusion as regards the existence of aid*

(144) For the reasons stated in recitals 108-119, the Commission concludes that measures 1 and 2 did not entail State aid to Estonian Air within the meaning of Article 107(1) of the Treaty.

(145) However, for the reasons stated in recitals 120-143 the Commission considers that measures 3, 4, 5 and 6 constitute State aid within the meaning of Article 107(1) of the Treaty and will therefore assess their lawfulness and compatibility with the internal market.

7.2. **Legality of the aid**

(146) Article 108(3) of the Treaty states that a Member State shall not put an aid measure into effect before the Commission has adopted a decision authorising the measure.

(147) The Commission first observes that Estonia implemented measures 3, 4 and 5 without notifying them previously to the Commission for approval. The Commission regrets that Estonia did not comply with the stand-still obligation and has therefore violated its obligation according to Article 108(3) of the Treaty.

(148) As regards measure 6, the Commission understands that the EUR 40,7 million capital injection has not yet been carried out. Thus, Article 108(3) of the Treaty has been respected in relation to the notified restructuring measure.

7.3. **Acceptability of the modified restructuring plan of 31 October 2014**

(149) Before analysing the compatibility of the aid measures identified described in Section 7.1, the Commission needs to establish on which of the submitted restructuring plans such analysis should be conducted. Since the modified restructuring plan of October 2014 significantly extends the restructuring period from 5 years to 6 years and one month, moves backwards its start date by more than two years and includes additional aid measures, it cannot be considered as a simple development of the notified restructuring plan of June 2013.

(150) As described in Section 4.7, the extension of the restructuring period effectively means that three distinct and opposing business strategies would be combined into a single restructuring plan. The strategy of Estonian Air in 2011 and at the beginning of 2012 was to expand operations (additional aircraft, routes, staff, etc.) with the aim of becoming a regional hub-and-spoke operator, while the strategy in 2012-2014 (developed by a newly appointed management team) was exactly the opposite — reduction of capacities and focus on point-to-point operations on a limited number of core routes. Further, the last part of the restructuring plan for 2015-2016, taking into account the entry of Infortar, envisages again a limited expansion. The restructuring plan would thus combine several radically different business strategies based on different business plans and prepared by different management teams with totally different business objectives.

(151) It is evident that originally (in November 2010 when the third measure was granted) the strategies described in Section 4.7 were not considered as one continuous restructuring plan. Further, their differences are such that they cannot be considered as mere adaptations to the original plan notified in June 2013 reacting to developments during its implementation. Their combination into one plan is made *ex post* with the sole apparent aim of including within restructuring aid the measures of the State in the period 2010-2012 (namely measures 3 and 4), in an attempt to avoid a breach of the 'one time, last time' principle for the originally notified restructuring aid. In addition, accepting the modified restructuring plan would lead to an absurd situation where part of the assessed restructuring aid was used in 2011/2012 to expand Estonian Air's capacity and operations while another part of the restructuring aid was subsequently used to reduce its capacities and operations as of 2013. No single restructuring plan would have included both of these mutually incompatible strategies.

(152) Moreover, the Commission notes that if Estonia had notified — and the Commission had authorised — measures 3 and 4 as restructuring aid, the fact that new aid in 2013 would have been in breach of the 'one time, last time' principle would be undisputable. Thus, if the Commission accepted the modified restructuring plan, which — due to the backward extension of the restructuring period — includes measures 3 and 4, Estonia would be better off by not notifying the aid than if it had notified it.

(153) In the past, the Commission has accepted the existence of restructuring continuums based on a single restructuring strategy, with some amendments and developments over time but never with totally opposing business strategies as in this case. For instance in the Varvaressos case ([39]), the Commission considered that the measures granted to this firm between 2006 and 2009 were to be assessed as part of a restructuring continuum on the basis of a restructuring plan dated 2009 (covering the period 2006-2011). The 2009 restructuring plan of Varvaressos was considered as an evolution of a 'strategic and business plan' dating from 2006 and was based on the same business strategy with basically the same restructuring measures which started as of 2006 and continued to be implemented till 2009 and beyond. The facts in the Varvaressos case were thus significantly different from the current case where the business model has radically changed twice throughout the extended restructuring period.

([39]) Commission Decision 2011/414/EU of 14 December 2010 on the State aid C-8/10 (ex N21/09 and NN 15/10) implemented by Greece in favour of Varvaressos S.A. (OJ L 184, 14.7.2011, p. 9). See as well Commission Decision (EU) 2015/1091 of 9 July 2014 on the measures SA.34191 (2012/C) (ex 2012/NN) (ex 2012/CP) implemented by Latvia for A/S Air Baltic Corporation (airBaltic) (OJ L 183, 10.7.2015, p. 1).

(154) For those reasons, the Commission considers that the modified restructuring plan of October 2014 cannot be accepted as a basis for assessing the notified restructuring aid. The assessment of the aid will thus be based on the originally notified restructuring plan of June 2013.

(155) The Commission also notes that even if, hypothetically, it were to accept the modified restructuring plan as a basis for assessment of the restructuring aid (*quid non*), significant compatibility issues would remain (such as the unusually long restructuring period of more than six years ([40]), the apparent lack of adequate compensatory measures which, despite an increase in the total amount of aid, are even less significant than in the June 2013 restructuring plan).

(156) Finally, the privatisation of Estonian Air through the sale by the State of […] % of its shares to Infortar for a negative price without any tendering procedure could lead to additional concerns about possible aid to Infortar. Despite an independent expert study provided by the Estonian authorities indicating the total equity value of Estonian Air at the time of Infortar's acquisition of those shares within a range of EUR […] million, Infortar would not actually pay anything to the State for that shareholding.

7.4. **Compatibility of the aid**

(157) Insofar as measures 3, 4, 5 and 6 constitute State aid within the meaning of Article 107(1) of the Treaty, their compatibility must be assessed in the light of the exceptions laid down in paragraphs 2 and 3 of that Article. According to the case-law of the Court of Justice, it is up to the Member State to invoke possible grounds of compatibility and to demonstrate that the conditions for such compatibility are met ([41]).

(158) The Estonian authorities are of the view that measures 5 and 6 entail State aid and have therefore provided arguments for assessing their compatibility Article 107(3)(c) of the Treaty, and in particular with the 2004 R&R Guidelines.

(159) However, on the basis of the originally notified restructuring plan, the Estonian authorities consider that measures 3 and 4 do not entail State aid and have not provided any possible grounds for compatibility. The Commission has nonetheless assessed whether any of the possible compatibility grounds laid down in the Treaty would be applicable to those measures.

(160) As stated in the rescue aid opening decisions, the Commission considers that the exceptions laid down in Article 107(2) of the Treaty are not applicable in view of the nature of measures 3 and 4. The same conclusion would apply to the exceptions provided for in Article 107(3), points (d) and (e), of the Treaty.

(161) In view of the difficult financial situation of Estonian Air at the time when measures 3 and 4 were provided (see recitals 24 to 26 above), it does not appear that the exception relating to the development of certain areas or of certain sectors laid down in Article 107(3)(a) of the Treaty could be applicable. This is so despite the fact that Estonian Air is located in an assisted area and could be eligible for regional aid. Also, as regards the crisis rules laid down in the Temporary Framework ([42]), the Commission notes that measures 3 and 4 do not fulfil the conditions for its applicability.

([40]) A restructuring period of 5 years and 6 months was considered as unreasonably long in case of restructuring aid to Cyprus Airways — see Commission Decision (EU) 2015/1073 of 9 January 2015 on the State aid SA.35888 (2013/C) (ex 2013/NN) SA.37220 (2014/C) (ex 2013/NN) SA.38225 (2014/C) (ex 2013/NN) implemented by Cyprus for Cyprus Airways (Public) Ltd (OJ L 179, 8.7.2015, p. 83, recitals 144 and 157). The restructuring period in previous positive decisions concerning restructuring aid to airlines normally did not exceed 5 years, see Decision (EU) 2015/1091, recital 179; Commission Decision (EU) 2015/494 of 9 July 2014 on the measures SA.32715 (2012/C) (ex 2012/NN) (ex 2011/CP) implemented by Slovenia for Adria Airways d.d. (OJ L 78, 24.3.2015, p. 18, recital 131); Commission Decision 2013/151/EU of 19 September 2012 on the State aid SA.30908 (11/C, ex N 176/10) implemented by the Czech Republic for České aerolinie, a.s. (ČSA — Czech Airlines — Restructuring plan) (OJ L 92, 3.4.2013, p. 16, recital 107) and Commission Decision 2012/661/EU of 27 June 2012 on the State aid No SA.33015 (2012/C) which Malta is planning to implement for Air Malta plc. (OJ L 301, 30.10.2012, p. 29, recital 93); Commission Decision (EU) 2015/119 of 29 July 2014 on the State aid SA.36874 (2013/N) which Poland is planning to implement for LOT Polish Airlines SA and on the measure SA.36752 (2014/NN) (ex 2013/CP) implemented by Poland for LOT Polish Airlines SA (OJ L 25, 30.1.2015, p. 1, recital 241).

([41]) Judgment in *Italy* v *Commission*, C-364/90, EU:C:1993:157, paragraph 20.

([42]) Commission communication — Temporary Community framework for State aid measures to support access to finance in the current financial and economic crisis (OJ C 16, 22.1.2009, p. 1), as modified by the communication from the Commission amending the Temporary Community Framework for State aid measures to support access to finance in the current financial and economic crisis (OJ C 303, 15.12.2009, p. 6). The Temporary Framework expired in December 2011.

(162) Therefore, it appears that the compatibility of measures 3 and 4 can only be assessed under Article 107(3)(c) of the Treaty, which states that aid can be authorised where it is granted to promote the development of certain economic sectors and where this aid does not adversely affect trading conditions to an extent contrary to the common interest. In particular, the compatibility of measures 3 and 4 should be assessed in the light of the 2004 R&R Guidelines ([43]), also bearing in mind the provisions of the 1994 Aviation guidelines. In view of the disbursement of the remaining part of the rescue loan facility on 28 November 2014, measure 5 needs to be assessed under Guidelines on State aid for rescuing and restructuring non-financial undertakings in difficulty (2014 R&R Guidelines) ([44]).

(163) The Commission will in turn assess whether at the time of measures 3, 4, 5 and 6 Estonian Air was eligible for rescue and/or restructuring aid under the 2004 R&R Guidelines (measures 3,4, and 6) and 2014 R&R Guidelines (measure 5).

7.4.1. *Difficulties of Estonian Air*

(164) Recital 9 of the 2004 R&R Guidelines states that the Commission regards a firm as being in difficulty when it is unable, whether through its own resources or with the funds it is able to obtain from its owners/shareholders or creditors, to stem losses which without outside intervention by the public authorities, will almost certainly condemn it to going out of business in the short or medium term.

(165) Recital 10 of the 2004 R&R Guidelines clarifies that a limited liability company is regarded as being in difficulty where more than half of its registered capital has disappeared and more than one quarter of that capital has been lost over the preceding 12 months, or where it fulfils the criteria under its domestic law for being the subject of collective insolvency proceedings.

(166) Recital 11 of the 2004 R&R Guidelines adds that, even if the conditions in recital 10 are not satisfied, a firm may be considered to be in difficulty in particular where the usual signs of a firm being in difficulty are present, such as increasing losses, diminishing turnover, growing stock inventories, excess capacity, declining cash flow, mounting debt, rising interest charges and falling or nil net asset value.

(167) The Commission first notes that Estonian Air has continuously registered significant losses since 2006:

Table 6

Net results of Estonian Air since 2006

(in EUR thousands)

2006	– 3 767
2007	– 3 324
2008	– 10 895
2009	– 4 744
2010	– 3 856
2011	– 17 120
2012	– 51 521
2013	– 8 124
2014	– 10 405

Source: Annual reports of Estonian Air, available at http://estonian-air.ee/en/info/about-the-company/financial-reports/. From 2006 to 2010 the annual reports of Estonian Air are expressed EEK. The conversion rate used is EUR 1 = EEK 15,65.

([43]) On 1 August 2014, the 2004 R&R Guidelines were replaced by the Guidelines on State aid for rescuing and restructuring non-financial undertakings in difficulty (OJ C 249, 31.7.2014, p. 1, '2014 R&R Guidelines'). According to recital 136 of the 2014 R&R Guidelines, notifications registered by the Commission prior to 1 August 2014 will be examined in the light of the criteria in force at the time of notification. Since measure 6 was notified on 20 June 2013, that measure will be assessed under the 2004 R&R Guidelines. Also, in line with recitals 137 and 138 of the 2014 R&R Guidelines, the Commission will assess the compatibility of measures 3 and 4 on the basis of the 2004 R&R Guidelines.

([44]) OJ C 249, 31.7.2014, p. 1.

(168) The significant losses of Estonian Air constitute a first indication of the airline's difficulties. In addition, it appears that some of the usual signs of a firm being in difficulty were also present. For instance, it appears that Estonian Air's interest expenses have been constantly increasing since 2008:

Table 7

Interest expenses of Estonian Air since 2006

(in EUR)

2006	– 94 523
2007	– 99 764
2008	– 94 842
2009	– 212 309
2010	– 337 325
2011	– 2 010 000
2012	– 2 436 000
2013	– 4 212 000
2014	– 3 474 000

Source: Annual reports of Estonian Air, available at http://estonian-air.ee/en/info/about-the-company/financial-reports/. From 2006 to 2010 the annual reports of Estonian Air are expressed EEK. The conversion rate used is EUR 1 = EEK 15,65.

(169) Estonian Air's return on assets and return on equity have consistently been negative since 2006, while the debt-to-equity ratio constantly increased between 2006 and 2008, when it reached [80-90] %. The reason why this ratio went down in 2009 and 2010 is due to the capital increases that took place in those years and not because Estonian Air's debt was reduced. In addition, between 2010 and 2011, the net debt of Estonian Air exploded, passing from EUR [5-10] million to EUR [40-50] million. The net debt continued to grow further in 2012 (EUR [50-60] million), 2013 (EUR [50-60] million) and 2014 (EUR [60-70] million).

(170) In addition, the Estonian authorities explained that at the end of November 2011, the airline had only EUR 3,1 million in cash, and was set to breach a cash covenant to […] at the end of the year, meaning the airline would have been in default of its loans to […]. Also, Estonian Air stopped paying some major suppliers in November 2011 and by the end of that month the working capital was not in balance: the accounts receivable were EUR 5,5 million, while the accounts payable were EUR 10,6 million. Without measure 4, the airline would have been in default of its loans to […]. Default of payment is a typical sign of a firm in difficulty.

(171) The Commission also notes that more than half of the airline's equity disappeared between 2010 and 2011. In that period, the airline lost more than one quarter of its capital. Therefore, the criterion of recital 10(a) of the 2004 R&R Guidelines also seems to be fulfilled.

(172) Despite the capital injections in December 2011 and March 2012 (measure 4), the airline's financial situation deteriorated in 2012 and by the end of July 2012, Estonian Air had reached a state of technical bankruptcy under Estonian law (see recital 25 above). Therefore, as from this point in time, Estonian Air could also be considered a firm in difficulty on the basis of recital 10(c) of the 2004 R&R Guidelines.

(173) Therefore, the Commission concludes that Estonian Air would qualify as a firm in difficulty under recital 11 of the 2004 R&R Guidelines since at least 2009. In addition, Estonian Air would also fulfil the requirements of recitals 10(a) and 10(c) of the 2004 R&R Guidelines at later points in time.

(174) In addition, Estonian Air would be regarded as a firm in difficulty under the 2014 R&R Guidelines since its total equity in 2014 was significantly negative amounting to EUR –31,393 million. Therefore, Estonian Air fulfils the requirements of recital 20(a) of the 2014 R&R Guidelines.

(175) Recital 12 of the 2004 R&R Guidelines as well as recital 21 of the 2014 R&R Guidelines states that a newly created firm is not eligible for rescue or restructuring aid even if its initial financial position is unsecure. A firm is in principle considered as newly created for the first three years following the start of operations in the relevant field of activity. Estonian Air was founded in 1991 and cannot be regarded as a newly created firm. In addition, Estonian Air does not belong to a business group in the sense of recital 13 of the 2004 R&R Guidelines and recital 22 of the 2014 R&R Guidelines.

(176) The Commission therefore concludes that Estonian Air was a firm in difficulty at the time when measures 3, 4, 5 and 6 were provided and that it meets the rest of requirements of the 2004 and 2014 R&R Guidelines to be eligible for rescue and/or restructuring aid.

7.4.2. *Compatibility of measure 3*

(177) The Commission first observes that the cumulative conditions for rescue aid laid down in point 25 of the 2004 R&R Guidelines are not met:

(a) measure 3 is a capital injection in the form of cash (EUR 17,9 million) and therefore does not consist of liquidity support in the form of loan guarantees or loans;

(b) Estonia has provided no justification allowing the Commission to consider that measure 3 was provided on the grounds of serious social difficulties;

(c) Estonia did not communicate to the Commission a restructuring plan or a liquidation plan six months after the first implementation of the measure;

(d) measure 3 was not restricted to the amount needed to keep the Estonian Air in business for the period during which the aid is authorised.

(178) The Commission also assessed whether the compatibility criteria for restructuring aid are met. Recital 34 of the 2004 R&R Guidelines requires that the granting of the aid is conditional on implementation of a restructuring plan, which must be endorsed by the Commission in all cases of individual aid, and which must aim at restoring the long-term viability of the firm within a reasonable timescale and on the basis of realistic assumptions as to future operating conditions. However, the Commission observes that Estonia granted measure 3 to Estonian Air in the absence of a credible restructuring plan satisfying the conditions laid down in the 2004 R&R Guidelines. Even though the 2010 business plan contained some elements of a restructuring plan under the 2004 R&R Guidelines (analysis of the market, restructuring measures, financial forecasts etc.), it cannot be considered as sufficiently robust and credible, ensuring a long-term viability of the company. As explained in recitals 123 and 124, the 2010 business plan was based on overly ambitious passenger growth forecasts and its sensitivity analysis was insufficient. That circumstance would in itself be sufficient to exclude the measure's compatibility with the internal market ([45]).

(179) Moreover, the Estonian authorities have not put forward any possible measures to avoid undue distortions of competition (compensatory measures) and have not provided any contribution from Estonian Air to its own restructuring. Those are essential elements for finding a measure compatible with the internal market as restructuring aid on the basis of the 2004 R&R Guidelines.

(180) Measure 3 therefore amounts to State aid incompatible with the internal market.

7.4.3. *Compatibility of measure 4*

(181) In relation to measure 4, the same conclusions as regards measure 3, described in recitals 177 to 180, apply *mutatis mutandis*.

(182) In particular, the capital increase of EUR 30 million does not meet the requirements of point 15 of 2004 R&R Guidelines for a rescue aid since (a) it does not consist of liquidity support in the form of loan guarantees or loans; (b) Estonia has provided no justification allowing the Commission to consider that measure 3 was provided on the grounds of serious social difficulties; (c) Estonia did not communicate to the Commission a restructuring plan or a liquidation plan six months after the first implementation of the measure; and (d) Measure 3 was not restricted to the amount needed to keep the Estonian Air in business for the period during which the aid is authorised.

([45]) See in this sense the judgment of the EFTA Court in joined cases E-10/11 and E-11/11 *Hurtigruten ASA, Norway* v *EFTA Surveillance Authority*, EFTA Ct. Rep [2012], p. 758, paragraphs 228 and 234-240.

(183) Further, the capital increase of EUR 30 million does not meet the compatibility conditions for restructuring aid under 2004 R&R Guidelines. The 2011 business plan cannot be considered as a credible restructuring plan since its forecasts were not realistic (see recitals 135 to 137) and it was in fact abandoned very rapidly by mid-2012 in view of the extremely negative results of the airline. In addition, the Estonian authorities have proposed neither appropriate own contribution by Estonian Air nor adequate compensatory measures. On the contrary, the capital increase was used to expand Estonian Air's operations and enter new routes.

(184) In addition, the Commission observes that according to the 'one time, last time' principle of Section 3.3 of the 2004 R&R Guidelines, 'where less than 10 years have elapsed since the rescue aid was granted or the restructuring period came to an end or implementation of the restructuring plan has been halted (whichever is the latest), the Commission will not allow further rescue or restructuring aid'. Insofar as measure 3 (unlawful and incompatible rescue aid) was granted to Estonian Air in November 2010, granting of capital injection (measure 4) would breach the 'one time, last time' principle. Of the possible exceptions to this principle according to point 73 of the 2004 R&R Guidelines, only exception (c) ('exceptional and unforeseeable circumstances for which the company is not responsible') could be applicable. However, Estonia has not put forward any argument that would allow the Commission to conclude that measure 4 was provided to Estonian Air on the basis of exceptional and unforeseeable circumstances.

(185) Therefore, the Commission concludes that measure 4 also amounts to State aid incompatible with the internal market.

7.4.4. *Compatibility of measure 5*

(186) In the rescue aid opening decisions, the Commission stated that measure 5 fulfilled most of the criteria in Section 3.1 of the 2004 R&R Guidelines concerning rescue aid but expressed doubts on whether the 'one time, last time' principle was met.

(187) The Commission notes that the 'one time, last time' principle of the 2014 R&R Guidelines essentially corresponds to the requirements of the previous 2004 R&R Guidelines. Given that Estonian Air received the rescue aid in November 2010 (capital injection of EUR 17,9 million — measure 3) and in December 2011 and March 2012 (capital injections of 15 million EUR each — measure 4), the Commission concludes that the 'one time, last time' principle has not been observed. In view of the fact that measures 3 and 4 amount to incompatible and unlawful rescue aid, the Commission concludes that the 'one time, last time' principle as set out in recital 70 of the 2014 R&R Guidelines has also been breached in relation to measure 5. Therefore, it is not necessary to examine whether other criteria of the 2014 R&R Guidelines would also have been met.

(188) On this basis, the Commission concludes that measure 5 also amounts to rescue aid incompatible with the internal market.

7.4.5. *Compatibility of measure 6*

(189) As regards the planned restructuring aid of EUR 40,7 million (measure 6), the Commission's doubts in relation to the restructuring aid opening decision have not been dispelled in the course of the formal investigation procedure.

(190) According to point 34 of the 2004 R&R Guidelines, the grant of restructuring aid must be conditional on implementation of a restructuring plan which must be endorsed by the Commission in all cases of individual aid. Point 35 explains that the restructuring plan, the duration of which must be as short as possible, must restore the long-term viability of the firm within a reasonable timescale and on the basis of realistic assumptions as to future operating conditions.

(191) Pursuant to point 36 of the 2004 R&R Guidelines, the restructuring plan must describe the circumstances that led to the company's difficulties and take account of the present state and future market prospects with best-case, worst-case and base-case scenarios.

(192) The restructuring plan must provide for a turnaround that will enable the company, after completing its restructuring, to cover all its costs including depreciation and financial charges. The expected return on capital must be high enough to enable the restructured firm to compete in the marketplace on its own merits (point 37 of the 2004 R&R Guidelines).

(193) As indicated in the opening decision, the Commission had doubts as to whether the restructuring plan of June 2013 was sufficiently solid in order to restore the long-term viability of Estonian Air. Estonia has provided few additional arguments to clarify the doubts of the Commission. Indeed, the Commission reiterates that the scenarios and sensitivity analysis of the restructuring plan may lead, under certain circumstances, to additional funding needs. The low (pessimistic) case assumes a 12 % decrease of passengers due to the assumption that GDP growth in Europe will continue to be low until 2017. In this pessimistic case, Estonian Air would reach slightly positive earnings before taxes in 2017 but still have a negative net cash position. Moreover, the sensitivity analysis shows that relatively minor changes in the assumptions would result, on a stand-alone basis, in the need for additional funding. This seriously questions the main aim of the plan to restore the long-term viability of Estonian Air. The fact that Estonian Air's performance in 2013 was broadly in line with the forecasts is irrelevant for the *ex ante* assessment of the restructuring plan. In addition, this was no longer the case in 2014 with revenues as well as profits below the forecasts in the restructuring plan.

(194) As regards the measures to limit undue distortions of competition (compensatory measures), the restructuring plan foresees the release of slots at three coordinated airports (London Gatwick, Helsinki and Vienna) and the discontinuation of 12 routes, which would account for 18 % of Estonian Air's capacity before restructuring. In order for those routes to be counted as compensatory measures, they must be profitable because otherwise they would have been cancelled in any event for viability reasons.

(195) The Estonian authorities have provided profitability figures for the 12 routes cancelled based on three different indicators, namely 'DOC contribution level', 'contribution margin level 1' and 'profitability margin'. According to Estonia's submissions, the 'DOC contribution level' covers all variable costs (passenger-related, roundtrip-related and fuel costs) but not payroll, fleet, maintenance and department costs. The 'contribution margin level 1' is defined as the total revenue less the passenger-related variable costs over total revenue, while the 'profitability margin' includes fixed costs (fixed maintenance costs, crew costs and fleet-related costs) but not overheads.

(196) According to the Commission's practice in a number of restructuring aid cases in the aviation sector, routes are considered profitable if they had a positive C1 contribution margin in the year preceding their surrender ([46]). The C1 contribution takes account of flight, passenger and distribution costs (namely variable costs) attributable to each individual route. The C1 contribution is the appropriate figure since it takes into account all costs which are directly linked to the route in question. Routes with a positive C1 contribution not only cover the variable costs of a route, but also contribute to covering the fixed costs of the company.

(197) The Commission's observes that the 'DOC contribution level' is largely equivalent to the C1 contribution. On this basis, the Commission notes that only two routes (Venice and Kuressaare) — representing together only around 1 % of the company's capacity in terms of ASK — would actually be profitable and could be counted as proper compensatory measures.

(198) Estonia argues that given the increase in yields under the new strategy foreseen in the restructuring plan, these routes could have been profitable in the new network and that these routes would be beneficial to other airlines to the extent they would get the marginal return from passengers who formerly flew with Estonian Air. However, Estonia does not provide any specific calculations as to the possible level of profitability under the new business model. On the contrary, the restructuring plan clearly indicates that these routes 'cannot be operated at a profit at this point in time, nor can they contribute to the cost of the aircraft'. Therefore, in line with the Commission's established case practice, 10 out of the 12 proposed routes cannot be accepted as compensatory measures.

(199) The Commission concludes that in order to outweigh the adverse effect of the restructuring aid for Estonian Air, it is not sufficient to release slots in three coordinated airports and to cancel two profitable routes representing around 1 % of the airline's capacity.

(200) The proposed own contribution of Estonian Air according to the restructuring plan consists of EUR 27,8 million from the planned sale of three aircraft in 2015; EUR 7,5 million from the sale of an office building to Tallinn Airport; EUR 2 million from the sale of other non-core assets; and EUR 0,7 million from a new loan provided

([46]) See Decision 2013/151/EU, recitals 130 and 131; Decision (EU) 2015/1091, recital 194; and Decision (EU) 2015/494, recital 143.

by […]. The main part of the own contribution (the planned sale of three aircraft) should take place in 2015 and there is no binding agreement to sell the aircraft. However, Estonia provided a *prima facie* credible valuation by a consultancy company estimating a possible sale price for the type of the aircraft concerned. Further, Estonia has indicated that the airline is now holding discussions with potential partners for a sale-and-lease-back transaction. On this basis, and bearing in mind previous airline cases, the Commission considers that the proposed own contribution reaching EUR 36,44 million — out of the total restructuring costs of EUR 78,7 million (see recital 55) or 46,3 % of the restructuring costs — is acceptable in view of the fact that Estonia is an assisted area.

(201) Although the own contribution appears acceptable, the Commission's doubts on the return to long-term viability and compensatory measures have not been dispelled.

(202) Finally, as in case of measures 4 and 5, the Commission concludes that for the same reasons the 'one time, last time' principle has also been breached in relation to measure 6. Several aid measures (measures 3, 4 and 5) had been granted to Estonian Air in difficulty over the years 2010-2014. In addition, the exceptions in point 73 of the 2004 R&R Guidelines are not applicable. Given the non-acceptability of the modified restructuring plan of 31 October 2014, the restructuring aid cannot be considered as following the rescue aid as part of a single restructuring operation (condition (a) of point 73). In addition, the Estonian authorities have not put forward any exceptional or unforeseeable circumstances under condition (c) of point 73.

(203) Therefore, the restructuring aid (measure 6) foreseen in the restructuring plan of June 2013 does not fulfil the criteria of the 2004 R&R Guidelines and amounts to incompatible State aid.

8. **RECOVERY**

(204) According to the Treaty and the Court of Justice's established case law, the Commission is competent to decide that the Member State concerned must abolish or alter aid ([47]) when it has found that it is incompatible with the internal market. The Court has also consistently held that the obligation of a Member State to abolish aid regarded by the Commission as being incompatible with the internal market is designed to re-establish the previously existing situation ([48]). In this context, the Court has established that that objective is attained once the recipient has repaid the amounts granted by way of unlawful aid, thus forfeiting the advantage which it had enjoyed over its competitors on the market, and the situation prior to the payment of the aid is restored ([49]).

(205) Following that case-law, Article 16 of Council Regulation (EU) 2015/1589 ([50]) states that 'where negative decisions are taken in respect of unlawful aid, the Commission shall decide that the Member State concerned shall take all necessary measures to recover the aid from the beneficiary'. Given that the measures at hand are to be considered incompatible aid, the aid has to be recovered in order to re-establish the situation that existed on the market prior to the granting of the aid. Recovery shall take effect from the time when the advantage occurred to the beneficiary, namely when the aid was put at the disposal of the beneficiary and shall bear recovery interest until effective recovery.

(206) With regard to the 2010 capital increase (**measure 3**), the Commission considers that, given the lack of any realistic possibility for the State to recover its investment, the totality of the EUR 17,9 million injected by the State in cash is the aid element. The same conclusion applies to the 2011/2012 capital increase (**measure 4**), for which the aid element amounts to the totality of the EUR 30 million injected by the State in cash.

(207) In relation to **measure 5**, the Commission considers that in view of the financial situation of Estonian Air at the moment of the granting the rescue loan facility loans, the State had no valid reason to expect repayment. Since the Commission considers that the conditions for rescue aid of the 2015 R&R Guidelines are not met, Estonia must ensure that Estonian Air reimburses the rescue loan provided to Estonian Air for the total amount of EUR 37 million. In case there is due and not paid interest, it should be included in the aid element.

(208) Finally, as regards the notified restructuring aid (**measure 6**), it has not been yet provided to Estonian Air and there is therefore no need to order recovery.

([47]) Judgment *Commission* v *Germany*, C-70/72, EU:C:1973:87, paragraph 13.
([48]) Judgment *Spain* v *Commission*, C-278/92, C-279/92 and C-280/92, EU:C:1994:325, paragraph 75.
([49]) Case *Belgium* v *Commission*, C-75/97, EU:C:1999:311, paragraphs 64-65.
([50]) Council Regulation (EU) 2015/1589 of 13 July 2015 laying down detailed rules for the application of Article 108 of the Treaty on the Functioning of the European Union (OJ L 248, 24.9.2015, p. 9).

9. **CONCLUSION**

(209) The Commission finds that Estonia has unlawfully implemented measures 3, 4 and 5 in breach of Article 108(3) of the Treaty. In addition, those measures are incompatible with the internal market.

(210) The incompatible aid should be recovered from Estonian Air as set out in Section 8. in order to re-establish the situation that existed on the market prior to the granting of the aid.

(211) In addition, the Commission finds that the notified restructuring aid of EUR 40,7 million (measure 6) constitutes incompatible aid. Therefore, that measure should not be implemented,

HAS ADOPTED THIS DECISION

Article 1

1. The financing of AS Estonian Air through the EUR 2,48 million capital injection which Estonia implemented in February 2009 does not constitute aid within the meaning of Article 107(1) of the Treaty.

2. The sale of the ground handling section of AS Estonian Air to Tallinn Airport for EUR 2,4 million in June 2009 does not constitute aid within the meaning of Article 107(1) of the Treaty.

Article 2

1. The State aid amounting to EUR 17,9 million unlawfully granted in favour of AS Estonian Air by Estonia on 10 November 2010, in breach of Article 108(3) of the Treaty, is incompatible with the internal market.

2. The State aid amounting to EUR 30 million unlawfully granted in favour of AS Estonian Air by Estonia on 20 December 2011 and 6 March 2012, in breach of Article 108(3) of the Treaty, is incompatible with the internal market.

3. The State aid for rescue purposes amounting to EUR 37 million unlawfully granted in favour of AS Estonian Air by Estonia between 2012 and 2014, in breach of Article 108(3) of the Treaty, is incompatible with the internal market.

Article 3

1. Estonia shall recover the aid referred to in Article 2 from the beneficiary.

2. The sums to be recovered shall bear interest from the date on which they were put at the disposal of the beneficiary until their actual recovery.

3. The interest shall be calculated on a compound basis in accordance with Chapter V of Commission Regulation (EC) No 794/2004 ([51]).

Article 4

1. Recovery of the aid referred to in Article 2 shall be immediate and effective.

2. Estonia shall ensure that this Decision is implemented within four months following the date of notification of this Decision.

Article 5

1. The State aid for restructuring purposes which Estonia is planning to implement for AS Estonian Air, amounting to EUR 40,7 million, is incompatible with the internal market.

2. The aid shall accordingly not be implemented.

([51]) Commission Regulation (EC) No 794/2004 of 21 April 2004 implementing Council Regulation (EC) No 659/1999 laying down detailed rules for the application of Article 93 of the EC Treaty (OJ L 140, 30.4.2004, p. 1)

Article 6

1. Within two months following notification of this Decision, Estonia shall submit the following information to the Commission:

(a) the total amount (principal and recovery interests) to be recovered from the beneficiary;

(b) a detailed description of the measures already taken and planned to comply with this Decision;

(c) documents demonstrating that the beneficiary has been ordered to repay the aid.

2. Estonia shall keep the Commission informed of the progress of the national measures taken to implement this Decision until recovery of the aid referred to in Article 2 has been completed. It shall immediately submit, on simple request by the Commission, information on the measures already taken and planned to comply with this Decision. It shall also provide detailed information concerning the amounts of aid and recovery interest already recovered from the beneficiary.

Article 7

This Decision is addressed to the Republic of Estonia.

Done at Brussels, 6 November 2015.

For the Commission

Margrethe VESTAGER

Member of the Commission

COMMISSION IMPLEMENTING DECISION (EU) 2016/1032

of 13 June 2016

establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the non-ferrous metals industries

(notified under document C(2016) 3563)

(Text with EEA relevance)

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) ([1]), and in particular Article 13(5) thereof,

Whereas:

(1) Best available techniques (BAT) conclusions are the reference for setting permit conditions for installations covered by Chapter II of Directive 2010/75/EU and competent authorities should set emission limit values which ensure that, under normal operating conditions, emissions do not exceed the emission levels associated with the best available techniques as laid down in the BAT conclusions.

(2) The forum composed of representatives of Member States, the industries concerned and non-governmental organisations promoting environmental protection, established by Commission Decision of 16 May 2011 ([2]), provided the Commission on 4 December 2014 with its opinion on the proposed content of the BAT reference document for the non-ferrous metals industries. That opinion is publicly available.

(3) The BAT conclusions set out in the Annex to this Decision are the key element of that BAT reference document.

(4) The measures provided for in this Decision are in accordance with the opinion of the Committee established by Article 75(1) of Directive 2010/75/EU,

HAS ADOPTED THIS DECISION:

Article 1

The best available techniques (BAT) conclusions for the non-ferrous metals industries, as set out in the Annex, are adopted.

Article 2

This Decision is addressed to the Member States.

Done at Brussels, 13 June 2016.

For the Commission

Karmenu VELLA

Member of the Commission

([1]) OJ L 334, 17.12.2010, p. 17.

([2]) OJ C 146, 17.5.2011, p. 3.

ANNEX

BAT CONCLUSIONS FOR THE NON-FERROUS METALS INDUSTRIES

SCOPE

These BAT conclusions concern certain activities specified in Sections 2.1, 2.5 and 6.8 of Annex I to Directive 2010/75/EU, namely:

— 2.1: Metal ore (including sulphide ore) roasting or sintering;

— 2.5: Processing of non-ferrous metals:

(a) production of non-ferrous crude metals from ore, concentrates or secondary raw materials by metallurgical, chemical or electrolytic processes;

(b) melting, including the alloyage, of non-ferrous metals, including recovered products and operation of non-ferrous metal foundries, with a melting capacity exceeding 4 tonnes per day for lead and cadmium or 20 tonnes per day for all other metals;

— 6.8: Production of carbon (hard-burnt coal) or electrographite by means of incineration or graphitisation.

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

— primary and secondary production of non-ferrous metals;

— the production of zinc oxide from fumes during the production of other metals;

— the production of nickel compounds from liquors during the production of a metal;

— the production of silicon-calcium (CaSi) and silicon (Si) in the same furnace as the production of ferro-silicon;

— the production of aluminium oxide from bauxite prior to the production of primary aluminium, where this is an integral part of the production of the metal;

— the recycling of aluminium salt slag;

— the production of carbon and/or graphite electrodes.

These BAT conclusions do not address the following activities or processes:

— Iron ore sintering. This is covered in the BAT conclusions for Iron and Steel production.

— The production of sulphuric acid based on SO_2 gases from non-ferrous metals production. This is covered in the BAT conclusions on Large Volume Inorganic Chemicals-Ammonia, Acids and Fertilisers.

— Foundries covered in the BAT conclusions for the Smitheries and Foundries Industry.

Other reference documents which could be of relevance for the activities covered in these BAT conclusions are the following.

Reference document	Subject
Energy Efficiency (ENE)	General aspects of energy efficiency
Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector (CWW)	Waste water treatment techniques to reduce emissions of metals to water
Large Volume Inorganic Chemicals-Ammonia, Acids and Fertilisers (LVIC-AAF)	Sulphuric acid production
Industrial Cooling Systems (ICS)	Indirect cooling with water and/or air
Emissions from Storage (EFS)	Storage and handling of materials
Economics and Cross-media Effects (ECM)	Economics and cross-media effects of techniques

Reference document	Subject
Monitoring of Emissions to Air and Water from IED installations (ROM)	Monitoring of emissions to air and water
Waste Treatments Industries (WT)	Waste handling and treatment
Large Combustion Plants (LCP)	Combustion plants generating steam and/or electricity
Surface Treatment Using Organic Solvents (STS)	Non-acid pickling
Surface Treatment of Metals and Plastics (STM)	Acid pickling

DEFINITIONS

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

Term used	Definition
New plant	A plant first permitted at the site of the installation following the publication of these BAT conclusions or a complete replacement of a plant on the existing foundations of the installation following the publication of these BAT conclusions
Existing plant	A plant that is not a new plant
Major upgrade	A major change in the design or technology of a plant and with major adjustments or replacements of the process units and associated equipment
Primary emissions	Emissions directly vented from the furnaces that are not spread to the areas surrounding the furnaces
Secondary emissions	Emissions escaping from the furnace lining or during operations such as charging or tapping and which are captured with a hood or enclosure (such as doghouse)
Primary production	Production of metals using ores and concentrates
Secondary production	Production of metals using residues and/or scraps, including remelting and alloying processes
Continuous measurement	Measurement using an 'automated measuring system' permanently installed on site for the continuous monitoring of emissions
Periodic measurement	Determination of a measurand (a particular quantity subject to measurement) at specified time intervals using manual or automated methods

GENERAL CONSIDERATIONS

Best Available Techniques

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

Unless otherwise stated, the BAT conclusions are generally applicable.

Emission levels to air associated with BAT

Emission levels associated with the best available techniques (BAT-AELs) for emissions to air given in these BAT conclusions refer to standard conditions: dry gas at a temperature of 273,15 K, and a pressure of 101,3 kPa.

Averaging periods for emissions to air

For averaging periods for emissions to air, the following definitions apply.

Daily average	Average over a period of 24 hours of valid half-hourly or hourly averages obtained by continuous measurements
Average over the sampling period	Average value of three consecutive measurements of at least 30 minutes each, unless otherwise stated (1)

(1) For batch processes, the average of a representative number of measurements taken over the total batch time or the result of a measurement carried out over the total batch time can be used.

Averaging periods for emissions to water

For averaging periods for emissions to water, the following definition applies.

Daily average	Average over a sampling period of 24 hours taken as a flow-proportional composite sample (or as a time-proportional composite sample provided that sufficient flow stability is demonstrated) (1)

(1) For discontinuous flows, a different sampling procedure yielding representative results (e.g. spot sampling) can be used.

ACRONYMS

Term	Meaning
BaP	Benzo[*a*]pyrene
ESP	Electrostatic precipitator
I-TEQ	International toxic equivalency derived by applying international toxic equivalence factors, as defined in Annex VI, part 2 of Directive 2010/75/EU
NO_X	The sum of nitrogen monoxide (NO) and nitrogen dioxide (NO_2), expressed as NO_2
PCDD/F	Polychlorinated dibenzo-*p*-dioxins and dibenzofurans (17 congeners)
PAH	Polycyclic aromatic hydrocarbons
TVOC	Total volatile organic carbon; total volatile organic compounds which are measured by a flame ionisation detector (FID) and expressed as total carbon
VOC	Volatile organic compounds as defined in Article 3(45) of Directive 2010/75/EU

1.1. GENERAL BAT CONCLUSIONS

Any relevant process-specific BAT conclusions in Sections 1.2 to 1.9 apply in addition to the general BAT conclusions in this section.

1.1.1. Environmental management systems (EMS)

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

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

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

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

(d) implementation of procedures paying particular attention to:

   (i) structure and responsibility,

   (ii) recruitment, training, awareness and competence,

   (iii) communication,

   (iv) employee involvement,

   (v) documentation,

   (vi) effective process control,

   (vii) maintenance programmes,

   (viii) emergency preparedness and response,

   (ix) safeguarding compliance with environmental legislation;

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

   (i) monitoring and measurement (see also the Reference Report on Monitoring of emissions to Air and Water from IED installations-ROM),

   (ii) corrective and preventive action,

   (iii) maintenance of records,

   (iv) independent (where practicable) internal or external auditing in order to determine whether or not the EMS conforms to planned arrangements and has been properly implemented and maintained;

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

(g) following the development of cleaner technologies;

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

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

The establishment and implementation of an action plan on diffuse dust emissions (see BAT 6) and the application of a maintenance management system which especially addresses the performance of dust abatement systems (see BAT 4) are also a part of the EMS.

Applicability

The scope (e.g. level of detail) and nature of the EMS (e.g. standardised or non-standardised) will generally be related to the nature, scale and complexity of the installation, and the range of environmental impacts it may have.

1.1.2. **Energy management**

BAT 2. In order to use energy efficiently, BAT is to use a combination of the techniques given below.

	Technique	Applicability
a	Energy efficiency management system (e.g. ISO 50001)	Generally applicable
b	Regenerative or recuperative burners	Generally applicable
c	Heat recovery (e.g. steam, hot water, hot air) from waste process heat	Only applicable for pyrometallurgical processes
d	Regenerative thermal oxidiser	Only applicable when the abatement of a combustible pollutant is required
e	Preheat the furnace charge, combustion air or fuel using the heat recovered from hot gases from the melting stage	Only applicable for roasting or smelting of sulphide ore/concentrate and for other pyrometallurgical processes
f	Raise the temperature of the leaching liquors using steam or hot water from waste heat recovery	Only applicable for alumina or hydrometallurgical processes
g	Use hot gases from the launder as preheated combustion air	Only applicable for pyrometallurgical processes
h	Use oxygen-enriched air or pure oxygen in the burners to reduce energy consumption by allowing autogenous smelting or the complete combustion of carbonaceous material	Only applicable for furnaces that use raw materials containing sulphur or carbon
i	Dry concentrates and wet raw materials at low temperatures	Only applicable when drying is performed
j	Recover the chemical energy content of the carbon monoxide produced in an electric or shaft/blast furnace by using the exhaust gases as a fuel, after the removal of metals, in other production processes or to produce steam/hot water or electricity	Only applicable to exhaust gases with a CO content > 10 vol-%. Applicability is also influenced by the composition of the exhaust gas and the unavailability of a continuous flow (i.e. batch processes)
k	Recirculate the flue-gas back through an oxy-fuel burner to recover the energy contained in the total organic carbon present	Generally applicable
l	Suitable insulation for high temperature equipment such as steam and hot water pipes	Generally applicable
m	Use the heat generated from the production of sulphuric acid from sulphur dioxide to preheat gas directed to the sulphuric acid plant or to generate steam and/or hot water	Only applicable for non-ferrous metals plants including sulphuric acid or liquid SO_2 production
n	Use high efficiency electric motors equipped with variable-frequency drive, for equipment such as fans	Generally applicable
o	Use control systems that automatically activate the air extraction system or adjust the extraction rate depending on actual emissions	Generally applicable

1.1.3. **Process control**

BAT 3. In order to improve overall environmental performance, BAT is to ensure stable process operation by using a process control system together with a combination of the techniques given below.

	Technique
a	Inspect and select input materials according to the process and the abatement techniques applied
b	Good mixing of the feed materials to achieve optimum conversion efficiency and reduce emissions and rejects
c	Feed weighing and metering systems
d	Processors to control material feed rate, critical process parameters and conditions including the alarm, combustion conditions and gas additions
e	On-line monitoring of the furnace temperature, furnace pressure and gas flow
f	Monitor the critical process parameters of the air emission abatement plant such as gas temperature, reagent metering, pressure drop, ESP current and voltage, scrubbing liquid flow and pH and gaseous components (e.g. O_2, CO, VOC)
g	Control dust and mercury in the exhaust gas before transfer to the sulphuric acid plant for plants including sulphuric acid or liquid SO_2 production
h	On-line monitoring of vibrations to detect blockages and possible equipment failure
i	On-line monitoring of the current, voltage and electrical contact temperatures in electrolytic processes
j	Temperature monitoring and control at melting and smelting furnaces to prevent the generation of metal and metal oxide fumes through overheating
k	Processor to control the reagents feeding and the performance of the waste water treatment plant, through on-line monitoring of temperature, turbidity, pH, conductivity and flow

BAT 4. In order to reduce channelled dust and metal emissions to air, BAT is to apply a maintenance management system which especially addresses the performance of dust abatement systems as part of the environmental management system (see BAT 1).

1.1.4. **Diffuse emissions**

1.1.4.1. *General approach for the prevention of diffuse emissions*

BAT 5. In order to prevent or, where this is not practicable, to reduce diffuse emissions to air and water, BAT is to collect diffuse emissions as much as possible nearest to the source and treat them.

BAT 6. In order to prevent or, where this is not practicable, to reduce diffuse dust emissions to air, BAT is to set up and implement an action plan on diffuse dust emissions, as part of the environmental management system (see BAT 1), that incorporates both of the following measures:

a. identify the most relevant diffuse dust emission sources (using e.g. EN 15445);

b. define and implement appropriate actions and techniques to prevent or reduce diffuse emissions over a given time frame.

1.1.4.2. *Diffuse emissions from the storage, handling and transport of raw materials*

BAT 7. In order to prevent diffuse emissions from the storage of raw materials, BAT is to use a combination of the techniques given below.

	Technique
a	Enclosed buildings or silos/bins for storing dust-forming materials such as concentrates, fluxes and fine materials
b	Covered storage of non-dust-forming materials such as concentrates, fluxes, solid fuels, bulk materials and coke and secondary materials that contain water-soluble organic compounds
c	Sealed packaging of dust-forming materials or secondary materials that contain water-soluble organic compounds
d	Covered bays for storing material which has been pelletised or agglomerated
e	Use water sprays and fog sprays with or without additives such as latex for dust-forming materials
f	Dust/gas extraction devices placed at the transfer and tipping points for dust-forming materials
g	Certified pressure vessels for storing chlorine gas or mixtures that contain chlorine
h	Tank construction materials that are resistant to the contained materials
i	Reliable leak detection systems and display of tank's level, with an alarm to prevent overfills
j	Store reactive materials in double-walled tanks or tanks placed in chemical-resistant bunds of the same capacity and use a storage area that is impermeable and resistant to the material stored
k	Design storage areas so that — any leaks from tanks and delivery systems are intercepted and contained in bunds that have a capacity capable of containing at least the volume of the largest storage tank within the bund; — delivery points are within the bund to collect any spilled material
l	Use inert gas blanketing for the storage of materials that react with air
m	Collect and treat emissions from storage with an abatement system designed to treat the compounds stored. Collect and treat before discharge any water that washes dust away.
n	Regular cleaning of the storage area and, when needed, moistening with water
o	Place the longitudinal axis of the heap parallel to the prevailing wind direction in the case of outdoor storage
p	Protective planting, windbreak fences or upwind mounts to lower the wind velocity in the case of outdoor storage
q	One heap instead of several where feasible in the case of outdoor storage
r	Use oil and solid interceptors for the drainage of open outdoor storage areas. Use of concreted areas that have kerbs or other containment devices for the storage of material that can release oil, such as swarf

Applicability

BAT 7. e is not applicable to processes that require dry materials or ores/concentrates that naturally contain sufficient humidity to prevent dust formation. The applicability may be limited in regions with water shortages or with very low temperatures

BAT 8. In order to prevent diffuse emissions from the handling and transport of raw materials, BAT is to use a combination of the techniques given below.

	Technique
a	Enclosed conveyors or pneumatic systems to transfer and handle dust-forming concentrates and fluxes and fine-grained material
b	Covered conveyors to handle non-dust-forming solid materials
c	Extraction of dust from delivery points, silo vents, pneumatic transfer systems and conveyor transfer points, and connection to a filtration system (for dust-forming materials)
d	Closed bags or drums to handle materials with dispersible or water-soluble components
e	Suitable containers to handle pelletised materials
f	Sprinkling to moisten the materials at handling points
g	Minimise transport distances
h	Reduce the drop height of conveyor belts, mechanical shovels or grabs
i	Adjust the speed of open belt conveyors (< 3,5 m/s)
j	Minimise the speed of descent or free fall height of the materials
k	Place transfer conveyors and pipelines in safe, open areas above ground so that leaks can be detected quickly and damage from vehicles and other equipment can be prevented. If buried pipelines are used for non-hazardous materials, document and mark their course and adopt safe excavation systems
l	Automatic resealing of delivery connections for handling liquid and liquefied gas
m	Back-vent displaced gases to the delivery vehicle to reduce emissions of VOC
n	Wash wheels and chassis of vehicles used to deliver or handle dusty materials
o	Use planned campaigns for road sweeping
p	Segregate incompatible materials (e.g. oxidising agents and organic materials)
q	Minimise material transfers between processes

Applicability

BAT 8.n. may not be applicable when ice could be formed.

1.1.4.3. *Diffuse emissions from metal production*

BAT 9. In order to prevent or, where this is not practicable, to reduce diffuse emissions from metal production, BAT is to optimise the efficiency of off-gas collection and treatment by using a combination of the techniques given below.

	Technique	Applicability
a	Thermal or mechanical pretreatment of secondary raw material to minimise organic contamination of the furnace feed	Generally applicable
b	Use a closed furnace with a properly designed dedusting system or seal the furnace and other process units with an adequate vent system	The applicability may be restricted by safety constraints (e.g. type/design of the furnace, risk of explosion)

	Technique	Applicability
c	Use a secondary hood for furnace operations such as charging and tapping	The applicability may be restricted by safety constraints (e.g. type/design of the furnace, risk of explosion)
d	Dust or fume collection where dusty material transfers take place (e.g. furnace charging and tapping points, covered launders)	Generally applicable
e	Optimise the design and operation of hooding and ductwork to capture fumes arising from the feed port and from hot metal, matte or slag tapping and transfers in covered launders	For existing plants, the applicability may be limited by space and plant configuration restrictions
f	Furnace/reactor enclosures such as 'house-in-house' or 'doghouse' for tapping and charging operations	For existing plants, the applicability may be limited by space and plant configuration restrictions
g	Optimise the off-gas flow from the furnace through computerised fluid dynamics studies and tracers	Generally applicable
h	Charging systems for semi-closed furnaces to add raw materials in small amounts	Generally applicable
i	Treat the collected emissions in an adequate abatement system	Generally applicable

1.1.5. Monitoring of emissions to air

BAT 10. BAT is to monitor the stack emissions to air with at least the frequency given below and in accordance with EN standards. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.

Parameter	Monitoring associated with	Minimum monitoring frequency	Standard(s)
Dust ([2])	**Copper**: BAT 38, BAT 39, BAT 40, BAT 43, BAT 44, BAT 45 **Aluminium**: BAT 56, BAT 58, BAT 59, BAT 60, BAT 61, BAT 67, BAT 81, BAT 88 **Lead, Tin**: BAT 94, BAT 96, BAT 97 **Zinc, Cadmium**: BAT 119, BAT 122 **Precious metals**: BAT 140 **Ferro-alloys**: BAT 155, BAT 156, BAT 157, BAT 158 **Nickel, Cobalt**: BAT 171 **Other non-ferrous metals:** emissions from production stages such as raw material pretreatment, charging, smelting, melting and tapping	Continuous ([1])	EN 13284-2

Parameter	Monitoring associated with	Minimum monitoring frequency	Standard(s)
	Copper: BAT 37, BAT 38, BAT 40, BAT 41, BAT 42, BAT 43, BAT 44, BAT 45 **Aluminium**: BAT 56, BAT 58, BAT 59, BAT 60, BAT 61, BAT 66, BAT 67, BAT 68, BAT 80, BAT 81, BAT 82, BAT 88 **Lead, Tin**: BAT 94, BAT 95, BAT 96, BAT 97 **Zinc, Cadmium**: BAT 113, BAT 119, BAT 121, BAT 122, BAT 128, BAT 132 **Precious metals**: BAT 140 **Ferro-alloys**: BAT 154, BAT 155, BAT 156, BAT 157, BAT 158 **Nickel, Cobalt**: BAT 171 **Carbon/graphite**: BAT 178, BAT 179, BAT 180, BAT 181 **Other non-ferrous metals:** emissions from production stages such as raw material pretreatment, charging, smelting, melting and tapping	Once per year (1)	EN 13284-1
Antimony and its compounds, expressed as Sb	**Lead, Tin:** BAT 96, BAT 97	Once per year	EN 14385
Arsenic and its compounds, expressed as As	**Copper**: BAT 37, BAT 38, BAT 39, BAT 40, BAT 42, BAT 43, BAT 44, BAT 45 **Lead, Tin**: BAT 96, BAT 97 **Zinc**: BAT 122	Once per year	EN 14385
Cadmium and its compounds, expressed as Cd	**Copper**: BAT 37, BAT 38, BAT 39, BAT 40, BAT 41, BAT 42, BAT 43, BAT 44, BAT 45 **Lead, Tin**: BAT 94, BAT 95, BAT 96, BAT 97 **Zinc, Cadmium**: BAT 122, BAT 132 **Ferro-alloys**: BAT 156	Once per year	EN 14385
Chromium (VI)	**Ferro-alloys:** BAT 156	Once per year	No EN standard available

Parameter	Monitoring associated with	Minimum monitoring frequency	Standard(s)
Copper and its compounds, expressed as Cu	**Copper**: BAT 37, BAT 38, BAT 39, BAT 40, BAT 42, BAT 43, BAT 44, BAT 45 **Lead, Tin**: BAT 96, BAT 97	Once per year	EN 14385
Nickel and its compounds, expressed as Ni	**Nickel, Cobalt:** BAT 172, BAT 173	Once per year	EN 14385
Lead and its compounds, expressed as Pb	**Copper**: BAT 37, BAT 38, BAT 39, BAT 40, BAT 41, BAT 42, BAT 43, BAT 44, BAT 45 **Lead, Tin**: BAT 94, BAT 95, BAT 96, BAT 97 **Ferro-alloys**: BAT 156	Once per year	EN 14385
Thallium and its compounds, expressed as Tl	**Ferro-alloys:** BAT 156	Once per year	EN 14385
Zinc and its compounds, expressed as Zn	**Zinc, Cadmium:** BAT 113, BAT 114, BAT 119, BAT 121, BAT 122, BAT 128, BAT 132	Once per year	EN 14385
Other metals, if relevant (3)	**Copper**: BAT 37, BAT 38, BAT 39, BAT 40, BAT 41, BAT 42, BAT 43, BAT 44, BAT 45 **Lead, Tin**: BAT 94, BAT 95, BAT 96, BAT 97 **Zinc, Cadmium**: BAT 113, BAT 119, BAT 121, BAT 122, BAT 128, BAT 132 **Precious metals**: BAT 140 **Ferro-alloys**: BAT 154, BAT 155, BAT 156, BAT 157, BAT 158 **Nickel, Cobalt**: BAT 171 **Other non-ferrous metals**	Once per year	EN 14385
Mercury and its compounds, expressed as Hg	**Copper, Aluminium, Lead, Tin, Zinc, Cadmium, Ferro-alloys, Nickel, Cobalt, Other non-ferrous metals:** BAT 11	Continuous or once per year (1)	EN 14884 EN 13211

Parameter	Monitoring associated with	Minimum monitoring frequency	Standard(s)
SO_2	**Copper**: BAT 49 **Aluminium**: BAT 60, BAT 69 **Lead, Tin**: BAT 100 **Precious metals**: BAT 142, BAT 143 **Nickel, Cobalt**: BAT 174 **Other non-ferrous metals** (6) (7)	Continuous or once per year (1) (4)	EN 14791
	Zinc, Cadmium: BAT 120	Continuous	
	Carbon/graphite: BAT 182	Once per year	
NO_X, expressed as NO_2	**Copper, Aluminium, Lead, Tin, FeSi, Si (pyrometallurgical processes)**: BAT 13 **Precious metals:** BAT 141 **Other non-ferrous metals** (7)	Continuous or once per year (1)	EN 14792
	Carbon/graphite	Once per year	
TVOC	**Copper**: BAT 46 **Aluminium**: BAT 83 **Lead, Tin**: BAT 98 **Zinc, Cadmium**: BAT 123 **Other non-ferrous metals** (8)	Continuous or once per year (1)	EN 12619
	Ferro-alloys: BAT 160 **Carbon/graphite:** BAT 183	Once per year	
Formaldehyde	**Carbon/graphite:** BAT 183	Once per year	No EN standard available
Phenol	**Carbon/graphite:** BAT 183	Once per year	No EN standard available
PCDD/F	**Copper**: BAT 48 **Aluminium**: BAT 83 **Lead, Tin**: BAT 99 **Zinc, Cadmium**: BAT 123 **Precious metals**: BAT 146 **Ferro-alloys**: BAT 159 **Other non-ferrous metals** (5) (7)	Once per year	EN 1948 parts 1, 2 and 3
H_2SO_4	**Copper**: BAT 50 **Zinc, Cadmium**: BAT 114	Once per year	No EN standard available
NH_3	**Aluminium**: BAT 89 **Precious metals**: BAT 145 **Nickel, Cobalt**: BAT 175	Once per year	No EN standard available

Parameter	Monitoring associated with	Minimum monitoring frequency	Standard(s)
Benzo-[*a*]-pyrene	**Aluminium**: BAT 59, BAT 60, BAT 61 **Ferro-alloys**: BAT 160 **Carbon/graphite**: BAT 178, BAT 179, BAT 180, BAT 181	Once per year	ISO 11338-1 ISO 11338-2
Gaseous fluorides, expressed as HF	**Aluminium:** BAT 60, BAT 61, BAT 67	Continuous (1)	ISO 15713
	Aluminium: BAT 60, BAT 67, BAT 84 **Zinc, Cadmium**: BAT 124	Once per year (1)	
Total fluorides	**Aluminium:** BAT 60, BAT 67	Once per year	No EN standard available
Gaseous chlorides, expressed as HCl	**Aluminium:** BAT 84	Continuous or once per year (1)	EN 1911
	Zinc, Cadmium: BAT 124 **Precious metals**: BAT 144	Once per year	
Cl_2	**Aluminium**: BAT 84 **Precious metals**: BAT 144 **Nickel, Cobalt**: BAT 172	Once per year	No EN standard available
H_2S	**Aluminium:** BAT 89	Once per year	No EN standard available
PH_3	**Aluminium:** BAT 89	Once per year	No EN standard available
Sum of AsH_3 and SbH_3	**Zinc, Cadmium:** BAT 114	Once per year	No EN standard available

Note: 'other non-ferrous metals' means the production of non-ferrous metals other than those dealt with specifically in Sections 1.2 to 1.8.

(1) For sources of high emissions, BAT is continuous measurement or, where continuous measurement is not applicable, more frequent periodic monitoring.

(2) For small sources (< 10 000 Nm^3/h) of dust emissions from the storage and handling of raw materials, monitoring could be based on the measurement of surrogate parameters (such as the pressure drop).

(3) The metals to be monitored depend on the composition of the raw materials used.

(4) Related to BAT 69(a), a mass balance can be used to calculate SO_2 emissions, based on the measurement of the sulphur content of each of the anode batches consumed.

(5) Where relevant in view of factors such as the halogenated organic compounds content of the raw materials used, the temperature profile, etc.

(6) Monitoring is relevant when the raw materials contain sulphur.

(7) Monitoring may not be relevant for hydrometallurgical processes.

(8) Where relevant in view of the organic compounds content of the raw materials used.

1.1.6. Mercury emissions

BAT 11. In order to reduce mercury emissions to air (other than those that are routed to the sulphuric acid plant) from a pyrometallurgical process, BAT is to use one or both of the techniques given below.

	Technique
a	Use raw materials with a low mercury content, including by cooperating with providers in order to remove mercury from secondary materials.
b	Use adsorbents (e.g. activated carbon, selenium) in combination with dust filtration (1)

(1) Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 1.

Table 1

BAT-associated emission levels for mercury emissions to air (other than those that are routed to the sulphuric acid plant) from a pyrometallurgical process using raw materials containing mercury

Parameter	BAT-AEL (mg/Nm^3) (1) (2)
Mercury and its compounds, expressed as Hg	0,01-0,05

(1) As a daily average or as an average over the sampling period.
(2) The lower end of the range is associated with the use of adsorbents (e.g. activated carbon, selenium) in combination with dust filtration, except for processes using Waelz kilns.

The associated monitoring is in BAT 10.

1.1.7. Sulphur dioxide emissions

BAT 12. In order to reduce emissions of SO_2 from off-gases with a high SO_2 content and to avoid the generation of waste from the flue-gas cleaning system, BAT is to recover sulphur by producing sulphuric acid or liquid SO_2.

Applicability

Only applicable to plants producing copper, lead, primary zinc, silver, nickel and/or molybdenum.

1.1.8. NO_X emissions

BAT 13. In order to prevent NO_X emissions to air from a pyrometallurgical process, BAT is to use one of the techniques given below.

	Technique (1)
a	Low-NO_X burners
b	Oxy-fuel burners
c	Flue-gas recirculation (back through the burner to reduce the temperature of the flame) in the case of oxy-fuel burners

(1) Descriptions of the techniques are given in Section 1.10.

The associated monitoring is in BAT 10.

1.1.9. Emissions to water, including their monitoring

BAT 14. In order to prevent or reduce the generation of waste water, BAT is to use one or a combination of the techniques given below.

	Technique	Applicability
a	Measure the amount of fresh water used and the amount of waste water discharged	Generally applicable
b	Reuse waste water from cleaning operations (including anode and cathode rinse water) and spills in the same process	Generally applicable
c	Reuse weak acid streams generated in a wet ESP and wet scrubbers	Applicability may be restricted depending on the metal and solid content of the waste water
d	Reuse waste water from slag granulation	Applicability may be restricted depending on the metal and solid content of the waste water
e	Reuse surface run-off water	Generally applicable
f	Use a closed circuit cooling system	Applicability may be restricted when a low temperature is required for process reasons
g	Reuse treated water from the waste water treatment plant	Applicability may be restricted by the salt content

BAT 15. In order to prevent the contamination of water and to reduce emissions to water, BAT is to segregate uncontaminated waste water streams from waste water streams requiring treatment.

Applicability

The segregation of uncontaminated rainwater may not be applicable in the case of existing waste water collection systems.

BAT 16. BAT is to use ISO 5667 for water sampling and to monitor the emissions to water at the point where the emission leaves the installation at least once per month [1] and in accordance with EN standards. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.

Parameter	Applicable for the production of [1]	Standard(s)
Mercury (Hg)	Copper, Lead, Tin, Zinc, Cadmium, Precious metals, Ferro-alloys, Nickel, Cobalt, and other non-ferrous metals	EN ISO 17852, EN ISO 12846
Iron (Fe)	Copper, Lead, Tin, Zinc, Cadmium, Precious metals, Ferro-alloys, Nickel, Cobalt, and other non-ferrous metals	EN ISO 11885 EN ISO 15586 EN ISO 17294-2
Arsenic (As)	Copper, Lead, Tin, Zinc, Cadmium, Precious metals, Ferro-alloys, Nickel, and Cobalt	
Cadmium (Cd)		
Copper (Cu)		
Nickel (Ni)		
Lead (Pb)		
Zinc (Zn)		

(1) The monitoring frequency may be adapted if the data series clearly demonstrate sufficient stability of the emissions.

Parameter	Applicable for the production of [1]	Standard(s)
Silver (Ag)	Precious metals	
Aluminium (Al)	Aluminium	
Cobalt (Co)	Nickel, and Cobalt	
Chromium total (Cr)	Ferro-alloys	
Chromium(VI) (Cr(VI))	Ferro-alloys	EN ISO 10304-3 EN ISO 23913
Antimony (Sb)	Copper, Lead, and Tin	EN ISO 11885 EN ISO 15586 EN ISO 17294-2
Tin (Sn)	Copper, Lead, and Tin	
Other metals, if relevant [2]	Aluminium, Ferro-alloys, and other non-ferrous metals	
Sulphate (SO_4^{2-})	Copper, Lead, Tin, Zinc, Cadmium, Precious metals, Nickel, Cobalt, and other non-ferrous metals	EN ISO 10304-1
Fluoride (F^-)	Primary aluminium	
Total suspended solids (TSS)	Aluminium	EN 872

(1) *Note:* 'other non-ferrous metals' means the production of non-ferrous metals other than those dealt with specifically in Sections 1.2 to 1.8.
(2) The metals monitored depend on the composition of the raw material used.

BAT 17. In order to reduce emissions to water, BAT is to treat the leakages from the storage of liquids and the waste water from non-ferrous metals production, including from the washing stage in the Waelz kiln process, and to remove metals and sulphates by using a combination of the techniques given below.

	Technique [1]	Applicability
a	Chemical precipitation	Generally applicable
b	Sedimentation	Generally applicable
c	Filtration	Generally applicable
d	Flotation	Generally applicable
e	Ultrafiltration	Only applicable to specific streams in non-ferrous metals production
f	Activated carbon filtration	Generally applicable
g	Reverse osmosis	Only applicable to specific streams in non-ferrous metals production

(1) Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels

The BAT-associated emission levels (BAT-AELs) for direct emissions to a receiving water body from the production of copper, lead, tin, zinc, cadmium, precious metals, nickel, cobalt and ferro-alloys are given in Table 2.

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

Table 2

BAT-associated emission levels for direct emissions to a receiving water body from the production of copper, lead, tin, zinc (including the waste water from the washing stage in the Waelz kiln process), cadmium, precious metals, nickel, cobalt and ferro-alloys

BAT-AEL (mg/l) (daily average)						
Parameter	Production of					
	Copper	Lead and/or Tin	Zinc and/or Cadmium	Precious metals	Nickel and/or Cobalt	Ferro-alloys
Silver (Ag)	NR			≤ 0,6	NR	
Arsenic (As)	≤ 0,1 (1)	≤ 0,1	≤ 0,1	≤ 0,1	≤ 0,3	≤ 0,1
Cadmium (Cd)	0,02–0,1	≤ 0,1	≤ 0,1	≤ 0,05	≤ 0,1	≤ 0,05
Cobalt (Co)	NR	≤ 0,1	NR		0,1-0,5	NR
Chromium total (Cr)	NR					≤ 0,2
Chromium (VI) (Cr(VI))	NR					≤ 0,05
Copper (Cu)	0,05-0,5	≤ 0,2	≤ 0,1	≤ 0,3	≤ 0,5	≤ 0,5
Mercury (Hg)	0,005–0,02	≤ 0,05	≤ 0,05	≤ 0,05	≤ 0,05	≤ 0,05
Nickel (Ni)	≤ 0,5	≤ 0,5	≤ 0,1	≤ 0,5	≤ 2	≤ 2
Lead (Pb)	≤ 0,5	≤ 0,5	≤ 0,2	≤ 0,5	≤ 0,5	≤ 0,2
Zinc (Zn)	≤ 1	≤ 1	≤ 1	≤ 0,4	≤ 1	≤ 1

NR: Not relevant
(1) In the case of a high arsenic content in the total input of the plant, the BAT-AEL may be up to 0,2 mg/l.

The associated monitoring is in BAT 16.

1.1.10. Noise

BAT 18. In order to reduce noise emissions, BAT is to use one or a combination of the techniques given below.

	Technique
a	Use embankments to screen the source of noise
b	Enclose noisy plants or components in sound-absorbing structures
c	Use anti-vibration supports and interconnections for equipment
d	Orientation of noise-emitting machinery
e	Change the frequency of the sound

1.1.11. **Odour**

BAT 19. In order to reduce odour emissions, BAT is to use one or a combination of the techniques given below.

	Technique	Applicability
a	Appropriate storage and handling of odorous materials	Generally applicable
b	Minimise the use of odorous materials	Generally applicable
c	Careful design, operation and maintenance of any equipment that could generate odour emissions	Generally applicable
d	Afterburner or filtration techniques, including biofilters	Applicable only in limited cases (e.g. in the impregnation stage during speciality production in the carbon and graphite sector)

1.2. BAT CONCLUSIONS FOR COPPER PRODUCTION

1.2.1. **Secondary materials**

BAT 20. In order to increase the secondary materials' recovery yield from scrap, BAT is to separate non-metallic constituents and metals other than copper by using one or a combination of the techniques given below.

	Technique
a	Manual separation of large visible constituents
b	Magnetic separation of ferrous metals
c	Optical or eddy current separation of aluminium
d	Relative density separation of different metallic and non-metallic constituents (using a fluid with a different density or air)

1.2.2. **Energy**

BAT 21. In order to use energy efficiently in primary copper production, BAT is to use one or a combination of the techniques given below.

	Technique	Applicability
a	Optimise the use of the energy contained in the concentrate using a flash smelting furnace	Only applicable for new plants and for major upgrades of existing plants
b	Use the hot process gases from the melting stages to heat up the furnace charge	Only applicable to shaft furnaces
c	Cover the concentrates during transport and storage	Generally applicable
d	Use the excess heat produced during the primary smelting or converting stages to melt secondary materials containing copper	Generally applicable
e	Use the heat in the gases from anode furnaces in a cascade for other processes such as drying	Generally applicable

BAT 22. In order to use energy efficiently in secondary copper production, BAT is to use one or a combination of the techniques given below.

	Technique	Applicability
a	Reduce the water content of the feed material	Applicability is limited when the moisture content of the materials is used as a technique to reduce diffuse emissions
b	Produce steam by recovering excess heat from the smelting furnace to heat up the electrolyte in refineries and/or to produce electricity in a co-generation installation	Applicable if an economically viable demand of steam exists
c	Melt scraps using the excess heat that is produced during the smelting or converting process	Generally applicable
d	Holding furnace between processing stages	Only applicable for batch-wise operated smelters where a buffer capacity of molten material is required
e	Preheat the furnace charge using the hot process gases from the melting stages	Only applicable to shaft furnaces

BAT 23. In order to use energy efficiently in electrorefining and electrowinning operations, BAT is to use a combination of the techniques given below.

	Technique	Applicability
a	Apply insulation and covers to electrolysis tanks	Generally applicable
b	Addition of surfactants to the electrowinning cells	Generally applicable
c	Improved cell design for lower energy consumption by optimisation of the following parameters: space between anode and cathode, anode geometry, current density, electrolyte composition and temperature	Only applicable for new plants and for major upgrades of existing plants
d	Use of stainless steel cathode blanks	Only applicable for new plants and for major upgrades of existing plants
e	Automatic cathode/anode changes to achieve an accurate placement of the electrodes into the cell	Only applicable for new plants and for major upgrades of existing plants
f	Short circuit detection and quality control to ensure that electrodes are straight and flat and that the anode is exact in weight	Generally applicable

1.2.3. **Air emissions**

BAT 24. In order to reduce secondary emissions to air from furnaces and auxiliary devices in primary copper production and to optimise the performance of the abatement system, BAT is to collect, mix and treat secondary emissions in a centralised off-gas cleaning system.

Description

Secondary emissions from various sources are collected, mixed, and treated in a single centralised off-gas cleaning system, designed to effectively treat the pollutants present in each of the flows. Care is taken not to mix streams which are not chemically compatible and to avoid undesirable chemical reactions among the different collected flows.

Applicability

The applicability may be limited for existing plants by their design and layout.

1.2.3.1. *Diffuse emissions*

BAT 25. In order to prevent or reduce diffuse emissions from pretreatment (such as blending, drying, mixing, homogenisation, screening and pelletisation) of primary and secondary materials, BAT is to use one or a combination of the techniques given below.

	Technique	Applicability
a	Use enclosed conveyers or pneumatic transfer systems for dusty materials	Generally applicable
b	Carry out activities with dusty materials such as mixing in an enclosed building	For existing plants, application may be difficult due to the space requirements
c	Use dust suppression systems such as water cannons or water sprinklers	Not applicable for mixing operations carried out indoors. Not applicable for processes that require dry materials. The application is also limited in regions with water shortages or with very low temperatures
d	Use enclosed equipment for operations with dusty material (such as drying, mixing, milling, air separation and pelletisation) with an air extraction system connected to an abatement system	Generally applicable
e	Use an extraction system for dusty and gaseous emissions, such as a hood in combination with a dust and gas abatement system	Generally applicable

BAT 26. In order to prevent or reduce diffuse emissions from charging, smelting and tapping operations in primary and secondary copper smelters and from holding and melting furnaces, BAT is to use a combination of the techniques given below.

	Technique	Applicability
a	Briquetting and pelletisation of raw materials	Applicable only when the process and the furnace can use pelletised raw materials
b	Enclosed charging system such as single jet burner, door sealing [1], closed conveyers or feeders equipped with an air extraction system in combination with a dust and gas abatement system	The jet burner is applicable only for flash furnaces
c	Operate the furnace and gas route under negative pressure and at a sufficient gas extraction rate to prevent pressurisation	Generally applicable
d	Capture hood/enclosures at charging and tapping points in combination with an off-gas abatement system (e.g. housing/tunnel for ladle operation during tapping, and which is closed with a movable door/barrier equipped with a ventilation and abatement system)	Generally applicable
e	Encapsulate the furnace in vented housing	Generally applicable
f	Maintain furnace sealing	Generally applicable

	Technique	Applicability
g	Hold the temperature in the furnace at the lowest required level	Generally applicable
h	Boosted suction systems ([1])	Generally applicable
i	Enclosed building in combination with other techniques to collect the diffuse emissions	Generally applicable
j	Double bell charging system for shaft/blast furnaces	Generally applicable
k	Select and feed the raw materials according to the type of furnace and abatement techniques used	Generally applicable
l	Use of lids on throats of rotary anode furnace	Generally applicable

([1]) Description of the technique is given in Section 1.10.

BAT 27. In order to reduce diffuse emissions from Peirce-Smith converter (PS) furnace in primary and secondary copper production, BAT is to use a combination of the techniques given below.

	Technique
a	Operate the furnace and gas route under negative pressure and at a sufficient gas extraction rate to prevent pressurisation
b	Oxygen enrichment
c	Primary hood over the converter opening to collect and transfer the primary emissions to an abatement system
d	Addition of materials (e.g. scrap and flux) through the hood
e	System of secondary hoods in addition to the main one to capture emissions during charging and tapping operations
f	Furnace located in enclosed building
g	Apply motor-driven secondary hoods, to move them according to the process stage, to increase the efficiency of the collection of secondary emissions
h	Boosted suction systems ([1]) and automatic control to prevent blowing when the converter is ‘rolled out’ or ‘rolled in’

([1]) Description of the technique is given in Section 1.10.

BAT 28. In order to reduce diffuse emissions from a Hoboken converter furnace in primary copper production, BAT is to use a combination of the techniques given below.

	Technique
a	Operate furnace and gas route under negative pressure during charging, skimming and tapping operations
b	Oxygen enrichment
c	Mouth with closed lids during operation
d	Boosted suction systems ([1])

([1]) Description of the technique is given in Section 1.10.

BAT 29. In order to reduce diffuse emissions from the matte conversion process, BAT is to use a flash converting furnace.

Applicability

Applicable only to new plants or major upgrades of existing plants.

BAT 30. In order to reduce diffuse emissions from a top-blown rotary converter (TBRC) furnace in secondary copper production, BAT is to use a combination of the techniques given below.

	Technique	Applicability
a	Operate the furnace and gas route under negative pressure and at a sufficient gas extraction rate to prevent pressurisation	Generally applicable
b	Oxygen enrichment	Generally applicable
c	Furnace located in enclosed building in combination with techniques to collect and transfer diffuse emissions from charging and tapping to an abatement system	Generally applicable
d	Primary hood over the converter opening to collect and transfer the primary emissions to an abatement system	Generally applicable
e	Hoods or crane integrated hood to collect and transfer the emissions from charging and tapping operations to an abatement system	For existing plants, a crane integrated hood is only applicable to major upgrades of the furnace hall
f	Addition of materials (e.g. scrap and flux) through the hood	Generally applicable
g	Boosted suction system [1]	Generally applicable

[1] Description of the technique is given in Section 1.10.

BAT 31. In order to reduce diffuse emissions from copper recovery with a slag concentrator, BAT is to use the techniques given below.

	Technique
a	Dust suppression techniques such as a water spray for handling, storage and crushing of slag
b	Grinding and flotation performed with water
c	Delivery of the slag to the final storage area via hydro transport in a closed pipeline
d	Maintain a water layer in the pond or use a dust suppressant such as lime milk in dry areas

BAT 32. In order to reduce diffuse emissions from copper-rich slag furnace treatment, BAT is to use a combination of the techniques given below.

	Technique
a	Dust suppression techniques such as a water spray for handling, storage and crushing of the final slag
b	Operation of the furnace under negative pressure
c	Enclosed furnace
d	Housing, enclosure and hood to collect and transfer the emissions to an abatement system
e	Covered launder

BAT 33. In order to reduce diffuse emissions from anode casting in primary and secondary copper production, BAT is to use one or a combination of the techniques given below.

	Technique
a	Use an enclosed tundish
b	Use a closed intermediate ladle
c	Use a hood, equipped with an air extraction system, over the casting ladle and over the casting wheel

BAT 34. In order to reduce diffuse emissions from electrolysis cells, BAT is to use one or a combination of the techniques given below.

	Technique	Applicability
a	Addition of surfactants to the electrowinning cells	Generally applicable
b	Use covers or a hood to collect and transfer the emissions to an abatement system	Only applicable for electrowinning cells or refining cells for low-purity anodes. Not applicable when the cell needs to remain uncovered to maintain the cell temperature at workable levels (approximately 65 °C)
c	Closed and fixed pipelines for transferring the electrolyte solutions	Generally applicable
d	Gas extraction from the washing chambers of the cathode stripping machine and anode scrap washing machine	Generally applicable

BAT 35. In order to reduce diffuse emissions from the casting of copper alloys, BAT is to use one or a combination of the techniques given below.

	Technique
a	Use enclosures or hoods to collect and transfer the emissions to an abatement system
b	Use covering for the melts in holding and casting furnaces
c	Boosted suction system ([1])

([1]) Description of the technique is given in Section 1.10.

BAT 36. In order to reduce diffuse emissions from non-acid and acid pickling, BAT is to use one of the techniques given below.

	Technique	Applicability
a	Encapsulate the pickling line with a solution of isopropanol operating in a closed circuit	Only applicable for pickling of copper wire rod in continuous operations
b	Encapsulate the pickling line to collect and transfer the emissions to an abatement system	Only applicable for acid pickling in continuous operations

1.2.3.2. *Channelled dust emissions*

Descriptions of the techniques mentioned in this section are given in Section 1.10.

The BAT-associated emission levels are all given in Table 3.

BAT 37. In order to reduce dust and metal emissions to air from the reception, storage, handling, transport, metering, mixing, blending, crushing, drying, cutting and screening of raw materials, and the pyrolytic treatment of copper turnings in primary and secondary copper production, BAT is to use a bag filter.

BAT 38. In order to reduce dust and metal emissions to air from concentrate drying in primary copper production, BAT is to use a bag filter.

Applicability

In the event of a high organic carbon content in the concentrates (e.g. around 10 wt-%), bag filters may not be applicable (due to blinding of the bags) and other techniques (e.g. ESP) may be used.

BAT 39. In order to reduce dust and metal emissions to air (other than those that are routed to the sulphuric acid or liquid SO_2 plant or power plant) from the primary copper smelter and converter, BAT is to use a bag filter and/or a wet scrubber.

BAT 40. In order to reduce dust and metal emissions to air (other than those that are routed to the sulphuric acid plant) from the secondary copper smelter and converter and from the processing of secondary copper intermediates, BAT is to use a bag filter.

BAT 41. In order to reduce dust and metal emissions to air from the secondary copper holding furnace, BAT is to use a bag filter.

BAT 42. In order to reduce dust and metal emissions to air from copper-rich slag furnace processing, BAT is to use a bag filter or a scrubber in combination with an ESP.

BAT 43. In order to reduce dust and metal emissions to air from the anode furnace in primary and secondary copper production, BAT is to use a bag filter or a scrubber in combination with an ESP.

BAT 44. In order to reduce dust and metal emissions to air from anode casting in primary and secondary copper production, BAT is to use a bag filter or, in the case of off-gases with a water content close to the dew point, a wet scrubber or a demister.

BAT 45. In order to reduce dust and metal emissions to air from a copper melting furnace, BAT is to select and feed the raw materials according to the furnace type and the abatement system used and to use a bag filter.

Table 3

BAT-associated emission levels for dust emissions to air from copper production

Parameter	BAT	Process	BAT-AEL (mg/Nm^3)
Dust	BAT 37	Reception, storage, handling, transport, metering, mixing, blending, crushing, drying, cutting and screening of raw materials, and the pyrolytic treatment of copper turnings in primary and secondary copper production	2-5 (1) (4)
	BAT 38	Concentrate drying in primary copper production	3-5 (2) (4) (5)
	BAT 39	Primary copper smelter and converter (emissions other than those that are routed to the sulphuric acid or liquid SO_2 plant or power plant)	2-5 (3) (4)

Parameter	BAT	Process	BAT-AEL (mg/Nm^3)
	BAT 40	Secondary copper smelter and converter and processing of secondary copper intermediates (emissions other than those that are routed to the sulphuric acid plant)	2-4 (2) (4)
	BAT 41	Secondary copper holding furnace	≤ 5 (1)
	BAT 42	Copper-rich slag furnace processing	2-5 (1) (6)
	BAT 43	Anode furnace (in primary and secondary copper production)	2-5 (2) (4)
	BAT 44	Anode casting (in primary and secondary copper production)	≤ 5-15 (2) (7)
	BAT 45	Copper melting furnace	2-5 (2) (8)

(1) As an average over the sampling period.
(2) As a daily average or as an average over the sampling period.
(3) As a daily average.
(4) Dust emissions are expected to be towards the lower end of the range when emissions of heavy metals are above the following levels: 1 mg/Nm^3 for lead, 1 mg/Nm^3 for copper, 0,05 mg/Nm^3 for arsenic, 0,05 mg/Nm^3 for cadmium.
(5) When the concentrates used have a high organic carbon content (e.g. around 10 wt-%), emissions of up to 10 mg/Nm^3 can be expected.
(6) Dust emissions are expected to be towards the lower end of the range when emissions of lead are above 1 mg/Nm^3.
(7) The lower end of the range is associated with the use of a bag filter.
(8) Dust emissions are expected to be towards the lower end of the range when emissions of copper are above 1 mg/Nm^3.

The associated monitoring is in BAT 10.

1.2.3.3. *Organic compound emissions*

BAT 46. In order to reduce organic compound emissions to air from the pyrolytic treatment of copper turnings, and the drying, smelting and melting of secondary raw materials, BAT is to use one of the techniques given below.

	Technique (1)	Applicability
a	Afterburner or post-combustion chamber or regenerative thermal oxidiser	The applicability is restricted by the energy content of the off-gases that need to be treated, as off-gases with a lower energy content require a higher fuel use
b	Injection of adsorbent in combination with a bag filter	Generally applicable
c	Design of furnace and the abatement techniques according to the raw materials available	Only applicable to new furnaces or major upgrades of existing furnaces
d	Select and feed the raw materials according to the furnace and the abatement techniques used	Generally applicable
e	Thermal destruction of TVOC at high temperatures in the furnace (> 1 000 °C)	Generally applicable

(1) Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 4.

Table 4

BAT-associated emission levels for emissions to air of TVOC from the pyrolytic treatment of copper turnings, and the drying, smelting and melting of secondary raw materials

Parameter	BAT-AEL (mg/Nm^3) (1) (2)
TVOC	3-30

(1) As a daily average or as an average over the sampling period.
(2) The lower end of the range is associated with the use of a regenerative thermal oxidiser.

The associated monitoring is in BAT 10.

BAT 47. In order to reduce organic compound emissions to air from solvent extraction in hydrometallurgical copper production, BAT is to use both of the techniques given below and to determine the VOC emissions annually, e.g. through mass balance.

	Technique
a	Process reagent (solvent) with lower steam pressure
b	Closed equipment such as closed mixing tanks, closed settlers and closed storage tanks

BAT 48. In order to reduce PCDD/F emissions to air from the pyrolytic treatment of copper turnings, smelting, melting, fire refining and converting operations in secondary copper production, BAT is to use one or a combination of the techniques given below.

	Technique
a	Select and feed the raw materials according to the furnace and the abatement techniques used
b	Optimise combustion conditions to reduce the emissions of organic compounds
c	Use charging systems, for a semi-closed furnace, to give small additions of raw material
d	Thermal destruction of PCDD/F in the furnace at high temperatures (> 850 °C)
e	Use oxygen injection in the upper zone of the furnace
f	Internal burner system
g	Post-combustion chamber or afterburner or regenerative thermal oxidiser (1)
h	Avoid exhaust systems with a high dust build-up for temperatures > 250 °C
i	Rapid quenching (1)
j	Injection of adsorption agent in combination with an efficient dust collection system (1)

(1) Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 5.

Table 5

BAT-associated emission levels for PCDD/F emissions to air from the pyrolytic treatment of copper turnings, smelting, melting, fire refining and converting operations in secondary copper production

Parameter	BAT-AEL (ng I-TEQ/Nm^3) (1)
PCDD/F	≤ 0,1

(1) As an average over a sampling period of at least six hours.

The associated monitoring is in BAT 10.

1.2.3.4. *Sulphur dioxide emissions*

Descriptions of the techniques mentioned in this section are given in Section 1.10.

BAT 49. In order to reduce SO_2 emissions (other than those that are routed to the sulphuric acid or liquid SO_2 plant or power plant) from primary and secondary copper production, BAT is to use one or a combination of the techniques given below.

	Technique	Applicability
a	Dry or semi-dry scrubber	Generally applicable
b	Wet scrubber	Applicability may be limited in the following cases: — very high off-gas flow rates (due to the significant amounts of waste and waste water generated) — in arid areas (due to the large volume of water necessary and the need for waste water treatment)
c	Polyether-based absorption/desorption system	Not applicable in the case of secondary copper production. Not applicable in the absence of a sulphuric acid or liquid SO_2 plant

BAT-associated emission levels: See Table 6.

Table 6

BAT-associated emission levels for SO_2 emissions to air (other than those that are routed to the sulphuric acid or liquid SO_2 plant or power plant) from primary and secondary copper production

Parameter	Process	BAT-AEL (mg/Nm^3) (1)
SO_2	Primary copper production	50-500 (2)
	Secondary copper production	50-300

(1) As a daily average or as an average over the sampling period.
(2) In the case of using a wet scrubber or a concentrate with a low sulphur content, the BAT-AEL can be up to 350 mg/Nm^3.

The associated monitoring is in BAT 10.

1.2.3.5. *Acid emissions*

BAT 50. In order to reduce acid gas emissions to air from exhaust gases from the electrowinning cells, the electrorefining cells, the washing chamber of the cathode stripping machine and the anode scrap washing machine, BAT is to use a wet scrubber or a demister.

1.2.4. **Soil and groundwater**

BAT 51. In order to prevent soil and groundwater contamination from copper recovery in the slag concentrator, BAT is to use a drainage system in cooling areas and a correct design of the final slag storage area to collect overflow water and avoid fluid leakage.

BAT 52. In order to prevent soil and groundwater contamination from the electrolysis in primary and secondary copper production, BAT is to use a combination of the techniques given below.

	Technique
a	Use of a sealed drainage system
b	Use of impermeable and acid-resistant floors
c	Use of double-walled tanks or placement in resistant bunds with impermeable floors

1.2.5. **Waste water generation**

BAT 53. In order to prevent the generation of waste water from primary and secondary copper production, BAT is to use one or a combination of the techniques given below.

	Technique
a	Use the steam condensate for heating the electrolysis cells, to wash the copper cathodes or send it back to steam boiler
b	Reuse the water collected from the cooling area, flotation process and hydro transportation of final slag in the slag concentration process
c	Recycle the pickling solutions and the rinse water
d	Treat the residues (crude) from the solvent extraction step in hydrometallurgical copper production to recover the organic solution content
e	Centrifuge the slurry from cleaning and settlers from the solvent extraction step in hydrometallurgical copper production
f	Reuse the electrolysis bleed after the metal removal stage in the electrowinning and/or the leaching process

1.2.6. **Waste**

BAT 54. In order to reduce the quantities of waste sent for disposal from primary and secondary copper production, BAT is to organise operations so as to facilitate process residues reuse or, failing that, process residues recycling, including by using one or a combination of the techniques given below.

	Technique	Applicability
a	Recover metals from the dust and slime coming from the dust abatement system	Generally applicable
b	Reuse or sell the calcium compounds (e.g. gypsum) generated by the abatement of SO_2	Applicability may be restricted depending on the metal content and on the availability of a market
c	Regenerate or recycle the spent catalysts	Generally applicable
d	Recover metal from the waste water treatment slime	Applicability may be restricted depending on the metal content and on the availability of a market/process
e	Use weak acid in the leaching process or for gypsum production	Generally applicable
f	Recover the copper content from the rich slag in the slag furnace or slag flotation plant	

	Technique	Applicability
g	Use the final slag from furnaces as an abrasive or (road) construction material or for another viable application	Applicability may be restricted depending on the metal content and on the availability of a market
h	Use the furnace lining for recovery of metals or reuse as refractory material	
i	Use the slag from the slag flotation as an abrasive or construction material or for another viable application	
j	Use the skimming from the melting furnaces to recover the metal content	Generally applicable
k	Use the spent electrolyte bleed to recover copper and nickel. Reuse the remaining acid to make up the new electrolyte or to produce gypsum	
l	Use the spent anode as a cooling material in pyro-metallurgical copper refining or remelting	
m	Use anode slime to recover precious metals	
n	Use the gypsum from the waste water treatment plant in the pyrometallurgical process or for sale	Applicability may be restricted depending on the quality of the generated gypsum
o	Recover metals from sludge	Generally applicable
p	Reuse the depleted electrolyte from the hydro-metallurgical copper process as a leaching agent	Applicability may be restricted depending on the metal content and on the availability of a market/process
q	Recycle copper scales from rolling in a copper smelter	Generally applicable
r	Recover metals from the spent acid pickling solution and reuse the cleaned acid solution	

1.3. BAT CONCLUSIONS FOR ALUMINIUM PRODUCTION INCLUDING ALUMINA AND ANODE PRODUCTION

1.3.1. **Alumina production**

1.3.1.1. *Energy*

BAT 55. In order to use energy efficiently during the production of alumina from bauxite, BAT is to use one or a combination of the techniques given below.

	Technique	Description	Applicability
a	Plate heat exchangers	Plate heat exchangers allow a higher heat recovery from the liquor flowing to the precipitation area in comparison with other techniques such as flash cooling plants	Applicable if the energy from the cooling fluid can be reused in the process and if the condensate balance and the liquor conditions allow it
b	Circulating fluidised bed calciners	Circulating fluidised bed calciners have a much higher energy efficiency than rotary kilns, since the heat recovery from the alumina and the flue-gas is greater	Only applicable to smelter-grade aluminas. Not applicable to special-ity/non-smelter-grade aluminas, as these require a higher level of calcination that can currently only be achieved with a rotary kiln

	Technique	Description	Applicability
c	Single stream digestion design	The slurry is heated up in one circuit without using live steam and therefore without dilution of the slurry (in contrast to the double-stream digestion design)	Only applicable to new plants
d	Selection of the bauxite	Bauxite with a higher moisture content carries more water into the process, which increases the energy need for evaporation. In addition, bauxites with a high monohydrate content (boehmite and/or diaspore) require a higher pressure and temperature in the digestion process, leading to higher energy consumption	Applicable within the constraints related to the specific design of the plant, since some plants are specifically designed for a certain quality of bauxite, which limits the use of alternative bauxite sources

1.3.1.2. *Air emissions*

BAT 56. In order to reduce dust and metal emissions from alumina calcination, BAT is to use a bag filter or an ESP.

1.3.1.3. *Waste*

BAT 57. In order to reduce the quantities of waste sent for disposal and to improve the disposal of bauxite residues from alumina production, BAT is to use one or both of the techniques given below.

	Technique
a	Reduce the volume of bauxite residues by compacting in order to minimise the moisture content, e.g. using vacuum or high-pressure filters to form a semi-dry cake
b	Reduce/minimise the alkalinity remaining in the bauxite residues in order to allow disposal of the residues in a landfill

1.3.2. **Anode production**

1.3.2.1. *Air emissions*

1.3.2.1.1. Dust, PAH and fluoride emissions from the paste plant

BAT 58. In order to reduce dust emissions to air from a paste plant (removing coke dust from operations such as coke storage and grinding), BAT is to use a bag filter.

BAT-associated emission levels: See Table 7.

BAT 59. In order to reduce dust and PAH emissions to air from a paste plant (hot pitch storage, paste mixing, cooling and forming), BAT is to use one or a combination of the techniques given below.

	Technique [1]
a	Dry scrubber using coke as the adsorbent agent, with or without precooling, followed by a bag filter
b	Regenerative thermal oxidiser
c	Catalytic thermal oxidiser

[1] Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 7.

Table 7

BAT-associated emission levels for dust and BaP (as an indicator of PAH) emissions to air from a paste plant

Parameter	Process	BAT-AEL (mg/Nm³)
Dust	— Hot pitch storage, paste mixing, cooling and forming — Removing coke dust from operations such as coke storage and grinding	2-5 (1)
BaP	Hot pitch storage, paste mixing, cooling and forming	0,001-0,01 (2)

(1) As a daily average or as an average over the sampling period.
(2) As an average over the sampling period.

The associated monitoring is in BAT 10.

1.3.2.1.2. Dust, sulphur dioxide, PAH and fluoride emissions from the baking plant

BAT 60. In order to reduce dust, sulphur dioxide, PAH and fluoride emissions to air from a baking plant in an anode production plant integrated with a primary aluminium smelter, BAT is to use one or a combination of the techniques given below.

	Technique (1)	Applicability
a	Use of raw materials and fuels containing a low amount of sulphur	Generally applicable for reducing SO_2 emissions
b	Dry scrubber using alumina as the adsorbent agent followed by a bag filter	Generally applicable for reducing dust, PAH and fluoride emissions
c	Wet scrubber	Applicability for reducing dust, SO_2, PAH and fluoride emissions may be limited in the following cases: — very high off-gas flow rates (due to the significant amounts of waste and waste water generated) — in arid areas (due to the large volume of water necessary and the need for waste water treatment)
d	Regenerative thermal oxidiser in combination with a dust abatement system	Generally applicable for reducing dust and PAH emissions.

(1) Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 8.

Table 8

BAT-associated emission levels for dust, BaP (as an indicator of PAH) and fluoride emissions to air from a baking plant in an anode production plant integrated with a primary aluminium smelter

Parameter	BAT-AEL (mg/Nm³)
Dust	2-5 (1)
BaP	0,001-0,01 (2)
HF	0,3-0,5 (1)

Parameter	BAT-AEL (mg/Nm^3)
Total fluorides	≤ 0,8 (2)

(1) As a daily average or as an average over the sampling period.
(2) As an average over the sampling period.

The associated monitoring is in BAT 10.

BAT 61. In order to reduce dust, PAH and fluoride emissions to air from a baking plant in a stand-alone anode production plant, BAT is to use a pre-filtration unit and a regenerative thermal oxidiser followed by a dry scrubber (e.g. lime bed).

BAT-associated emission levels: See Table 9.

Table 9

BAT-associated emission levels for dust, BaP (as an indicator of PAH) and fluoride emissions to air from a baking plant in a stand-alone anode production plant

Parameter	BAT-AEL (mg/Nm^3)
Dust	2-5 (1)
BaP	0,001-0,01 (2)
HF	≤ 3 (1)

(1) As a daily average.
(2) As an average over the sampling period.

The associated monitoring is in BAT 10.

1.3.2.2. *Waste water generation*

BAT 62. In order to prevent the generation of waste water from anode baking, BAT is to use a closed water cycle.

Applicability

Generally applicable to new plants and major upgrades. The applicability may be limited due to water quality and/or product quality requirements.

1.3.2.3. *Waste*

BAT 63. In order to reduce the quantities of waste sent for disposal, BAT is to recycle carbon dust from the coke filter as a scrubbing medium.

Applicability

There may be restrictions on applicability depending on the ash content of the carbon dust.

1.3.3. **Primary aluminium production**

1.3.3.1. *Air emissions*

BAT 64. In order to prevent or collect diffuse emissions from electrolytic cells in primary aluminium production using the Søderberg technology, BAT is to use a combination of the techniques given below.

	Technique
a	Use of paste with a pitch content between 25 % and 28 % (dry paste)
b	Upgrade the manifold design to allow closed point feeding operations and improved off-gas collection efficiency
c	Alumina point feeding

	Technique
d	Increased anode height combined with the treatment in BAT 67
e	Anode top hooding when high current density anodes are used, connected to the treatment in BAT 67

Description

BAT 64(c): Point feeding of alumina avoids the regular crust-breaking (such as during manual side feed or bar broken feed), and thus reduces the associated fluoride and dust emissions.

BAT 64(d): An increased anode height helps to achieve lower temperatures in the anode top, resulting in lower emissions to air.

BAT-associated emission levels: See Table 12.

BAT 65. In order to prevent or collect diffuse emissions from electrolytic cells in primary aluminium production using prebaked anodes, BAT is to use a combination of the techniques given below.

	Technique
a	Automatic multiple point feeding of alumina
b	Complete hood coverage of the cell and adequate off-gas extraction rates (to lead the off-gas to the treatment in BAT 67) taking into account fluoride generation from bath and carbon anode consumption
c	Boosted suction system connected to the abatement techniques listed in BAT 67
d	Minimisation of the time for changing anodes and other activities that require cell hoods to be removed
e	Efficient process control system avoiding process deviations that might otherwise lead to increased cell evolution and emissions
f	Use of a programmed system for cell operations and maintenance
g	Use of established efficient cleaning methods in the rodding plant to recover fluorides and carbon
h	Storage of removed anodes in a compartment near the cell, connected to the treatment in BAT 67, or storage of the butts in confined boxes

Applicability

BAT 65.c and h are not applicable to existing plants

BAT-associated emission levels: See Table 12.

1.3.3.1.1. Channelled dust and fluoride emissions

BAT 66. In order to reduce dust emissions from the storage, handling and transport of raw materials, BAT is to use a bag filter.

BAT-associated emission levels: See Table 10.

Table 10

BAT-associated emission levels for dust from the storage, handling and transport of raw materials

Parameter	BAT-AEL (mg/Nm^3) (1)
Dust	≤ 5-10

(1) As an average over the sampling period.

The associated monitoring is in BAT 10.

BAT 67. In order to reduce dust, metal and fluoride emissions to air from electrolytic cells, BAT is to use one of the techniques given below.

	Technique (1)	Applicability
a	Dry scrubber using alumina as the adsorbent agent followed by a bag filter	Generally applicable
b	Dry scrubber using alumina as the adsorbent agent followed by a bag filter and a wet scrubber	Applicability may be limited in the following cases: — very high off-gas flow rates (due to the significant amounts of waste and waste water generated) — in arid areas (due to the large volume of water necessary and the need for waste water treatment)

(1) Descriptions of the techniques are given in Section 1.10

BAT-associated emission levels: See Table 11 and Table 12.

Table 11

BAT-associated emission levels for dust and fluoride emissions to air from electrolytic cells

Parameter	BAT-AEL (mg/Nm^3)
Dust	2-5 (1)
HF	≤ 1,0 (1)
Total fluorides	≤ 1,5 (2)

(1) As a daily average or as an average over the sampling period.
(2) As an average over the sampling period.

The associated monitoring is in BAT 10.

1.3.3.1.2. Total emissions of dust and fluorides

BAT-associated emission levels for the total emissions of dust and fluoride to air from the electrolysis house (collected from the electrolytic cells and roof vents): See Table 12.

Table 12

BAT-associated emission levels for the total emissions of dust and fluoride to air from the electrolysis house (collected from the electrolytic cells and roof vents)

Parameter	BAT	BAT-AELs for existing plants (kg/t Al) (1) (2)	BAT-AELs for new plants (kg/t Al) (1)
Dust	Combination of BAT 64, BAT 65 and BAT 67	≤ 1,2	≤ 0,6
Total fluorides		≤ 0,6	≤ 0,35

(1) As mass of pollutant emitted during a year from the electrolysis house divided by the mass of liquid aluminium produced in the same year.
(2) These BAT-AELs are not applicable to plants that due to their configuration cannot measure roof emissions.

The associated monitoring is in BAT 10.

BAT 68. In order to prevent or reduce dust and metal emissions to air from melting and molten metal treatment and casting in primary aluminium production, BAT is to use one or both of the techniques given below.

	Technique
a	Use of liquid metal from electrolysis and uncontaminated aluminium material, i.e. solid material free of substances such as paint, plastic or oil (e.g. the top and the bottom part of the billets that are cut for quality reasons)
b	Bag filter (1)

(1) Description of the technique is given in Section 1.10.

BAT-associated emission levels: See Table 13.

Table 13

BAT-associated emission levels for dust emissions to air from melting and molten metal treatment and casting in primary aluminium production

Parameter	BAT-AEL (mg/Nm^3) (1) (2)
Dust	2-25

(1) As an average of the samples obtained over a year.
(2) The lower end of the range is associated with the use of a bag filter.

The associated monitoring is in BAT 10.

1.3.3.1.3. Sulphur dioxide emissions

BAT 69. In order to reduce emissions to air from electrolytic cells, BAT is to use one or both of the techniques given below.

	Technique	Applicability
a	Use of low-sulphur anodes	Generally applicable
b	Wet scrubber (1)	Applicability may be limited in the following cases: — very high off-gas flow rates (due to the significant amounts of waste and waste water generated) — in arid areas (due to the large volume of water necessary and the need for waste water treatment)

(1) Description of the technique is given in Section 1.10.

Description

BAT 69(a): Anodes containing less than 1,5 % sulphur as a yearly average can be produced by an appropriate combination of the raw materials used. A minimum sulphur content of 0,9 % as a yearly average is required for the viability of the electrolysis process.

BAT-associated emission levels: See Table 14.

Table 14

BAT-associated emission levels for SO_2 emissions to air from electrolytic cells

Parameter	BAT-AEL (kg/t Al) (1) (2)
SO_2	≤ 2,5-15

(1) As mass of pollutant emitted during a year divided by the mass of liquid aluminium produced in the same year.
(2) The lower end of the range is associated with the use of a wet scrubber. The higher end of the range is associated with the use of low-sulphur anodes.

The associated monitoring is in BAT 10.

1.3.3.1.4. Perfluorocarbon emissions

BAT 70. In order to reduce perfluorocarbon emissions to air from primary aluminium production, BAT is to use all of the techniques given below.

	Technique	Applicability
a	Automatic multiple point feeding of alumina	Generally applicable
b	Computer control of the electrolysis process based on active cell databases and monitoring of cell operating parameters	Generally applicable
c	Automatic anode effect suppression	Not applicable to Søderberg cells because the anode design (one piece only) does not allow the bath flow associated with this technique

Description

BAT 70(c): The anode effect takes place when the alumina content of the electrolyte falls below 1-2 %. During anode effects, instead of decomposing alumina, the cryolite bath is decomposed into metal and fluoride ions, the latter forming gaseous perfluorocarbons, which react with the carbon anode.

1.3.3.1.5. PAH and CO emissions

BAT 71. In order to reduce CO and PAH emissions to air from primary aluminium production using the Søderberg technology, BAT is to combust the CO and the PAH in the cell exhaust gas.

1.3.3.2. *Waste water generation*

BAT 72. In order to prevent the generation of waste water, BAT is to reuse or recycle cooling water and treated waste water, including rainwater, within the process.

Applicability

Generally applicable to new plants and major upgrades. The applicability may be limited due to water quality and/or product quality requirements. The amount of cooling water, treated waste water and rainwater that is reused or recycled cannot be higher than the amount of water needed for the process.

1.3.3.3. *Waste*

BAT 73. In order to reduce the disposal of spent pot lining, BAT is to organise operations on site so as to facilitate its external recycling, such as in cement manufacturing in the salt slag recovery process, as a carburiser in the steel or ferro-alloy industry or as a secondary raw material (e.g. rock wool), depending on the end consumer's requirements.

1.3.4. **Secondary aluminium production**

1.3.4.1. *Secondary materials*

BAT 74. In order to increase the raw materials' yield, BAT is to separate non-metallic constituents and metals other than aluminium by using one or a combination of the techniques given below depending on the constituents of the treated materials.

	Technique
a	Magnetic separation of ferrous metals
b	Eddy current separation (using moving electromagnetic fields) of aluminium from the other constituents
c	Relative density separation (using a fluid with a different density) of different metals and non-metallic constituents

1.3.4.2. *Energy*

BAT 75. In order to use energy efficiently, BAT is to use one or a combination of the techniques given below.

	Technique	Applicability
a	Preheating of the furnace charge with the exhaust gas	Only applicable for non-rotating furnaces
b	Recirculation of the gases with unburnt hydrocarbons back into the burner system	Only applicable for reverberatory furnaces and dryers
c	Supply the liquid metal for direct moulding	Applicability is limited by the time needed for the transportation (maximum 4-5 hours)

1.3.4.3. *Air emissions*

BAT 76. In order to prevent or reduce emissions to air, BAT is to remove oil and organic compounds from the swarf before the smelting stage using centrifugation and/or drying ([1]).

Applicability

Centrifugation is only applicable to highly oil-contaminated swarf, when it is applied before the drying. The removal of oil and organic compounds may not be needed if the furnace and the abatement system are designed to handle the organic material.

1.3.4.3.1. Diffuse emissions

BAT 77. In order to prevent or reduce diffuse emissions from the pretreatment of scraps, BAT is to use one or both of the techniques given below.

	Technique
a	Closed or pneumatic conveyor, with an air extraction system
b	Enclosures or hoods for the charging and for the discharge points, with an air extraction system

BAT 78. In order to prevent or reduce diffuse emissions from the charging and discharging/tapping of melting furnaces, BAT is to use one or a combination of the techniques given below.

	Technique	Applicability
a	Placing a hood on top of the furnace door and at the taphole with off-gas extraction connected to a filtration system	Generally applicable
b	Fume collection enclosure that covers both the charging and tapping zones	Only applicable for stationary drum furnaces
c	Sealed furnace door ([1])	Generally applicable
d	Sealed charging carriage	Only applicable for non-rotating furnaces
e	Boosted suction system that can be modified according to the process needed ([1])	Generally applicable

([1]) Description of the technique is given in Section 1.10.

([1]) Description of the techniques are given in Section 1.10.

Description

BAT 78(a) and (b): Consist of applying a covering with extraction to collect and handle the off-gases from the process.

BAT 78(d): The skip seals against the open furnace door during the discharge of scrap and maintains furnace sealing during this stage.

BAT 79. In order to reduce emissions from skimmings/dross treatment, BAT is to use one or a combination of the techniques given below.

	Technique
a	Cooling of skimmings/dross, as soon as they are skimmed from the furnace, in sealed containers under inert gas
b	Prevention of wetting of the skimmings/dross
c	Compaction of skimmings/dross with an air extraction and dust abatement system

1.3.4.3.2. Channelled dust emissions

BAT 80. In order to reduce dust and metal emissions from the swarf drying and the removal of oil and organic compounds from the swarf, from the crushing, milling and dry separation of non-metallic constituents and metals other than aluminium, and from the storage, handling and transport in secondary aluminium production, BAT is to use a bag filter.

BAT-associated emission levels: See Table 15.

Table 15

BAT-associated emission levels for dust emissions to air from the swarf drying and the removal of oil and organic compounds from the swarf, from the crushing, milling and dry separation of non-metallic constituents and metals other than aluminium, and from the storage, handling and transport in secondary aluminium production

Parameter	BAT-AEL (mg/Nm^3) (1)
Dust	≤ 5

(1) As an average over the sampling period.

The associated monitoring is in BAT 10.

BAT 81. In order to reduce dust and metal emissions to air from furnace processes such as charging, melting, tapping and molten metal treatment in secondary aluminium production, BAT is to use a bag filter.

BAT-associated emission levels: See Table 16.

Table 16

BAT-associated emission levels for dust emissions to air from furnace processes such as charging, melting, tapping and molten metal treatment in secondary aluminium production

Parameter	BAT-AEL (mg/Nm^3) (1)
Dust	2-5

(1) As a daily average or as an average over the sampling period.

The associated monitoring is in BAT 10.

BAT 82. In order to reduce dust and metal emissions to air from remelting in secondary aluminium production, BAT is to use one or a combination of the techniques given below.

	Technique
a	Use of uncontaminated aluminium material i.e. solid material free of substances such as paint, plastic or oil (e.g. billets)
b	Optimise combustion conditions to reduce the emissions of dust
c	Bag filter

BAT-associated emission levels: See Table 17.

Table 17

BAT-associated emission levels for dust from remelting in secondary aluminium production

Parameter	BAT-AEL (mg/Nm^3) (1) (2)
Dust	2-5

(1) As an average over the sampling period.
(2) For furnaces designed to use and using only uncontaminated raw material, for which dust emissions are below 1 kg/h, the upper end of the range is 25 mg/Nm^3 as an average of the samples obtained over a year.

The associated monitoring is in BAT 10.

1.3.4.3.3. Organic compound emissions

BAT 83. In order to reduce emissions to air of organic compounds and PCDD/F from the thermal treatment of contaminated secondary raw materials (e.g. swarf) and from the melting furnace, BAT is to use a bag filter in combination with at least one of the techniques given below.

	Technique (1)
a	Select and feed the raw materials according to the furnace and the abatement techniques used
b	Internal burner system for melting furnaces
c	Afterburner
d	Rapid quenching
e	Activated carbon injection

(1) Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 18.

Table 18

BAT-associated emission levels for emissions to air of TVOC and PCDD/F from the thermal treatment of contaminated secondary raw materials (e.g. swarf) and from the melting furnace

Parameter	Unit	BAT-AEL
TVOC	mg/Nm^3	≤ 10-30 (1)
PCDD/F	ng I-TEQ/Nm^3	≤ 0,1 (2)

(1) As a daily average or as an average over the sampling period.
(2) As an average over a sampling period of at least six hours.

The associated monitoring is in BAT 10.

1.3.4.3.4. Acid emissions

BAT 84. In order to reduce emissions to air of HCl, Cl_2 and HF from the thermal treatment of contaminated secondary raw materials (e.g. swarf), the melting furnace, and remelting and molten metal treatment, BAT is to use one or a combination of the techniques given below.

	Technique
a	Select and feed the raw materials according to the furnace and the abatement techniques used (1)
b	$Ca(OH)_2$ or sodium bicarbonate injection in combination with a bag filter (1)
c	Control of the refining process, adapting the quantity of refining gas used to remove the contaminants present into the molten metals
d	Use of dilute chlorine with inert gas in the refining process

(1) Description of the techniques are given in Section 1.10.

Description

BAT 84(d): Using chlorine diluted with inert gas instead of only pure chlorine, to reduce the emission of chlorine. Refining can also be performed using only the inert gas.

BAT-associated emission levels: See Table 19.

Table 19

BAT-associated emission levels for HCl, Cl_2 and HF emissions to air from the thermal treatment of contaminated secondary raw materials (e.g. swarf), the melting furnace, and remelting and molten metal treatment

Parameter	BAT-AEL (mg/Nm^3)
HCl	≤ 5-10 (1)
Cl_2	≤ 1 (2) (3)
HF	≤ 1 (4)

(1) As a daily average or as an average over the sampling period. For refining carried out with chemicals containing chlorine, the BAT-AEL refers to the average concentration during chlorination.
(2) As an average over the sampling period. For refining carried out with chemicals containing chlorine, the BAT-AEL refers to the average concentration during chlorination.
(3) Only applicable to emissions from refining processes carried out with chemicals containing chlorine.
(4) As an average over the sampling period.

The associated monitoring is in BAT 10.

1.3.4.4. *Waste*

BAT 85. In order to reduce the quantities of waste sent for disposal from secondary aluminium production, BAT is to organise operations on site so as to facilitate process residues reuse or, failing that, process residues recycling, including by using one or a combination of the techniques given below.

	Technique
a	Reuse collected dust in the process in the case of a melting furnace using salt cover or in the salt slag recovery process
b	Full recycling of the salt slag
c	Apply skimmings/dross treatment to recover aluminium in the case of furnaces that do not use salt cover

BAT 86. In order to reduce the quantities of salt slag produced from secondary aluminium production, BAT is to use one or a combination of the techniques given below.

	Technique	Applicability
a	Increase the quality of raw material used through the separation of the non-metallic constituents and metals other than aluminium for scraps where aluminium is mixed with other constituents	Generally applicable
b	Remove oil and organic constituents from contaminated swarf before melting	Generally applicable
c	Metal pumping or stirring	Not applicable for rotary furnaces
d	Tilting rotary furnace	There may be restrictions on the use of this furnace due to the size of the feed materials

1.3.5. **Salt slag recycling process**

1.3.5.1. *Diffuse emissions*

BAT 87. In order to prevent or reduce diffuse emissions from the salt slag recycling process, BAT is to use one or both of the techniques given below.

	Technique
a	Enclose equipment with gas extraction connected to a filtration system
b	Hood with gas extraction connected to a filtration system

1.3.5.2. *Channelled dust emissions*

BAT 88. In order to reduce dust and metal emissions to air from crushing and dry milling associated with the salt slag recovery process, BAT is to use a bag filter.

BAT-associated emission levels: See Table 20.

Table 20

BAT-associated emission levels for dust emissions to air from crushing and dry milling associated with the salt slag recovery process

Parameter	BAT-AEL (mg/Nm^3) (1)
Dust	2-5

(1) As a daily average or as an average over the sampling period.

The associated monitoring is in BAT 10.

1.3.5.3. *Gaseous compounds*

BAT 89. In order to reduce gaseous emissions to air from wet milling and leaching from the salt slag recovery process, BAT is to use one or a combination of the techniques given below.

	Technique (1)
a	Activated carbon injection
b	Afterburner
c	Wet scrubber with H_2SO_4 solution

(1) Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 21.

Table 21

BAT-associated emission levels for gaseous emissions to air from wet milling and leaching from the salt slag recovery process

Parameter	BAT-AEL (mg/Nm^3) (1)
NH_3	≤ 10
PH_3	≤ 0,5
H_2S	≤ 2

(1) As an average over the sampling period.

The associated monitoring is in BAT 10.

1.4. BAT CONCLUSIONS FOR LEAD AND/OR TIN PRODUCTION

1.4.1. **Air emissions**

1.4.1.1. *Diffuse emissions*

BAT 90. In order to prevent or reduce diffuse emissions from preparation (such as metering, mixing, blending, crushing, cutting, screening) of primary and secondary materials (excluding batteries), BAT is to use one or a combination of the techniques given below.

	Technique	Applicability
a	Enclosed conveyer or pneumatic transfer system for dusty material	Generally applicable
b	Enclosed equipment. When dusty materials are used the emissions are collected and sent to an abatement system	Only applicable for feed blends prepared with a dosing bin or loss-in-weight system
c	Mixing of raw materials carried out in an enclosed building	Only applicable for dusty materials. For existing plants, application may be difficult due to the space required
d	Dust suppression systems such as water sprays	Only applicable for mixing carried out outdoors
e	Pelletisation of raw materials	Applicable only when the process and the furnace can use pelletised raw materials

BAT 91. In order to prevent or reduce diffuse emissions from material pretreatment (such as drying, dismantling, sintering, briquetting, pelletising and battery crushing, screening and classifying) in primary lead and secondary lead and/or tin production, BAT is to use one or both of the techniques given below.

	Technique
a	Enclosed conveyer or pneumatic transfer system for dusty material
b	Enclosed equipment. When dusty materials are used the emissions are collected and sent to an abatement system

BAT 92. In order to prevent or reduce diffuse emissions from charging, smelting and tapping operations in lead and/or tin production, and from pre-decoppering operations in primary lead production, BAT is to use an appropriate combination of the techniques given below.

	Technique	Applicability
a	Encapsulated charging system with an air extraction system	Generally applicable
b	Sealed or enclosed furnaces with door sealing ([1]) for processes with a discontinuous feed and output	Generally applicable
c	Operate furnace and gas routes under negative pressure and at a sufficient gas extraction rate to prevent pressurisation	Generally applicable
d	Capture hood/enclosures at charging and tapping points	Generally applicable
e	Enclosed building	Generally applicable
f	Complete hood coverage with an air extraction system	In existing plants or major upgrades of existing plants, application may be difficult due to the space requirements
g	Maintain furnace sealing	Generally applicable
h	Maintain the temperature in the furnace at the lowest required level	Generally applicable
i	Apply a hood at the tapping point, ladles and drossing area with an air extraction system	Generally applicable
j	Pretreatment of dusty raw material, such as pelletisation	Applicable only when the process and the furnace can use pelletised raw materials
k	Apply a doghouse for ladles during tapping	Generally applicable
l	An air extraction system for charging and tapping area connected to a filtration system	Generally applicable

([1]) Descriptions of the techniques are given in Section 1.10.

BAT 93. In order to prevent or reduce diffuse emissions from remelting, refining and casting in primary and secondary lead and/or tin production, BAT is to use a combination of the techniques given below.

	Technique
a	Hood on the crucible furnace or kettle with an air extraction system
b	Lids to close the kettle during the refining reactions and addition of chemicals
c	Hood with air extraction system at launders and tapping points
d	Temperature control of the melt
e	Closed mechanical skimmers for removal of dusty dross/residues

1.4.1.2. *Channelled dust emissions*

BAT 94. In order to reduce dust and metal emissions to air from raw material preparation (such as reception, handling, storage, metering, mixing, blending, drying, crushing, cutting and screening) in primary and secondary lead/or and tin production, BAT is to use a bag filter.

BAT-associated emission levels: See Table 22.

Table 22

BAT-associated emission levels for dust emissions to air from raw material preparation in primary and secondary lead and/or tin production

Parameter	BAT-AEL (mg/Nm^3) (1)
Dust	≤ 5

(1) As a daily average or as an average over the sampling period.

The associated monitoring is in BAT 10.

BAT 95. In order to reduce dust and metal emissions to air from battery preparation (crushing, screening and classifying), BAT is to use a bag filter or a wet scrubber.

BAT-associated emission levels: See Table 23.

Table 23

BAT-associated emission levels for dust emissions to air from battery preparation (crushing, screening and classifying)

Parameter	BAT-AEL (mg/Nm^3) (1)
Dust	≤ 5

(1) As an average over the sampling period.

The associated monitoring is in BAT 10.

BAT 96. In order to reduce dust and metal emissions to air (other than those that are routed to the sulphuric acid or liquid SO_2 plant) from charging, smelting and tapping in primary and secondary lead and/or tin production, BAT is to use a bag filter.

BAT-associated emission levels: See Table 24.

Table 24

BAT-associated emission levels for dust and lead emissions to air (other than those that are routed to the sulphuric acid or liquid SO_2 plant) from charging, smelting and tapping in primary and secondary lead and/or tin production

Parameter	BAT-AEL (mg/Nm^3)
Dust	2-4 (1) (2)
Pb	≤ 1 (3)

(1) As a daily average or as an average over the sampling period.
(2) Dust emissions are expected to be towards the lower end of the range when emissions are above the following levels: 1 mg/Nm^3 for copper, 0,05 mg/Nm^3 for arsenic, 0,05 mg/Nm^3 for cadmium.
(3) As an average over the sampling period.

The associated monitoring is in BAT 10.

BAT 97. In order to reduce dust and metal emissions to air from remelting, refining and casting in primary and secondary lead and/or tin production, BAT is to use the techniques given below.

	Technique
a	For pyrometallurgical processes: maintain the temperature of the melt bath at the lowest possible level according to the process stage in combination with a bag filter
b	For hydrometallurgical processes: use a wet scrubber

BAT-associated emission levels: See Table 25.

Table 25

BAT-associated emission levels for dust and lead emissions to air from remelting, refining and casting in primary and secondary lead and/or tin production

Parameter	BAT-AEL (mg/Nm^3)
Dust	2-4 (1) (2)
Pb	≤ 1 (3)

(1) As a daily average or as an average over the sampling period.
(2) Dust emissions are expected to be towards the lower end of the range when emissions are above the following levels: 1 mg/Nm^3 for copper, 1 mg/Nm^3 for antimony, 0,05 mg/Nm^3 for arsenic, 0,05 mg/Nm^3 for cadmium.
(3) As an average over the sampling period.

The associated monitoring is in BAT 10.

1.4.1.3. *Organic compound emissions*

BAT 98. In order to reduce emissions of organic compounds to air from the raw material drying and smelting process in secondary lead and/or tin production, BAT is to use one or a combination of the techniques given below.

	Technique (1)	Applicability
a	Select and feed the raw materials according to the furnace and the abatement techniques used	Generally applicable
b	Optimise combustion conditions to reduce the emissions of organic compounds	Generally applicable
c	Afterburner or regenerative thermal oxidiser	The applicability is restricted by the energy content of the off-gases that need to be treated, as off-gases with a lower energy content lead to a higher use of fuels

(1) Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 26.

Table 26

BAT-associated emission levels for TVOC emissions to air from the raw material drying and smelting process in secondary lead and/or tin production

Parameter	BAT-AEL (mg/Nm^3) (1)
TVOC	10-40

(1) As a daily average or as an average over the sampling period.

The associated monitoring is in BAT 10.

BAT 99. In order to reduce PCDD/F emissions to air from the smelting of secondary lead and/or tin raw materials, BAT is to use one or a combination of the techniques given below.

	Technique
a	Select and feed the raw materials according to the furnace and the abatement techniques used (1)
b	Use charging systems, for a semi-closed furnace, to give small additions of raw material (1)

	Technique
c	Internal burner system [1] for melting furnaces
d	Afterburner or regenerative thermal oxidiser [1]
e	Avoid exhaust systems with a high dust build-up at temperatures > 250 °C [1]
f	Rapid quenching [1]
g	Injection of adsorption agent in combination with efficient dust collection system [1]
h	Use of efficient dust collection system
i	Use of oxygen injection in the upper zone of the furnace
j	Optimise combustion conditions to reduce the emissions of organic compounds [1]

[1] Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 27.

Table 27

BAT-associated emission levels for PCDD/F emissions to air from the smelting of secondary lead and/or tin raw materials

Parameter	BAT-AEL (ng I-TEQ/Nm^3) [1]
PCDD/F	≤ 0,1

[1] As an average over a sampling period of at least six hours.

The associated monitoring is in BAT 10.

1.4.1.4. *Sulphur dioxide emissions*

BAT 100. In order to prevent or reduce SO_2 emissions to air (other than those that are routed to the sulphuric acid or liquid SO_2 plant) from charging, smelting and tapping in primary and secondary lead and/or tin production, BAT is to use one or a combination of the techniques given below.

	Technique	Applicability
a	Alkaline leaching of raw materials that contain sulphur in the form of sulphate	Generally applicable
b	Dry or semi-dry scrubber [1]	Generally applicable
c	Wet scrubber [1]	Applicability may be limited in the following cases: — very high off-gas flow rates (due to the significant amounts of waste and waste water generated) — in arid areas (due to the large volume of water necessary and the need for waste water treatment)
d	Fixation of sulphur in the smelt phase	Only applicable for secondary lead production

[1] Descriptions of the techniques are given in Section 1.10.

Description

BAT 100(a): An alkali salt solution is used to remove sulphates from secondary materials prior to smelting.

BAT 100(d): The fixation of sulphur in the smelt phase is achieved by adding iron and soda (Na_2CO_3) in the smelters which react with the sulphur contained in the raw materials to form Na_2S-FeS slag.

BAT-associated emission levels: See Table 28.

Table 28

BAT-associated emission levels for SO_2 emissions to air (other than those that are routed to the sulphuric acid or liquid SO_2 plant) from charging, smelting and tapping in primary and secondary lead and/or tin production

Parameter	BAT-AEL (mg/Nm^3) (1) (2)
SO_2	50-350

(1) As a daily average or as an average over the sampling period.
(2) When wet scrubbers are not applicable, the upper end of the range is 500 mg/Nm^3.

The associated monitoring is in BAT 10.

1.4.2. Soil and groundwater protection

BAT 101. In order to prevent the contamination of soil and groundwater from battery storage, crushing, screening and classifying operations, BAT is to use an acid-resistant floor surface and a system for the collection of acid spillages.

1.4.3. Waste water generation and treatment

BAT 102. In order to prevent the generation of waste water from the alkaline leaching process, BAT is to reuse the water from the sodium sulphate crystallisation of the alkali salt solution.

BAT 103. In order to reduce emissions to water from battery preparation when the acid mist is sent to the waste water treatment plant, BAT is to operate an adequately designed waste water treatment plant to abate the pollutants contained in this stream.

1.4.4. Waste

BAT 104. In order to reduce the quantities of waste sent for disposal from primary lead production, BAT is to organise operations on site so as to facilitate process residues reuse or, failing that, process residues recycling, including by using one or a combination of the techniques given below.

	Technique	Applicability
a	Reuse of the dust from the dust removal system in the lead production process	Generally applicable
b	Se and Te recovery from wet or dry gas cleaning dust/sludge	The applicability can be limited by the quantity of mercury present
c	Ag, Au, Bi, Sb and Cu recovery from the refining dross	Generally applicable
d	Recovery of metals from the waste water treatment sludge	Direct smelting of the waste water treatment plant sludge might be limited by the presence of elements such as As, Tl and Cd
e	Addition of flux materials that make the slag more suitable for external use	Generally applicable

BAT 105. In order to allow the recovery of the polypropylene and polyethylene content of the lead battery, BAT is to separate it from the batteries prior to smelting.

Applicability

This may not be applicable for shaft furnaces due to the gas permeability provided by undismantled (whole) batteries, which is required by the furnace operations.

BAT 106. In order to reuse or recover the sulphuric acid collected from the battery recovery process, BAT is to organise operations on site so as to facilitate its internal or external reuse or recycling, including one or a combination of the techniques given below.

	Technique	Applicability
a	Reuse as a pickling agent	Generally applicable depending on the local conditions such as presence of the pickling process and compatibility of the impurities present in the acid with the process
b	Reuse as raw material in a chemical plant	Applicability may be restricted depending on the local availability of a chemical plant
c	Regeneration of the acid by cracking	Only applicable when a sulphuric acid or liquid sulphur dioxide plant is present
d	Production of gypsum	Only applicable if the impurities present in the recovery acid do not affect the gypsum quality or if gypsum of a lower quality can be used for other purposes such as a flux agent
e	Production of sodium sulphate	Only applicable for the alkaline leaching process

BAT 107. In order to reduce the quantities of waste sent for disposal from secondary lead and/or tin production, BAT is to organise operations on site so as to facilitate process residues reuse or, failing that, process residues recycling, including by using one or a combination of the techniques given below.

	Technique
a	Reuse the residues in the smelting process to recover lead and other metals
b	Treat the residues and the wastes in dedicated plants for material recovery
c	Treat the residues and the wastes so that they can be used for other applications

1.5. BAT CONCLUSIONS FOR ZINC AND/OR CADMIUM PRODUCTION

1.5.1. **Primary zinc production**

1.5.1.1. *Hydrometallurgical zinc production*

1.5.1.1.1. Energy

BAT 108. In order to use energy efficiently, BAT is to recover heat from the off-gases produced in the roaster using one or a combination of the techniques given below.

	Technique	Applicability
a	Use a waste heat boiler and turbines to produce electricity	Applicability may be restricted depending on energy prices and the energy policy of the Member State
b	Use a waste heat boiler and turbines to produce mechanical energy to be used within the process	Generally applicable
c	Use a waste heat boiler to produce heat to be used within the process and/or for office heating	Generally applicable

1.5.1.1.2. Air emissions

1.5.1.1.2.1. Diffuse emissions

BAT 109. In order to reduce diffuse dust emissions to air from the roaster feed preparation and the feeding itself, BAT is to use one or both of the techniques given below.

	Technique
a	Wet feeding
b	Completely enclosed process equipment connected to an abatement system

BAT 110. In order to reduce diffuse dust emissions to air from calcine processing, BAT is to use one or both of the techniques given below.

	Technique
a	Perform operations under negative pressure
b	Completely enclosed process equipment connected to an abatement system

BAT 111. In order to reduce diffuse emissions to air from leaching, solid-liquid separation and purification, BAT is to use one or a combination of the techniques given below.

	Technique	Applicability
a	Cover tanks with a lid	Generally applicable
b	Cover process liquid inlet and outlet launders	Generally applicable
c	Connect tanks to a central mechanical draught abatement system or to a single tank abatement system	Generally applicable
d	Cover vacuum filters with hoods and connect them to an abatement system	Only applicable to the filtering of hot liquids in the leaching and solid-liquid separation stages

BAT 112. In order to reduce diffuse emissions to air from electrowinning, BAT is to use additives, especially foaming agents, in the electrowinning cells.

1.5.1.1.2.2. Channelled emissions

BAT 113. In order to reduce dust and metal emissions to air from the handling and storage of raw materials, dry roaster feed preparation, dry roaster feeding and calcine processing, BAT is to use a bag filter.

BAT-associated emission levels: See Table 29.

Table 29

BAT-associated emission levels for dust emissions to air from the handling and storage of raw materials, dry roaster feed preparation, dry roaster feeding and calcine processing

Parameter	BAT-AEL (mg/Nm^3) (1)
Dust	≤ 5

(1) As an average over the sampling period.

The associated monitoring is in BAT 10.

BAT 114. In order to reduce zinc and sulphuric acid emissions to air from leaching, purification and electrolysis, and to reduce arsane and stibane emissions from purification, BAT is to use one or a combination of the techniques given below.

	Technique (1)
a	Wet scrubber
b	Demister
c	Centrifugal system

(1) Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 30.

Table 30

BAT-associated emission levels for zinc and sulphuric acid emissions to air from leaching, purification and electrolysis and for arsane and stibane emissions from purification

Parameter	BAT-AEL (mg/Nm^3) (1)
Zn	≤ 1
H_2SO_4	< 10
Sum of AsH_3 and SbH_3	≤ 0,5

(1) As an average over the sampling period.

The associated monitoring is in BAT 10.

1.5.1.1.3. Soil and groundwater protection

BAT 115. In order to prevent soil and groundwater contamination, BAT is to use a watertight bunded area for tanks used during leaching or purification and a secondary containment system of the cell houses.

1.5.1.1.4. Waste water generation

BAT 116. In order to reduce fresh water consumption and prevent the generation of waste water, BAT is to use a combination of the techniques given below.

	Technique
a	Return of the bleed from the boiler and the water from the closed cooling circuits of the roaster to the wet gas cleaning or the leaching stage
b	Return of the waste water from the cleaning operations/spills of the roaster, the electrolysis and the casting to the leaching stage
c	Return of the waste water from the cleaning operations/spills of the leaching and purification, the filter cake washing and the wet gas scrubbing to the leaching and/or purification stages

1.5.1.1.5. Waste

BAT 117. In order to reduce the quantities of waste sent for disposal, BAT is to organise operations on site so as to facilitate process residues reuse or, failing that, process residues recycling, including by using one or a combination of the techniques given below.

	Technique	Applicability
a	Reuse of the dust collected in the concentrate storage and handling within the process (together with the concentrate feed)	Generally applicable
b	Reuse of the dust collected in the roasting process via the calcine silo	Generally applicable
c	Recycling of residues containing lead and silver as raw material in an external plant	Applicable depending on the metal content and on the availability of a market/process
d	Recycling of residues containing Cu, Co, Ni, Cd, Mn as raw material in an external plant to obtain a saleable product	Applicable depending on the metal content and on the availability of a market/process

BAT 118. In order to make the leaching waste suitable for final disposal, BAT is to use one of the techniques given below.

	Technique	Applicability
a	Pyrometallurgical treatment in a Waelz kiln	Only applicable to neutral leaching wastes that do not contain too many zinc ferrites and/or do not contain high concentrations of precious metals
b	Jarofix process	Only applicable to jarosite iron residues. Limited applicability due to an existing patent
c	Sulphidation process	Only applicable to jarosite iron residues and direct leach residues
d	Compacting iron residues	Only applicable to goethite residues and gypsum-rich sludge from the waste water treatment plant

Description

BAT 118(b): The Jarofix process consists of mixing jarosite precipitates with Portland cement, lime and water.

BAT 118(c): The sulphidation process consists of the addition of NaOH and Na_2S to the residues in an elutriating tank and in sulphidation reactors.

BAT 118(d): Compacting iron residues consists of reducing the moisture content by means of filters and the addition of lime or other agents.

1.5.1.2. *Pyrometallurgical zinc production*

1.5.1.2.1. Air emissions

1.5.1.2.1.1. Channelled dust emissions

BAT 119. In order to reduce dust and metal emissions to air (other than those that are routed to the sulphuric acid plant) from pyrometallurgical zinc production, BAT is to use a bag filter.

Applicability

In the event of a high organic carbon content in the concentrates (e.g. around 10 wt-%), bag filters might not be applicable due to the blinding of the bags and other techniques (e.g. wet scrubber) might be used.

BAT-associated emission levels: See Table 31.

Table 31

BAT-associated emission levels for dust emissions to air (other than those that are routed to the sulphuric acid plant) from pyrometallurgical zinc production

Parameter	BAT-AEL (mg/Nm^3) (1) (2)
Dust	2-5

(1) As a daily average or as an average over the sampling period.
(2) When a bag filter is not applicable, the upper end of the range is 10 mg/Nm^3.

The associated monitoring is in BAT 10.

BAT 120. In order to reduce SO_2 emissions to air (other than those that are routed to the sulphuric acid plant) from pyrometallurgical zinc production, BAT is to use a wet desulphurisation technique.

BAT-associated emission levels: See Table 32.

Table 32

BAT-associated emission levels for SO_2 emissions to air (other than those that are routed to the sulphuric acid plant) from pyrometallurgical zinc production

Parameter	BAT-AEL (mg/Nm^3) (1)
SO_2	≤ 500

(1) As a daily average.

The associated monitoring is in BAT 10.

1.5.2. Secondary zinc production

1.5.2.1. *Air emissions*

1.5.2.1.1. Channelled dust emissions

BAT 121. In order to reduce dust and metal emissions to air from pelletising and slag processing, BAT is to use a bag filter.

BAT-associated emission levels: See Table 33.

Table 33

BAT-associated emission levels for dust emissions to air from pelletising and slag processing

Parameter	BAT-AEL (mg/Nm^3) (1)
Dust	≤ 5

(1) As an average over the sampling period.

The associated monitoring is in BAT 10.

BAT 122. In order to reduce dust and metal emissions to air from the melting of metallic and mixed metallic/oxidic streams, and from the slag fuming furnace and the Waelz kiln, BAT is to use a bag filter.

Applicability

A bag filter may not be applicable for a clinker operation (where chlorides need to be abated instead of metal oxides).

BAT-associated emission levels: See Table 34.

Table 34

BAT-associated emission levels for dust emissions to air from the melting of metallic and mixed metallic/oxidic streams, and from the slag fuming furnace and the Waelz kiln

Parameter	BAT-AEL (mg/Nm^3) (1) (2) (3)
Dust	2-5

(1) As a daily average or as an average over the sampling period.
(2) When a bag filter is not applicable, the upper end of the range may be higher, up to 15 mg/Nm^3.
(3) Dust emissions are expected to be towards the lower end of the range when emissions of arsenic or cadmium are above 0,05 mg/Nm^3.

The associated monitoring is in BAT 10.

1.5.2.1.2. Organic compound emissions

BAT 123. In order to reduce emissions of organic compounds to air from the melting of metallic and mixed metallic/oxidic streams, and from the slag fuming furnace and the Waelz kiln, BAT is to use one or a combination of the techniques given below.

	Technique (1)	Applicability
a	Injection of adsorbent (activated carbon or lignite coke) followed by a bag filter and/or ESP	Generally applicable
b	Thermal oxidiser	Generally applicable
c	Regenerative thermal oxidiser	May not be applicable due to safety reasons

(1) Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 35.

Table 35

BAT-associated emission levels for emissions to air of TVOC and PCDD/F from the melting of metallic and mixed metallic/oxidic streams, and from the slag fuming furnace and the Waelz kiln

Parameter	Unit	BAT-AEL
TVOC	mg/Nm^3	2-20 (1)
PCDD/F	ng I-TEQ/Nm^3	≤ 0,1 (2)

(1) As a daily average or as an average over the sampling period.
(2) As an average over a sampling period of at least six hours.

The associated monitoring is in BAT 10.

1.5.2.1.3. Acid emissions

BAT 124. In order to reduce emissions of HCl and HF to air from the melting of metallic and mixed metallic/oxidic streams, and from the slag fuming furnace and the Waelz kiln, BAT is to use one of the techniques given below.

	Technique (1)	Process
a	Injection of adsorbent followed by a bag filter	— Melting of metallic and mixed metallic/oxidic streams — Waelz kiln
b	Wet scrubber	— Slag fuming furnace

(1) Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 36.

Table 36

BAT-associated emission levels for emissions of HCl and HF to air from the melting of metallic and mixed metallic/oxidic streams, and from the slag fuming furnace and the Waelz kiln

Parameter	BAT-AEL (mg/Nm^3) (1)
HCl	≤ 1,5
HF	≤ 0,3

(1) As an average over the sampling period.

The associated monitoring is in BAT 10.

1.5.2.2. *Waste water generation and treatment*

BAT 125. In order to reduce the consumption of fresh water in the Waelz kiln process, BAT is to use multiple-stage countercurrent washing.

Description

Water coming from a previous washing stage is filtered and reused in the following washing stage. Two or three stages can be used, allowing up to three times less water consumption in comparison with single-stage countercurrent washing.

BAT 126. In order to prevent or reduce halide emissions to water from the washing stage in the Waelz kiln process, BAT is to use crystallisation.

1.5.3. Melting, alloying and casting of zinc ingots and zinc powder production

1.5.3.1. *Air emissions*

1.5.3.1.1. Diffuse dust emissions

BAT 127. In order to reduce diffuse dust emissions to air from the melting, alloying and casting of zinc ingots, BAT is to use equipment under negative pressure.

1.5.3.1.2. Channelled dust emissions

BAT 128. In order to reduce dust and metal emissions to air from the melting, alloying and casting of zinc ingots and zinc powder production, BAT is to use a bag filter.

BAT-associated emission levels: See Table 37.

Table 37

BAT-associated emission levels for dust emissions to air from the melting, alloying and casting of zinc ingots and zinc powder production

Parameter	BAT-AEL (mg/Nm^3) (1)
Dust	≤ 5

(1) As an average over the sampling period.

The associated monitoring is in BAT 10.

1.5.3.2. *Waste water*

BAT 129. In order to prevent the generation of waste water from the melting and casting of zinc ingots, BAT is to reuse the cooling water.

1.5.3.3. *Waste*

BAT 130. In order to reduce the quantities of waste sent for disposal from the melting of zinc ingots, BAT is to organise operations on site so as to facilitate process residues reuse or, failing that, process residues recycling, including by using one or both of the techniques given below.

	Technique
a	Use of the oxidised fraction of the zinc dross and the zinc-bearing dust from the melting furnaces in the roasting furnace or in the hydrometallurgical zinc production process
b	Use of the metallic fraction of the zinc dross and the metallic dross from cathode casting in the melting furnace or recovery as zinc dust or zinc oxide in a zinc refining plant

1.5.4. **Cadmium production**

1.5.4.1. *Air emissions*

1.5.4.1.1. Diffuse emissions

BAT 131. In order to reduce diffuse emissions to air, BAT is to use one or both of the techniques given below.

	Technique
a	Central extraction system connected to an abatement system for leaching and solid-liquid separation in hydrometallurgical production; for briquetting/pelletising and fuming in pyrometallurgical production; and for melting, alloying and casting processes
b	Cover cells for the electrolysis stage in hydrometallurgical production

1.5.4.1.2. Channelled dust emissions

BAT 132. In order to reduce dust and metal emissions to air from pyrometallurgical cadmium production and the melting, alloying and casting of cadmium ingots, BAT is to use one or a combination of the techniques given below.

	Technique [1]	Applicability
a	Bag filter	Generally applicable
b	ESP	Generally applicable
c	Wet scrubber	Applicability may be limited in the following cases: — very high off-gas flow rates (due to the significant amounts of waste and waste water generated) — in arid areas (due to the large volume of water necessary and the need for waste water treatment)

[1] Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 38.

Table 38

BAT-associated emission levels for dust and cadmium emissions to air from pyrometallurgical cadmium production and the melting, alloying and casting of cadmium ingots

Parameter	BAT-AEL (mg/Nm^3) [1]
Dust	2-3
Cd	≤ 0,1

[1] As an average over the sampling period.

The associated monitoring is in BAT 10.

1.5.4.2. *Waste*

BAT 133. In order to reduce the quantities of waste sent for disposal from hydrometallurgical cadmium production, BAT is to organise operations on site so as to facilitate process residues reuse or, failing that, process residues recycling, including by using one of the techniques given below.

	Technique	Applicability
a	Extract the cadmium from the zinc process as a cadmium-rich cementate in the purification section, further concentrate and refine it (by electrolysis or a pyrometallurgical process) and finally transform it into marketable cadmium metal or cadmium compounds	Only applicable if an economically viable demand exists
b	Extract the cadmium from the zinc process as a cadmium-rich cementate in the purification section, and then apply a set of hydrometallurgical operations in order to obtain a cadmium-rich precipitate (e.g. cement (Cd metal), $Cd(OH)_2$) that is landfilled, while all other process flows are recycled in the cadmium plant or in the zinc plant flow	Only applicable if suitable landfill is available

1.6. BAT CONCLUSIONS FOR PRECIOUS METALS PRODUCTION

1.6.1. **Air emissions**

1.6.1.1. *Diffuse emissions*

BAT 134. In order to reduce diffuse emissions to air from a pretreatment operation (such as crushing, sieving and mixing), BAT is to use one or a combination of the techniques given below.

	Technique
a	Enclose pretreatment areas and transfer systems for dusty materials
b	Connect pretreatment and handling operations to dust collectors or extractors via hoods and a ductwork system for dusty materials
c	Electrically interlock pretreatment and handling equipment with their dust collector or extractor, in order to ensure that no equipment may be operated unless the dust collector and filtering system are in operation

BAT 135. In order to reduce diffuse emissions to air from smelting and melting (both Doré and non-Doré operations), BAT is to use all of the techniques given below.

	Technique
a	Enclose buildings and/or smelting furnace areas
b	Perform operations under negative pressure
c	Connect furnace operations to dust collectors or extractors via hoods and a ductwork system
d	Electrically interlock furnace equipment with their dust collector or extractor, in order to ensure that no equipment may be operated unless the dust collector and filtering system are in operation

BAT 136. In order to reduce diffuse emissions to air from leaching and gold electrolysis, BAT is to use one or a combination of the techniques given below.

	Technique
a	Closed tanks/vessels and closed pipes for transfer of solutions
b	Hoods and extraction systems for electrolytic cells
c	Water curtain for gold production, to prevent chlorine gas emissions during the leaching of anode slimes with hydrochloric acid or other solvents

BAT 137. In order to reduce diffuse emissions from a hydrometallurgical operation, BAT is to use all of the techniques given below.

	Technique
a	Containment measures, such as sealed or enclosed reaction vessels, storage tanks, solvent extraction equipment and filters, vessels and tanks fitted with level control, closed pipes, sealed drainage systems, and planned maintenance programmes
b	Reaction vessels and tanks connected to a common ductwork system with off-gas extraction (automatic standby/back-up unit available in case of failure)

BAT 138. In order to reduce diffuse emissions to air from incineration, calcining and drying, BAT is to use all of the techniques given below.

	Technique
a	Connect all calcining furnaces, incinerators and drying ovens to a ductwork system extracting process exhaust gases
b	Scrubber plant on a priority electricity circuit which is served by a back-up generator in the event of power failure
c	Operating start-up and shutdown, spent acid disposal, and fresh acid make-up of scrubbers via an automated control system

BAT 139. In order to reduce diffuse emissions to air from the melting of final metal products during refining, BAT is to use both of the techniques given below.

	Technique
a	Enclosed furnace with negative pressure
b	Appropriate housing, enclosures and capture hoods with efficient extraction/ventilation

1.6.1.2. *Channelled dust emissions*

BAT 140. In order to reduce dust and metal emissions to air from all dusty operations, such as crushing, sieving, mixing, melting, smelting, incineration, calcining, drying and refining, BAT is to use one of the techniques given below.

	Technique [1]	Applicability
a	Bag filter	May not be applicable for off-gases containing a high level of volatilised selenium

	Technique (1)	Applicability
b	Wet scrubber in combination with an ESP, allowing the recovery of selenium	Only applicable to off-gases containing volatilised selenium (e.g. Doré metal production)

(1) Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 39.

Table 39

BAT-associated emission levels for dust emissions to air from all dusty operations, such as crushing, sieving, mixing, melting, smelting, incineration, calcining, drying and refining

Parameter	BAT-AEL (mg/Nm^3) (1)
Dust	2-5

(1) As a daily average or as an average over the sampling period.

The associated monitoring is in BAT 10.

1.6.1.3. *NO_X emissions*

BAT 141. In order to reduce NO_X emissions to air from a hydrometallurgical operation involving dissolving/leaching with nitric acid, BAT is to use one or both of the techniques given below.

	Technique (1)
a	Alkaline scrubber with caustic soda
b	Scrubber with oxidation agents (e.g. oxygen, hydrogen peroxide) and reducing agents (e.g. nitric acid, urea) for those vessels in hydrometallurgical operations with the potential to generate high concentrations of NO_X. It is often applied in combination with BAT 141(a)

(1) Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 40.

Table 40

BAT-associated emission levels for NO_X emissions to air from a hydrometallurgical operation involving dissolving/leaching with nitric acid

Parameter	BAT-AEL (mg/Nm^3) (1)
NO_X	70-150

(1) As an hourly average or as an average over the sampling period.

The associated monitoring is in BAT 10.

1.6.1.4. *Sulphur dioxide emissions*

BAT 142. In order to reduce SO_2 emissions to air (other than those that are routed to the sulphuric acid plant) from a melting and smelting operation for the production of Doré metal, including the associated incineration, calcining and drying operations, BAT is to use one or a combination of the techniques given below.

	Technique (1)	Applicability
a	Lime injection in combination with a bag filter	Generally applicable
b	Wet scrubber	Applicability may be limited in the following cases: — very high off-gas flow rates (due to the significant amounts of waste and waste water generated) — in arid areas (due to the large volume of water necessary and the need for waste water treatment)

(1) Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 41.

Table 41

BAT-associated emission levels for SO_2 emissions to air (other than those that are routed to the sulphuric acid plant) from a melting and smelting operation for the production of Doré metal, including the associated incineration, calcining and drying operations

Parameter	BAT-AEL (mg/Nm^3) (1)
SO_2	50-480

(1) As a daily average or as an average over the sampling period.

The associated monitoring is in BAT 10.

BAT 143. In order to reduce SO_2 emissions to air from a hydrometallurgical operation, including the associated incineration, calcining and drying operations, BAT is to use a wet scrubber.

BAT-associated emission levels: See Table 42.

Table 42

BAT-associated emission levels for SO_2 emissions to air from a hydrometallurgical operation, including the associated incineration, calcining and drying operations

Parameter	BAT-AEL (mg/Nm^3) (1)
SO_2	50-100

(1) As a daily average or as an average over the sampling period.

The associated monitoring is in BAT 10.

1.6.1.5. *HCl and Cl_2 emissions*

BAT 144. In order to reduce HCl and Cl_2 emissions to air from a hydrometallurgical operation, including the associated incineration, calcining and drying operations, BAT is to use an alkaline scrubber.

BAT-associated emission levels: See Table 43.

Table 43

BAT-associated emission levels for HCl and Cl_2 emissions to air from a hydrometallurgical operation, including the associated incineration, calcining and drying operations

Parameter	BAT-AEL (mg/Nm^3) (1)
HCl	≤ 5-10
Cl_2	0,5-2

(1) As an average over the sampling period.

The associated monitoring is in BAT 10.

1.6.1.6. *NH_3 emissions*

BAT 145. In order to reduce NH_3 emissions to air from a hydrometallurgical operation using ammonia or ammonium chloride, BAT is to use a wet scrubber with sulphuric acid.

BAT-associated emission levels: See Table 44.

Table 44

BAT-associated emission levels for NH_3 emissions to air from a hydrometallurgical operation using ammonia or ammonium chloride

Parameter	BAT-AEL (mg/Nm^3) (1)
NH_3	1-3

(1) As an average over the sampling period.

The associated monitoring is in BAT 10.

1.6.1.7. *PCDD/F emissions*

BAT 146. In order to reduce PCDD/F emissions to air from a drying operation where the raw materials contain organic compounds, halogens or other PCDD/F precursors, from an incineration operation, and from a calcining operation, BAT is to use one or a combination of the techniques given below.

	Technique
a	Afterburner or regenerative thermal oxidiser (1)
b	Injection of adsorption agent in combination with an efficient dust collection system (1)
c	Optimise combustion or process conditions for the abatement of emissions of organic compounds (1)
d	Avoid exhaust systems with a high dust build-up for temperatures > 250 °C (1)
e	Rapid quenching (1)
f	Thermal destruction of PCDD/F in the furnace at high temperatures (> 850 °C)
g	Use of oxygen injection in the upper zone of the furnace
h	Internal burner system (1)

(1) Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 45.

Table 45

BAT-associated emission levels for PCDD/F emissions to air from a drying operation where the raw materials contain organic compounds, halogens or other PCDD/F precursors, from an incineration operation, and from a calcining operation

Parameter	BAT-AEL (ng I-TEQ/Nm^3) (1)
PCDD/F	≤ 0,1

(1) As an average over a sampling period of at least six hours.

The associated monitoring is in BAT 10.

1.6.2. Soil and groundwater protection

BAT 147. In order to prevent soil and groundwater contamination, BAT is to use a combination of the techniques given below.

	Technique
a	Use of sealed drainage systems
b	Use of double-walled tanks or placement in resistant bunds
c	Use of impermeable and acid-resistant floors
d	Automatic level control of reaction vessels

1.6.3. Waste water generation

BAT 148. In order to prevent the generation of waste water, BAT is to use one or both of the techniques given below.

	Technique
a	Recycling of spent/recovered scrubbing liquids and other hydrometallurgical reagents in leaching and other refining operations
b	Recycling of solutions from leaching, extraction and precipitation operations

1.6.4. Waste

BAT 149. In order to reduce the quantities of waste sent for disposal, BAT is to organise operations on site so as to facilitate process residues reuse or, failing that, process residues recycling, including by using one or a combination of the techniques given below.

	Technique	Process
a	Recovery of the metal content from slags, filter dust and residues of the wet dedusting system	Doré production
b	Recovery of the selenium collected in the wet dedusting system's off-gases containing volatilised selenium	
c	Recovery of silver from spent electrolyte and spent slime washing solutions	Silver electrolytic refining
d	Recovery of metals from residues from electrolyte purification (e.g. silver cement, copper carbonate-based residue)	
e	Recovery of gold from electrolyte, slimes and solutions from the gold leaching processes	Gold electrolytic refining
f	Recovery of metals from spent anodes	Silver or gold electrolytic refining
g	Recovery of platinum group metals from platinum group metal-enriched solutions	
h	Recovery of metals from the treatment of process end liquors	All processes

1.7. BAT CONCLUSIONS FOR FERRO-ALLOYS PRODUCTION

1.7.1. **Energy**

BAT 150. In order to use energy efficiently, BAT is to recover energy from the CO-rich exhaust gas generated in a closed submerged arc furnace or in a closed plasma dust process using one or a combination of the techniques given below.

	Technique	Applicability
a	Use of a steam boiler and turbines to recover the energy content of the exhaust gas and produce electricity	Applicability may be restricted depending on energy prices and the energy policy of the Member State
b	Direct use of the exhaust gas as fuel within the process (e.g. for drying raw materials, preheating charging materials, sintering, heating of ladles)	Only applicable if a demand for process heat exists
c	Use of the exhaust gas as fuel in neighbouring plants	Only applicable if an economically viable demand for this type of fuel exists

BAT 151. In order to use energy efficiently, BAT is to recover energy from the hot exhaust gas generated in a semi-closed submerged arc furnace using one or both of the techniques given below.

	Technique	Applicability
a	Use of a waste heat boiler and turbines to recover the energy content of the exhaust gas and produce electricity	Applicability may be restricted depending on energy prices and the energy policy of the Member State
b	Use of a waste heat boiler to produce hot water	Only applicable if an economically viable demand exists

BAT 152. In order to use energy efficiently, BAT is to recover energy from the exhaust gas generated in an open submerged arc furnace via the production of hot water.

Applicability

Only applicable if an economically viable demand for hot water exists.

1.7.2. **Air emissions**

1.7.2.1. *Diffuse dust emissions*

BAT 153. In order to prevent or reduce and collect diffuse emissions to air from tapping and casting, BAT is to use one or both of the techniques given below.

	Technique	Applicability
a	Use of a hooding system	For existing plants, applicable depending on the configuration of the plant
b	Avoid casting by using ferro-alloys in the liquid state	Only applicable when the consumer (e.g. steel producer) is integrated with the ferro-alloy producer

1.7.2.2. *Channelled dust emissions*

BAT 154. In order to reduce dust and metal emissions to air from the storage, handling and transport of solid materials, and from pretreatment operations such as metering, mixing, blending and degreasing, and from tapping, casting and packaging, BAT is to use a bag filter.

BAT-associated emission levels: See Table 46.

BAT 155. In order to reduce dust and metal emissions to air from crushing, briquetting, pelletising and sintering, BAT is to use a bag filter or a bag filter in combination with other techniques.

Applicability

The applicability of a bag filter may be limited in the case of low ambient temperatures (– 20 °C to – 40 °C) and high humidity of the off-gases, as well as for the crushing of CaSi due to safety concerns (i.e. explosivity).

BAT-associated emission levels: See Table 46.

BAT 156. In order to reduce dust and metal emissions to air from an open or a semi-closed submerged arc furnace, BAT is to use a bag filter.

BAT-associated emission levels: See Table 46.

BAT 157. In order to reduce dust and metal emissions to air from a closed submerged arc furnace or a closed plasma dust process, BAT is to use one of the techniques given below.

	Technique (1)	Applicability
a	Wet scrubber in combination with an ESP	Generally applicable
b	Bag filter	Generally applicable unless safety concerns exist related to the CO and H_2 content in the exhaust gases

(1) Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 46.

BAT 158. In order to reduce dust and metal emissions to air from a refractory-lined crucible for the production of ferro-molybdenum and ferro-vanadium, BAT is to use a bag filter.

BAT-associated emission levels: See Table 46.

Table 46

BAT-associated emission levels for dust emissions to air from ferro-alloys production

Parameter	Process	BAT-AEL (mg/Nm^3)
Dust	— Storage, handling and transport of solid materials — Pretreatment operations such as metering, mixing, blending and degreasing — Tapping, casting and packaging	2-5 (1)
	Crushing, briquetting, pelletising and sintering	2-5 (2) (3)
	Open or semi-closed submerged arc furnace	2-5 (2) (4) (5)
	— Closed submerged arc furnace or closed plasma dust process — Refractory-lined crucible for the production of ferro-molybdenum and ferro-vanadium	2-5 (2)

(1) As an average over the sampling period.
(2) As a daily average or as an average over the sampling period.
(3) The upper end of the range can be up to 10 mg/Nm^3 for cases where a bag filter cannot be used.
(4) The upper end of the range may be up to 15 mg/Nm^3 for the production of FeMn, SiMn, CaSi due to the sticky nature of the dust (caused e.g. by its hygroscopic capacity or chemical characteristics) affecting the efficiency of the bag filter.
(5) Dust emissions are expected to be towards the lower end of the range when emissions of metals are above the following levels: 1 mg/Nm^3 for lead, 0,05 mg/Nm^3 for cadmium, 0,05 mg/Nm^3 for chromium^{VI}, 0,05 mg/Nm^3 for thallium.

The associated monitoring is in BAT 10.

1.7.2.3. *PCDD/F emissions*

BAT 159. In order to reduce PCDD/F emissions to air from a furnace producing ferro-alloys, BAT is to inject adsorbents and to use an ESP and/or a bag filter.

BAT-associated emission levels: See Table 47.

Table 47

BAT-associated emission levels for PCDD/F emissions to air from a furnace producing ferro-alloys

Parameter	BAT-AEL (ng I-TEQ/Nm^3)
PCDD/F	≤ 0,05 (1)

(1) As an average over a sampling period of at least six hours.

The associated monitoring is in BAT 10.

1.7.2.4. *PAH and organic compound emissions*

BAT 160. In order to reduce PAH and organic compound emissions to air from the degreasing of titanium swarf in rotary kilns, BAT is to use a thermal oxidiser.

1.7.3. **Waste**

BAT 161. In order to reduce the quantities of slag sent for disposal, BAT is to organise operations on site so as to facilitate slag reuse or, failing that, slag recycling, including by using one or a combination of the techniques given below.

	Technique	Applicability
a	Use of slag in construction applications	Only applicable to slags from high-carbon FeCr and SiMn production, slags from alloy recovery from steel mill residues and standard exhaust slag from FeMn and FeMo production
b	Use of slag as sandblasting grit	Only applicable to slags from high-carbon FeCr production
c	Use of slag for refractory castables	Only applicable to slags from high-carbon FeCr production
d	Use of slag in the smelting process	Only applicable to slags from silico-calcium production
e	Use of slag as raw material for the production of silico-manganese or other metallurgical applications	Only applicable to rich slag (high content of MnO) from FeMn production

BAT 162. In order to reduce the quantities of filter dust and sludge sent for disposal, BAT is to organise operations on site so as to facilitate filter dust and sludge reuse or, failing that, filter dust and sludge recycling, including one or a combination of the techniques given below.

	Technique	Applicability (1)
a	Use of filter dust in the smelting process	Only applicable to filter dust from FeCr and FeMo production
b	Use of filter dust in stainless steel production	Only applicable to filter dust from crushing and screening operations in high-carbon FeCr production
c	Use of filter dust and sludge as a concentrate feed	Only applicable to filter dust and sludge from the off-gas cleaning in Mo roasting

	Technique	Applicability [1]
d	Use of filter dust in other industries	Only applicable to FeMn, SiMn, FeNi, FeMo and FeV production
e	Use of micro-silica as an additive in the cement industry	Only applicable to micro-silica from FeSi and Si production
f	Use of filter dust and sludge in the zinc industry	Only applicable to furnace dust and wet scrubber sludge from the alloy recovery from steel mill residues

(1) Highly contaminated dusts and sludges cannot be reused or recycled. Reuse and recycling might also be limited by accumulation problems (e.g. reusing dust from FeCr production might lead to Zn accumulation in the furnace).

1.8. BAT CONCLUSIONS FOR NICKEL AND/OR COBALT PRODUCTION

1.8.1. **Energy**

BAT 163. In order to use energy efficiently, BAT is to use one or a combination of the techniques given below.

	Technique
a	Use of oxygen-enriched air in smelting furnaces and oxygen converters
b	Use of heat recovery boilers
c	Use of the flue-gas generated in the furnace within the process (e.g. drying)
d	Use of heat exchangers

1.8.2. **Air emissions**

1.8.2.1. *Diffuse emissions*

BAT 164. In order to reduce diffuse dust emissions to air from the charging of a furnace, BAT is to use enclosed conveyor systems.

BAT 165. In order to reduce diffuse dust emissions to air from smelting, BAT is to use covered and hooded launders connected to an abatement system.

BAT 166. In order to reduce diffuse dust emissions from converting processes, BAT is to use operation under negative pressure and capture hoods connected to an abatement system.

BAT 167. In order to reduce diffuse emissions from atmospheric and pressure leaching, BAT is to use both of the techniques given below.

	Technique
a	Sealed or closed reactors, settlers and pressure autoclaves/vessels
b	Use of oxygen or chlorine instead of air in leaching stages

BAT 168. In order to reduce diffuse emissions from solvent extraction refining, BAT is to use one of the techniques given below.

	Technique
a	Use of a low or a high shear mixer for the solvent/aqueous mixture
b	Use of covers for the mixer and separator
c	Use of completely sealed tanks connected to an abatement system

BAT 169. In order to reduce diffuse emissions from electrowinning, BAT is to use a combination of the techniques given below.

	Technique	Applicability
a	Collection and reuse of chlorine gas	Only applicable to chloride-based electro-winning
b	Use of polystyrene beads to cover cells	Generally applicable
c	Use of foaming agents to cover the cells with a stable layer of foam	Only applicable to sulphate-based electro-winning

BAT 170. In order to reduce diffuse emissions from the hydrogen reduction process when producing nickel powder and nickel briquettes (pressure processes), BAT is to use a sealed or closed reactor, a settler and a pressure autoclave/vessel, a powder conveyor and a product silo.

1.8.2.2. *Channelled dust emissions*

BAT 171. When processing sulphidic ores, in order to reduce dust and metal emissions to air from the handling and storage of raw materials, material pretreatment processes (such as ore preparation and ore/concentrate drying), furnace charging, smelting, converting, thermal refining and nickel powder and briquette production, BAT is to use a bag filter or a combination of an ESP and a bag filter.

BAT-associated emission levels: See Table 48.

Table 48

BAT-associated emission levels for dust emissions to air from the handling and storage of raw materials, material pretreatment processes (such as ore preparation and ore/concentrate drying), furnace charging, smelting, converting, thermal refining and nickel powder and briquette production when processing sulphidic ores

Parameter	BAT-AEL (mg/Nm^3) (1)
Dust	2-5

(1) As a daily average or as an average over the sampling period.

The associated monitoring is in BAT 10.

1.8.2.3. *Nickel and chlorine emissions*

BAT 172. In order to reduce nickel and chlorine emissions to air from the atmospheric or pressure leaching processes, BAT is to use a wet scrubber.

BAT-associated emission levels: See Table 49.

Table 49

BAT-associated emission levels for nickel and chlorine emissions to air from the atmospheric or pressure leaching processes

Parameter	BAT-AEL (mg/Nm^3) (1)
Ni	≤ 1
Cl_2	≤ 1

(1) As an average over the sampling period.

The associated monitoring is in BAT 10.

BAT 173. In order to reduce nickel emissions to air from the nickel matte refining process using ferric chloride with chlorine, BAT is to use a bag filter.

BAT-associated emission levels: See Table 50.

Table 50

BAT-associated emission levels for nickel emissions to air from the nickel matte refining process using ferric chloride with chlorine

Parameter	BAT-AEL (mg/Nm^3) (1)
Ni	≤ 1

(1) As an average over the sampling period.

The associated monitoring is in BAT 10.

1.8.2.4. *Sulphur dioxide emissions*

BAT 174. When processing sulphidic ores, in order to reduce SO_2 emissions to air (other than those that are routed to the sulphuric acid plant) from smelting and converting, BAT is to use one of the techniques given below.

	Technique (1)
a	Lime injection followed by a bag filter
b	Wet scrubber

(1) Descriptions of the techniques are given in Section 1.10.

1.8.2.5. *NH_3 emissions*

BAT 175. In order to reduce NH_3 emissions to air from nickel powder and briquette production, BAT is to use a wet scrubber.

1.8.3. **Waste**

BAT 176. In order to reduce the quantities of waste sent for disposal, BAT is to organise operations on site so as to facilitate process residues reuse or, failing that, process residues recycling, including by using one or a combination of the techniques given below.

	Technique	Applicability
a	Use of the granulated slag generated in the electric arc furnace (used in smelting) as an abrasive or construction material	Applicability depends on the metal content of the slag
b	Use of the off-gas dust recovered from the electric arc furnace (used in smelting) as a raw material for zinc production	Generally applicable
c	Use of the matte granulation off-gas dust recovered from the electric arc furnace (used in smelting) as a raw material for the nickel refinery/re-smelting	Generally applicable
d	Use of the sulphur residue obtained after matte filtration in the chlorine-based leaching as a raw material for sulphuric acid production	Generally applicable
e	Use of the iron residue obtained after sulphate-based leaching as a feed to the nickel smelter	Applicability depends on the metal content of the waste
f	Use of the zinc carbonate residue obtained from the solvent extraction refining as a raw material for zinc production	Applicability depends on the metal content of the waste

	Technique	Applicability
g	Use of the copper residues obtained after leaching from the sulphate- and chlorine-based leaching as a raw material for copper production	Generally applicable

1.9. BAT CONCLUSIONS FOR CARBON AND/OR GRAPHITE PRODUCTION

1.9.1. Air emissions

1.9.1.1. *Diffuse emissions*

BAT 177. In order to reduce diffuse PAH emissions to air from the storage, handling and transport of liquid pitch, BAT is to use one or a combination of the techniques given below.

	Technique
a	Back-venting of the liquid pitch storage tank
b	Condensation by external and/or internal cooling with air and/or water systems (e.g. conditioning towers), followed by filtration techniques (adsorption scrubbers or ESP)
c	Collection and transfer of collected off-gases to abatement techniques (dry scrubber or thermal oxidiser/regenerative thermal oxidiser) available at other stages of the process (e.g. mixing and shaping or baking)

1.9.1.2. *Dust and PAH emissions*

BAT 178. In order to reduce dust emissions to air from the storage, handling and transportation of coke and pitch, and mechanical processes (such as grinding) and graphitising and machining, BAT is to use a bag filter.

BAT-associated emission levels: See Table 51.

Table 51

BAT-associated emission levels for dust and BaP (as an indicator of PAH) emissions to air from the storage, handling and transportation of coke and pitch, and mechanical processes (such as grinding) and graphitising and machining

Parameter	BAT-AEL (mg/Nm^3) (1)
Dust	2-5
BaP	≤ 0,01 (2)

(1) As an average over the sampling period.
(2) BaP particles are only expected if processing solid pitch.

The associated monitoring is in BAT 10.

BAT 179. In order to reduce dust and PAH emissions to air from the production of green paste and green shapes, BAT is to use one or a combination of the techniques given below.

	Technique (1)
a	Dry scrubber using coke as the adsorbent agent and with or without precooling, followed by a bag filter
b	Coke filter
c	Regenerative thermal oxidiser
d	Thermal oxidiser

(1) Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 52.

Table 52

BAT-associated emission levels for dust and BaP (as an indicator of PAH) emissions to air from the production of green paste and green shapes

Parameter	BAT-AEL (mg/Nm^3) (1)
Dust	2-10 (2)
BaP	0,001-0,01

(1) As an average over the sampling period.
(2) The lower end of the range is associated with the use of a dry scrubber using coke as the adsorbent agent followed by a bag filter. The upper end of the range is associated with the use of a thermal oxidiser.

The associated monitoring is in BAT 10.

BAT 180. In order to reduce dust and PAH emissions to air from baking, BAT is to use one or a combination of the techniques given below.

	Technique (1)	Applicability
a	ESP, in combination with a thermal oxidation step (e.g. regenerative thermal oxidiser) when highly volatile compounds are expected	Generally applicable
b	Regenerative thermal oxidiser, in combination with a pretreatment (e.g. ESP) in cases of a high dust content in the exhaust gas	Generally applicable
c	Thermal oxidiser	Not applicable to continuous ring furnaces

(1) Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 53.

Table 53

BAT-associated emission levels for dust and BaP (as an indicator of PAH) emissions to air from baking and rebaking

Parameter	BAT-AEL (mg/Nm^3) (1)
Dust	2-10 (2)
BaP	0,005-0,015 (3) (4)

(1) As an average over the sampling period.
(2) The lower end of the range is associated with the use of a combination of an ESP and a regenerative thermal oxidiser. The higher end of the range is associated with the use of a thermal oxidiser.
(3) The lower end of the range is associated with the use of a thermal oxidiser. The upper end of the range is associated with the use of a combination of an ESP and a regenerative thermal oxidiser.
(4) For cathode production, the upper end of the range is 0,05 mg/Nm^3.

The associated monitoring is in BAT 10.

BAT 181. In order to reduce dust and PAH emissions to air from impregnation, BAT is to use one or a combination of the techniques given below.

	Technique (1)
a	Dry scrubber followed by a bag filter

	Technique ([1])
b	Coke filter
c	Thermal oxidiser

([1]) Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 54.

Table 54

BAT-associated emission levels for dust and BaP (as an indicator of PAH) emissions to air from impregnation

Parameter	BAT-AEL (mg/Nm^3) ([1])
Dust	2-10
BaP	0,001-0,01

([1]) As an average over the sampling period.

The associated monitoring is in BAT 10.

1.9.1.3. *Sulphur dioxide emissions*

BAT 182. In order to reduce SO_2 emissions to air when there is a sulphur addition in the process, BAT is to use a dry and/or wet scrubber.

1.9.1.4. *Organic compound emissions*

BAT 183. In order to reduce emissions of organic compounds to air, including phenol and the formaldehyde from the impregnation stage where special impregnation agents such as resins and biodegradable solvents are used, BAT is to use one of the techniques given below.

	Technique ([1])
a	Regenerative thermal oxidiser in combination with an ESP for the mixing, baking and impregnation stages
b	Biofilter and/or bioscrubber for the impregnation stage where special impregnation agents such as resins and biodegradable solvents are used

([1]) Descriptions of the techniques are given in Section 1.10.

BAT-associated emission levels: See Table 55.

Table 55

BAT-associated emission levels for TVOC emissions to air from mixing, baking and impregnation

Parameter	BAT-AEL (mg/Nm^3) ([1]) ([2])
TVOC	≤ 10-40

([1]) As an average over the sampling period.
([2]) The lower end of the range is associated with the use of an ESP in combination with a regenerative thermal oxidiser. The upper end of the range is associated with the use of a biofilter and/or a bioscrubber.

The associated monitoring is in BAT 10.

1.9.2. **Waste**

BAT 184. In order to reduce the quantities of waste sent for disposal, BAT is to organise operations on site so as to facilitate process residues reuse or, failing that, process residues recycling, including by reuse or recycling of carbon and other residues from the production processes within the process or in other external processes.

1.10. DESCRIPTION OF TECHNIQUES

1.10.1. Air emissions

The techniques described below are listed according to the main pollutant(s) they are aimed to abate.

1.10.1.1. *Dust emissions*

Technique	Description
Bag filter	Bag filters, often referred to as fabric filters, are constructed from porous woven or felted fabric through which gases flow to remove particles. The use of a bag filter requires a fabric material selection suited to the characteristics of the off-gases and the maximum operating temperature.
Electrostatic precipitator (ESP)	Electrostatic precipitators operate such that particles are charged and separated under the influence of an electrical field. They are capable of operating over a wide range of conditions. In a dry ESP, the collected material is mechanically removed (e.g. by shaking, vibration, compressed air), while in a wet ESP it is flushed with a suitable liquid, usually water.
Wet scrubber	Wet scrubbing entails separating the dust by intensively mixing the incoming gas with water, usually combined with the removal of the coarse particles through the use of centrifugal force. The removed dust is collected at the bottom of the scrubber. Also, substances such as SO_2, NH_3, some VOC and heavy metals may be removed

1.10.1.2. *NO_X emissions*

Technique	Description
Low-NO_X burner	Low-NO_X burners reduce the formation of NO_X by reducing peak flame temperatures, delaying but completing the combustion and increasing the heat transfer (increased emissivity of the flame). The ultra-low-NO_x burners includes combustion staging (air/fuel) and flue-gas recirculation
Oxy-fuel burner	The technique involves the replacement of the combustion air with oxygen, with the consequent elimination/reduction of thermal NO_X formation from nitrogen entering the furnace. The residual nitrogen content in the furnace depends on the purity of the oxygen supplied, on the quality of the fuel and on the potential air inlet
Flue-gas recirculation	This implies the reinjection of flue-gas from the furnace into the flame to reduce the oxygen content and therefore the temperature of the flame. The use of special burners is based on internal recirculation of combustion gases which cool the root of the flames and reduce the oxygen content in the hottest part of the flames

1.10.1.3. *SO_2, HCl, and HF emissions*

Technique	Description
Dry or semi-dry scrubber	Dry powder or a suspension/solution of an alkaline reagent (e.g. lime or sodium bicarbonate) is introduced and dispersed in the off-gas stream. The material reacts with the acidic gaseous species (e.g. SO_2) to form a solid which is removed by filtration (bag filter or electrostatic precipitator). The use of a reaction tower improves the removal efficiency of the scrubbing system. Adsorption can also be achieved by the use of packed towers (e.g. coke filter). For existing plants, the performance is linked to process parameters such as temperature (min. 60 °C), moisture content, contact time, gas fluctuations and to the capability of the dust filtration system (e.g. bag filter) to cope with the additional dust load

Technique	Description
Wet scrubber	In the wet scrubbing process, gaseous compounds are dissolved in a scrubbing solution (e.g. an alkaline solution containing lime, NaOH, or H_2O_2). Downstream of the wet scrubber, the off-gases are saturated with water and a separation of the droplets is carried out before discharging the off-gases. The resulting liquid is further treated by a waste water process and the insoluble matter is collected by sedimentation or filtration. For existing plants, this technique may require significant space availability
Use of low-sulphur fuels	The use of natural gas or low-sulphur fuel oil reduces the amount of SO_2 and SO_3 emissions from the oxidation of sulphur contained in the fuel during combustion
Polyether-based absorption/desorption system	A polyether-based solvent is used to selectively absorb the SO_2 from the exhaust gases. Then the absorbed SO_2 is stripped in another column and the solvent is fully regenerated. The stripped SO_2 is used to produce liquid SO_2 or sulphuric acid

1.10.1.4. *Mercury emissions*

Technique	Description
Activated carbon adsorption	This process is based on the adsorption of mercury onto the activated carbon. When the surface has adsorbed as much as it can, the adsorbed content is desorbed as part of the regeneration of the adsorbent
Selenium adsorption	This process is based on the use of selenium-coated spheres in a packed bed. The red amorphous selenium reacts with the mercury in the gas to form HgSe. The filter is then treated to regenerate the selenium.

1.10.1.5. *VOC, PAH, and PCDD/F emissions*

Technique	Description
Afterburner or thermal oxidiser	Combustion system in which the pollutant within the exhaust gas stream reacts with oxygen in a temperature-controlled environment to create an oxidation reaction
Regenerative thermal oxidiser	Combustion system that employs a regenerative process to utilise the thermal energy in the gas and carbon compounds by using refractory support beds. A manifold system is needed to change the direction of the gas flow to clean the bed. It is also known as a regenerative afterburner
Catalytic thermal oxidiser	Combustion system where the decomposition is carried out on a metal catalyst surface at lower temperatures, typically from 350 °C to 400 °C. It is also known as a catalytic afterburner
Biofilter	It consists of a bed of organic or inert material, where pollutants from off-gas streams are biologically oxidised by microorganisms
Bioscrubber	It combines wet gas scrubbing (absorption) and biodegradation, the scrubbing water containing a population of microorganisms suitable to oxidise the noxious gas components
Select and feed the raw materials according to the furnace and the abatement techniques used	The raw materials are selected in such a way that the furnace and the abatement system used to achieve the required abatement performance can treat the contaminants contained in the feed properly

Technique	Description
Optimise combustion conditions to reduce the emissions of organic compounds	Good mixing of air or oxygen and carbon content, control of the temperature of the gases and residence time at high temperatures to oxidise the organic carbon comprising PCDD/F. It can also include the use of enriched air or pure oxygen
Use charging systems, for a semi-closed furnace, to give small additions of raw material	Add raw material in small portions in semi-closed furnaces to reduce the furnace cooling effect during charging. This maintains a higher gas temperature and prevents the reformation of PCDD/F
Internal burner system	The exhaust gas is directed through the burner flame and the organic carbon is converted with oxygen to CO_2
Avoid exhaust systems with a high dust build-up for temperatures > 250 °C	The presence of dust at temperatures above 250 °C promotes the formation of PCDD/F by *de novo* synthesis
Injection of adsorption agent in combination with efficient dust collection system	PCDD/F may be adsorbed onto dust and hence emissions can be reduced using an efficient dust filtration system. The use of a specific adsorption agent promotes this process and reduces the emissions of PCDD/F
Rapid quenching	PCDD/F *de novo* synthesis is prevented by rapid gas cooling from 400 °C to 200 °C

1.10.2. **Water emissions**

Techniques	Descriptions
Chemical precipitation	The conversion of dissolved pollutants into an insoluble compound by adding chemical precipitants. The solid precipitates formed are subsequently separated by sedimentation, flotation or filtration. If necessary, this may be followed by ultrafiltration or reverse osmosis. Typical chemicals used for metal precipitation are lime, sodium hydroxide, and sodium sulphide.
Sedimentation	The separation of suspended particles and suspended material by gravitational settling
Flotation	The separation of solid or liquid particles from waste water by attaching them to fine gas bubbles, usually air. The buoyant particles accumulate at the water surface and are collected with skimmers
Filtration	The separation of solids from waste water by passing them through a porous medium. Sand is the most commonly used filtering medium
Ultrafiltration	A filtration process in which membranes with pore sizes of approximately 10 µm are used as the filtering medium
Activated carbon filtration	A filtration process in which activated carbon is used as the filtering medium
Reverse osmosis	A membrane process in which a pressure difference applied between the compartments separated by the membrane causes water to flow from the more concentrated solution to the less concentrated one

1.10.3. **Other**

Techniques	Descriptions
Demister	Demisters are filter devices that remove entrained liquid droplets from a gas stream. They consist of a woven structure of metal or plastic wires, with a high specific surface area. Through their momentum, small droplets present in the gas stream impinge against the wires and coalesce into bigger drops
Centrifugal system	Centrifugal systems use inertia to remove droplets from off-gas streams by imparting centrifugal forces
Boosted suction system	Systems designed to modify the extraction fan capacity based on the sources of the fumes which change over the charging, melting and tapping cycles. Automated control of the burner rate during charging is also applied to ensure a minimum gas flow during operations with the door opened
Centrifugation of swarf	Centrifugation is a mechanical method to separate the oil from the swarf. To increase the velocity of the sedimentation process, a centrifugation force is applied to the swarf and the oil is separated
Drying of swarf	The swarf drying process uses an indirectly heated rotary drum. To remove the oil, a pyrolytic process takes place at a temperature between 300 °C and 400 °C
Sealed furnace door or furnace door sealing	The furnace door is designed to provide efficient sealing to prevent diffuse emissions escaping and to maintain the positive pressure inside the furnace during the smelting/melting stage

ISSN 1977-0677 (electronic edition)
ISSN 1725-2555 (paper edition)

Publications Office of the European Union
2985 Luxembourg
LUXEMBOURG

EN