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Report for the Stage 3 in-depth review of emission inventories submitted under the UNECE LRTAP Convention and EU National Emissions Ceilings Directive for:

MONACO

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INTRODUCTION

The mandate and overall objectives for the emission inventory review process under the LRTAP Convention is given by the UNECE document '*Updated methods and procedures for the technical reviews of air pollutant emission inventories reported under the Convention*'[1] – hereafter referred to as the 'Review guidelines 2018'.

1. This annual review, has checked all pollutants covered by LRTAP Convention and its protocols (SO_2, NOx, NMVOC, NH_3, plus PM_{10} $PM_{2.5}$, BC, 3 HMs and POP_S) for the time series years 1990 – 2019 reflecting current priorities from EMEP Steering Body and the Task Force on Emission Inventories and Projections (TFEIP). HMs and POPs have been reviewed to the extent possible.

2. This report covers the stage 3 centralised reviews of the UNECE LRTAP Convention of Monaco coordinated by the EMEP emission centre CEIP acting as review secretariat. The review took place during May and June and was performed as desk review with virtual meetings. The following team of nominated experts from the roster of experts performed the review: Generalist – Ben Richmond (UK), Energy – Garmt J Venhuis (Netherlands), Transport – Thamara Vieira da Rocha (France), IPPU – Julien Jabot (Norway), Agriculture - Nicole Mandl (Austria), Waste – Zuzana Jonacek (Slovakia).

3. Ben Richmond was the lead reviewer. The review was coordinated by Katarina Marečková, (EMEP Centre on Emission Inventories and Projections - CEIP).

[1] Decision 2018/1 adopted by EB: *Updated methods and procedures for the technical review of air pollutant emission Inventories reported under the Convention*. ECE/EB.AIR/142/Add.1 http://www.unece.org/fileadmin/DAM/env/documents/2002/eb/air/EB%20Decisions/Decision_2018_1.pdf

PART A: KEY REVIEW FINDINGS

4. The inventory is generally in line with the 2019 *EMEP EEA inventory guidebook* and UNECE Reporting Guidelines. However, the ERT note that in some areas the 2016 Guidebook is currently used.

(a) Monaco's inventory is largely complete for the pollutants reviewed for the majority of sectors.

(b) Activity data are reported for most sectors and years in the Annex 1 reporting template.

(c) The ERT noted that emissions trends and recalculations have not been described in detail in the IIR.

(d) The ERT noted that Monaco applies Tier 1 methods and default parameters to some key categories (e.g. shipping).

(e) The 2021 submission shows an improvement in the number of issues identified, nevertheless the ERT identified a need for further improvements in the transparency, completeness and consistency of both the reported emissions data and the IIR.

(f) The ERT thanks Monaco for their co-operation during the Stage 3 review.

INVENTORY SUBMISSION

5. In its 2021 submission, Monaco has reported emissions for its Protocol base years (1990) and a full time series to 2019 (the latest year) for its protocol pollutants in the NFR format. In addition, Monaco has also provided a full NFR 1990 - 2019 time series for CO, PM_{10}, $PM_{2.5}$, HM and POPs. Monaco reported 2014-2019 gridded emissions for Gothenburg protocol pollutants. Monaco also submitted a detailed IIR.

6. Emissions are reported in NFR19 categories, however five categories are reported as 'IE' and three as 'NE'. Transport emissions are based on fuel sold.

7. The CLRTAP inventory submitted by Monaco is of good quality and is in general sufficiently documented in the informative inventory report (IIR).

8. National total I reported for the entire territory is based on fuel sold' (Line 141 of the Annex I Emissions reporting template). Monaco did not provide emissions information based on fuel used (rows 143 to 149). Monaco have also reported a national total for compliance, which does not differ from the national total reported in row 141.

KEY CATEGORIES

9. Monaco has compiled and presented in its IIR a level Key Source Category Analysis for the following pollutants: NO_X, CO, NMVOC, SO_X, NH_3, TSP, PM_{10} and

$PM_{2.5,}$ BC , Pb, Cd, Hg, As, Cr, Cu, Ni, Se, Zn, Dioxins, PAHs and PCBs. All sectors have been included. The level assessment is performed for the year 2019 for all pollutants.

QUALITY

Transparency

10. The ERT recognises the level of effort undertaken by Monaco in providing an inventory with a significant level of detail. Monaco's IIR is detailed and well presented. EF and activity time series are presented where appropriate throughout the IIR (NFR level), assumptions are indicated and references are provided. The ERT encourages Monaco to compliment the excellent work done on the IIR with the provision of more detailed descriptions of recalculations in future IIRs.

11. The ERT commends Monaco on not using zero-values in the reporting tables, but instead using notation keys. The ERT recommends Monaco to use the appropriate notation keys (e.g. NO where emissions are "Not Occurring", NE where emissions are "Not Estimates" and IE where emissions are "Included Elsewhere") for reporting where estimates are not available or necessary, and that these are reflected correctly in the IIR.

Completeness

12. The ERT acknowledges the effort to which Monaco has gone to provide estimates of emissions for all sub-sectors and all pollutants reviewed.

13. Monaco's inventory for the pollutants reviewed is generally complete. The ERT identified some possible missing sources in the energy (fugitives from re-fuelling) and waste (accidental fires) sectors. The ERT recommends for Monaco to estimate emissions from these sources in time for the next submission.

14. The ERT encourages that Monaco performs additional reviews to identify potential gaps in the inventory. The usage of notation keys is highly recommended to support the finding of such gaps.

Consistency, including recalculations and time-series

15. Monaco have undertaken a number of recalculations for their 2021 submission, predominantly in the IPPU sector. Graphs provided in the IIR for each chapter present a clear indication of how these changes impact the inventory on a sector specific level. The chapter on recalculations provides a good insight into how the changes impact the inventory for each year.

16. Where the time series is not consistent, Monaco does provide an adequate explanation, e.g. emissions of particulate matter.

Comparability

17. The ERT notes that the inventory of Monaco is comparable with those of other reporting parties. The allocation of source categories follows that of the EMEP/UNECE reporting Guidelines. The ERT encourages Monaco to continue with this approach to national inventory calculation.

Accuracy and uncertainties

18. Monaco have compiled uncertainty estimates for their UNECE submission and have documented their assumptions well throughout the IIR. The ERT commends Monaco on its transparent approach and encourages it to continue this in future.

Verification and quality assurance/quality control approaches

19. Monaco has elaborated and implemented a quality assurance/quality control (QA/QC) plan in accordance with the EMEP/EEA Guidebook (Inventory Management Chapter). This includes general QC procedures (tier 1) as well as source category-specific procedures (tier 2) for key categories and for those individual categories in which significant methodological and/or data revisions have occurred.

20. The ERT commends Monaco on its general quality assurance/quality control (QA/QC) activities. Where carried out, sector specific checks are documented in the IIR. The ERT encourages Monaco to build on their good work thus far and continue to implement sector specific checks for further areas of the inventory, e.g. Road Transport.

Reporting of Condensable

21. No information regarding the condensable component of PM could be located in the IIR. The ERT recommends that Monaco provide an overview table of sectors which do and do not consider the condensable component in the next submission.

FOLLOW-UP TO PREVIOUS REVIEWS

22. The ERT commends Monaco for implementing recommendations from previous reviews in this most recent submission, including, but not limited to a key category analysis and an uncertainty analysis.

AREAS FOR IMPROVEMENTS IDENTIFIED BY MONACO

23. The IIR identifies several areas for improvement. In its response to previous reviews and review stages this year, Monaco indicates that it is working to improve its estimates by:

(a) Consolidating data from direct stack measurements in sector 1A1.

(b) Verifying the consistency of historic aviation data, which would lead to improved accounting of domestic flights. Monaco also plan to incorporate the approach set out by the Airport Carbon Accreditation (2018).

(c) Updating the inventory such that the EMEP/EEA 2019 Guidebook is used across as many sectors as possible, particularly in NFR 2.

(d) Investigating the availability of improved activity data for the waste water sector (5D) following modernisations to the facility between 2018 and 2020.

(e) Calculating emissions from crematoria (5C1bv).

TECHNICAL CORRECTIONS CONSIDERED AND OR CALCULATED BY ERT

24. The IIR identified no significant inconsistencies in the inventories and hence, did not propose technical corrections for Monaco.

PART B: RECOMMENDATIONS FOR IMPROVEMENTS TO THE PARTY

CROSS CUTTING IMPROVEMENTS IDENTIFIED BY THE ERT

25. The ERT identifies the following cross-cutting issues for improvement:

(a) Updating the inventory to use the 2019 EMEP/EEA Guidebook throughout.

(b) Addition of a table to clarify the sectors where the PM emissions include and exclude the condensable component.

(c) State emissions of individual Large Point Sources in the Annex VI template as opposed to replicating the gridded data provided in Annex V.

(d) Ensure that the notation keys listed in the IIR and reported in Annex I are identical, providing explanations where 'IE' (Included Elsewhere) or 'NE' (Not Estimated) are used.

(e) Ensure that where activity data is reported, emissions of all relevant pollutants are reported.

(f) Ensure that where emissions are reported in Annex I, activity data is presented in the relevant columns.

(g) Quantify sector specific recalculations within the relevant IIR chapter.

SECTOR SPECIFIC RECOMMENDATIONS FOR IMPROVEMENTS IDENTIFIED BY ERT

ENERGY

Review Scope

Pollutants Reviewed		SO_2, NO_x, NMVOC, NH_3, PM_{10} & $PM_{2.5}$, Cd, Hg, Pb, Dioxin, PAH		
Years		1990 – 2019		
Code	**Name**	**Reviewed**	**Not Reviewed**	**Recommendation Provided**
1A1a	Public electricity and heat production	X		X
1A1b	Petroleum refining	-		
1A1c	Manufacture of solid fuels and other energy industries	-		
1A2a	Iron and steel	-		
1A2b	Non-ferrous metals	-		
1A2c	Chemicals	-		
1A2d	Pulp, Paper and Print	-		
1A2e	Food processing, beverages and tobacco	X		X
1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	-		
1A2gviii	Stationary combustion in manufacturing industries and construction: Other	X		X
1A3ei	Pipeline transport	-		
1A3eii	Other	-		
1A4ai	Commercial/institutional: Stationary	X		X
1A4bi	Residential: Stationary	X		X
1A4ci	Agriculture/Forestry/Fishing: Stationary	-		
1A5a	Other stationary (including military)	X		X
1B1a	Fugitive emission from solid fuels: Coal mining and handling	-		
1B1b	Fugitive emission from solid fuels: Solid fuel transformation	-		
1B1c	Other fugitive emissions from solid fuels	-		
1B2ai	Fugitive emissions oil: Exploration, production, transport	-		
1B2aiv	Fugitive emissions oil: Refining / storage	-		
1B2av	Distribution of oil products	X		X
1B2b	Fugitive emissions from natural gas (exploration, production, processing, transmission, storage, distribution and other)	X		X
1B2c	Venting and flaring (oil, gas, combined oil and gas)	-		
1B2d	Other fugitive emissions from energy production	-		
Note: Where a sector has been partially reviewed (e.g. some of the NFR codes) please indicate which have and which have not in the respective columns.				

General recommendations on cross cutting issues

Transparency

26. The ERT commends Monaco to have provided a detailed and generally transparent energy sector emissions inventory. Estimates are provided at a detailed level for all energy sectors.

27. The IIR of Monaco includes information on subsector level on source descriptions and on methodology and trend descriptions. The ERT commends Monaco to include per subsector detailed descriptions on activity data and emission factors used in the inventory with references to the information sources, as well as details related to completeness, recalculations, QA/QC and planned improvements.

Completeness

28. The ERT considers the Energy sector to be complete and comprehensive with good levels of detail in the methodology descriptions.

29. The ERT commends Monaco for estimating all pollutants according to methods provided in the Guidebook as recommended by the ERT in the 2017 review.

Consistency including recalculation and time series

30. The ERT commends Monaco that the time series for all sectors and substances are presented and well described in the IIR and that Monaco has followed up on recommendations made in the previous review with regard to time series consistency.

Comparability

31. The ERT considers the inventory of Monaco is comparable with those of other reporting Parties. The methods used in the energy sector are consistent with the 2019 version of the Guidebook and the emissions are reported in the NFR 2019 format. The IIR contains generally enough information to understand how the emissions were estimated.

Accuracy and uncertainties

32. The ERT did not identify any over- or under-estimates and commends Monaco for the thorough quality work in the Energy sector and for providing information on general QA/QC procedures in its IIR.

33. The ERT encourages Party to implement (sub)sector specific OA/QC procedures for the Energy sector.

34. The ERT noted that Monaco used Tier 2/3 methodology for most Key categories identified. For some other Key categories (some pollutants in 1A1a and 1A4bi) a Tier 1 methodology is applied using emission factors from the Guidebook. The Party has indicated that it intends to move to higher tier methods in the next submission. The ERT recommends that Monaco follow up on their planned

improvement and move to a higher tier method as according to Reporting Guidelines paragraph 21. Parties should make every effort to use a Tier 2 or higher (detailed) methodology, particularly when concerning key categories.

Condensable

35. The ERT notes that Monaco does not provide any information on the condensable component in PM for relevant categories. The ERT recommends the Party to include information on whether particle emissions include or exclude the condensable component in the next submissions in line with Reporting Guidelines Annex II.

Improvement

36. The ERT commends Monaco for following up on ERT's recommendations from the 2017 review, and the way Monaco has documented the resulting improvements in the IIR (chapter 8, table 48). The ERT encourages Monaco to maintain this level of improving their IIR and NFR with documenting and implementing planned improvements.

Potential Technical Corrections

37. The ERT did not prepare any technical corrections for the energy sector inventory for Monaco.

Sub-Sector Specific Recommendations

Category issue 1: 1.A.1.a Public electricity and heat production – HCB, PAHs

38. The ERT noted that sector 1A1a is a key source for HCB and PAHs, but in the IIR (table 1) Monaco reported that a T1 method from the Guidebook was used to estimate emissions. However, for key sources a Tier 2 or 3 method should have been used. During the review week Monaco commented that for Sector 1A1a, with respect to the evaluation of emissions from waste, the Tier 1 method for HCB and PAHs was most appropriate method. This is because it is mentioned that the Tier 2 method is for 'Without energy recovery', and no other Tier 2 Table is proposed for 'With energy recovery', in Monaco waste is incinerated with energy recovery. Monaco also replied that if the ERT recommends the use of higher Tier methodologies, this will be applied in the next submission. The ERT thanks Monaco for their response and recommends Monaco to use a higher Tier methodology for HCB and PAHs in sector 1A1a in the next submission.

Category issue 2: 1A2e Food processing, beverages and tobacco - All Pollutants

39. The ERT noted that for sector 1.A.2.e Monaco reports NO for all pollutants and all activity data. However, in the IIR, in table 28, sector 1A2e is not included as NO. During the review week, Monaco confirmed that for 1A2e the correct notation key is NO for all pollutants and all activity data, and that sector 1A2e will be labelled as NO

in the IIR for the next submission. The ERT thanks Monaco for their response and recommends Monaco to correct this in future submissions of the IIR.

Category issue 3: 1A2gviii Stationary combustion in manufacturing industries and construction: Other - NH_3, HCB, PCBs

40. The ERT noted that for sector 1A2gviii Monaco used the notation key 'IE' for NH3, and NA for HCB and PCBs in the Annex I reporting template. In the IIR (page 79) Monaco stated that 'Due to the fuels used, no NH3 emissions are expected.' In the Guidebook 2019 (tables 3-3 and 3-4) it is mentioned that T1 emission factors are not estimated for NH_3, HCB and PCBs. During the review week Monaco replied that in the principality, combustion in Manufacturing industries (1A2gviii) is the same as in the Residential sector (1A4bi). Buildings and installations use domestic fuel and natural gas both in the industrial sector as in the residential sector. The methodology for calculating emissions adopted is therefore the same for this sector as that of sector 1A4bi. In the 2019 EMEP/EEA Guidebook, Tables 3-4 and 3-5 of Chapter 1A4, the notation keys are NE for NH_3 and NA for HCB and PCBs. Monaco stated that the notation key for NH_3 will be changed for NE in the next submission. The ERT thanks Monaco for their response and recommends Monaco to follow up on their intent.

Category issue 4: 1A4ai Commercial/institutional: Stationary - NH_3

41. The ERT noted that for sector 1A4ai Monaco used the notation key IE for NH3 in the Annex I reporting template. In the 2019 Guidebook (tables 3.8 and 3.9) it is mentioned that T1 emission factor are not estimated for NH3. During the review week Monaco replied that an error was made, and that NA is the correct notation key to use. Monaco stated that the notation key for NH_3 will be changed to NE in the next submission. The ERT thanks Monaco for their response and recommends Monaco to follow up on their intent.

Category issue 5: 1A4ai Commercial/institutional: Stationary - HCB, PCBs

42. The ERT noted that for sector 1A4ai, Monaco used the notation key NA for HCB and PCBs in the NFR. In the EMEP/EEA 2019 Guidebook (Table 3.9), Tier 1 emission factors are given for HCB and PCBs. The ERT asked Monaco to comment on why emissions for HCB and PCBs were not estimated using presented AD and Guidebook emission factors. During the review week Monaco responded that in the Principality, combustion in commercial/institutional (1A4ai) is the same as in the residential sector (1A4bi). Buildings and installations use domestic fuel and natural gas both in the industrial sector as in the residential sector. The methodology for calculating emissions adopted is therefore the same for this sector as that of sector 1A4bi. In the EMEP/EEA 2019 Guidebook, Tables 3-4 and 3-5 of Chapter 1A4, the notation keys are NE for NH_3 and NA for HCB and PCBs. The ERT thanks Monaco for their response.

Category issue 6: 1A4bi Residential: Stationary – SO_2, NOx, $PM_{2.5}$

43. The ERT noted that SO_2, NOx and PM2.5 are Key sources for sector 1A4bi, but in the IIR table 1 Monaco reported that a T1 method from the Guidebook was used to estimate emissions. However, for key sources a Tier 2 or 3 method should have

been used. During the review week Monaco replied that a higher methodology will be used for next submission for SO_2, NOx and PM2.5 for sector 1A4bi. The ERT thanks Monaco for their response and recommends Monaco to follow up on their intent.

Category issue 7: 1A5a Other stationary (including military) - HCB, PCBs

44. The ERT noted that for sector 1A5a Monaco reported NO for all activity data. However, for pollutants HCB and PCB's the notation key NA is used. During the review week Monaco replied that notation key NO should have been used instead and that this will be corrected in the next submission. The ERT thanks Monaco for their response and recommends Monaco to follow up on their intent.

Category issue 8: 1B2av Distribution of oil products - NMVOC

45. The ERT noted that that for sector 1B2av Monaco reported activity data (Other) but no emission estimates, notation keys NA and NE were used instead. However, in the Guidebook 2019, emission factors are provided for NMVOCs. During the review week Monaco replied that they did not estimate the emissions of the oil products tanks, but that they should manage to do it for next submission. The ERT thanks Monaco for their response and recommends Monaco to estimate NMVOC emissions for sector 1B2av using presented AD and Guidebook emission factors.

Category issue 9: 1B2b Fugitive emissions from natural gas - Activity data

46. The ERT noted that for sector 1B2b Monaco presented in the NFR emissions for NMVOC, but no activity data was given. The ERT asked Monaco to provide activity data for this sector. During the review week Monaco replied that for this sector calculation of AD is based on network activity, in meters. Monaco will report the activity in meters in the next submission. The ERT thanks Monaco for their response and recommends Monaco to report this AD in the NFR tables under *Other activity* (specified) and *Other activity* units.

TRANSPORT

Review Scope

Pollutants Reviewed		All Pollutants		
Years		1990 – 2019		
Code	**Name**	**Reviewed**	**Not Reviewed**	**Recommendation Provided**
1A2gvii	Mobile Combustion in manufacturing industries and construction	x		
1A3ai(i)	International aviation LTO (civil)	x		x
1A3ai(ii)	International aviation cruise (civil)	x		x
1A3aii(i)	Domestic aviation LTO (civil)	x		x
1A3aii(ii)	Domestic aviation cruise (civil)	x		x
1A3bi	Road transport: Passenger cars	x		x
1A3bii	Road transport: Light duty vehicles	x		x
1A3biii	Road transport: Heavy duty vehicles and buses	x		x
1A3biv	Road transport: Mopeds & motorcycles	x		x
1A3bv	Road transport: Gasoline evaporation	x		x
1A3bvi	Road transport: Automobile tyre and brake wear	x		x
1A3bvii	Road transport: Automobile road abrasion	x		x
1A3c	Railways	x		
1A3di(ii)	International inland waterways	x		
1A3dii	National navigation (shipping)	x		x
1A4aii	Commercial/institutional: Mobile	x		
1A4bii	Residential: Household and gardening (mobile)	x		
1A4cii	Agriculture/Forestry/Fishing: Off-road vehicles and other machinery	x		
1A4ciii	Agriculture/Forestry/Fishing: National fishing	x		
1A5b	Other, Mobile (including military, land based and recreational boats)	x		
1A3di(i)	International maritime navigation	x		
1A3	Transport (fuel used)	x		
Note: Where a sector has been partially reviewed (e.g. some of the NFR codes) please indicate which have and which have not in the respective columns.				

General recommendations on cross cutting issues

Transparency

47. Monaco provided a generally transparent emissions inventory. The ERT noted that the estimates are not always provided in the most detail for all subsectors, for instance for aviation as explained below.

Completeness

48. The ERT considers the transport sector of Monaco's inventory to be, in general, complete and comprehensive with a sufficient level of detail provided in the methodology descriptions. Nevertheless, the ERT found missing estimates for pollutants and sub-sectors as explained below.

Consistency including recalculation and time series

49. Monaco provides explanations and descriptions of key trends in its IIR. Moreover, the Party also provided satisfactory explanations for most of the questions during the current Stage 3 review process relating to time series consistency.

Comparability

50. The ERT noted that the inventory is comparable to the inventories of other countries regarding the basis of the transport sector emissions, as Monaco reports emissions from road transport based on the fuel sold within the territory.

Accuracy and uncertainties

51. The ERT noted Monaco's efforts to implement an uncertainty analysis for the transport sector.

52. ERT encourages Monaco to implement OA/QC procedures for the transport sector in the IIR.

Improvement

53. The ERT encourages Monaco further improve its inventory by considering the recommendations of the current Stage 3 review.

Potential Technical Corrections

54. The ERT did not specify any potential technical corrections for the transport sector inventory of Monaco.

Sub-Sector Specific Recommendations

Category issue 1: 1A3a Aviation - NOx, NMVOC, SOx, CO

55. In Monaco's NFR tables displayed in Annex I, NOx, NMVOC, SOx and CO emissions for 1A3ai(i) and 1A3aii(i) emission estimates are presented, however, the notation key 'NO' (Not Occurring) is used for 1A3ai(ii) and 1A3aii(ii). During the current Stage 3 review process, Monaco informed the ERT that the Party will change the 'NO' notation Keys to 'IE' as 1A3ai(ii) and 1A3aii(ii) emissions are included within 1A3ai(i) and 1A3aii(i). To accomplish this, Monaco intends to work on estimating the activity data split in LTO and cruise phases, accordingly to the data available. The ERT welcomes this plan and recommends that Monaco carry this out.

Category issue 2: 1A3a Aviation - CO

56. The ERT notes with reference to Annex 1 of Monaco's IIR that 1A3ai(i) and 1A3aii(i) are respectively 1st and 2nd Key sources for CO emissions (representing together 80% of total CO emissions), but Monaco reports that a T1 method from the Guidebook was used to estimate emissions. This overestimate may have an impact on total emissions that is above the threshold of significance (i.e. a change in the National Total of more than 5%).The ERT notes that this overestimate may be because Monaco allocates all aviation activity in LTO phase instead of separating activity into LTO (in the National Total) and cruise phases (in memo items). In accordance with the previous issue, the ERT recommends splitting aviation activity data in LTO and cruise phases.

Category issue 3: 1A3b Road transport - All

57. Given the geographic peculiarity of Monaco, for which a large share of emissions is expected to be attributed to the "tank tourism", the ERT recommends taking into account this activity (i.e. share between Monaco fleet and foreign vehicles) of the emission estimation). During the current Stage 3 review process, Monaco informed the ERT that the Part is using a Tier 1 method since there is insufficient data regarding activity of the fleet. Monaco intends to be able to move to a Tier 2 method for next submission and estimate these emissions. The ERT welcomes this plan.

Category issue 4: 1A3dii National navigation (shipping)- NOx, $PM_{2.5}$

58. The ERT notes with reference to Annex 1 of Monaco's IIR that 1A3dii is the second highest category for NOx and PM2.5 emissions (17% of total emissions for both pollutants). Monaco reports that a Tier 1 method from EMEP/EEA Guidebook was used to estimate emissions. However, for key sources a Tier 2 or 3 method should be used. During the current Stage 3 review process, Monaco informed the ERT that there is not enough data to able to use a Tier 2 or Tier 3 method at present. Monaco expects to improve it for the next submission. The ERT welcomes this plan.

INDUSTRIAL PROCESSES

Review Scope

Pollutants Reviewed		SO_2, NOx, NMVOC, NH_3, PM_{10} & PM2.5		
Years		1990 – 2019		
Code	**Name**	**Reviewed**	**Not Reviewed**	**Recommendation Provided**
2A1	Cement production	NO		
2A2	Lime production	NO		
2A3	Glass production	NO		
2A5a	Quarrying and mining of minerals other than coal	NO		
2A5b	Construction and demolition	X		X
2A5c	Storage, handling and transport of mineral products	NO		
2A6	Other mineral products	NO		
2B1	Ammonia production	NO		
2B2	Nitric acid production	NO		
2B3	Adipic acid production	NO		
2B5	Carbide production	NO		
2B6	Titanium dioxide production	NO		
2B7	Soda ash production	NO		
2B10a	Chemical industry: Other	NO		
2B10b	Storage, handling and transport of chemical products	NO		
2C1	Iron and steel production	NO		
2C2	Ferroalloys production	NO		
2C3	Aluminium production	NO		
2C4	Magnesium production	NO		
2C5	Lead production	NO		
2C6	Zinc production	NO		
2C7a	Copper production	NO		
2C7b	Nickel production	NO		
2C7c	Other metal production	NO		
2C7d	Storage, handling and transport of metal products	NO		
2D3b	Road paving with asphalt	X		X
2D3c	Asphalt roofing	NO		
2H1	Pulp and paper industry	NO		
2H2	Food and beverages industry	NO		
2H3	Other industrial processes	NO		
2I	Wood processing	NO		
2J	Production of POPs	NO		
2K	Consumption of POPs and heavy metals (e.g. electrical and scientific equipment)	NO		
2L	Other production, consumption, storage, transportation or handling of bulk products	NO		
Note: Where a sector has been partially reviewed (e.g. some of the NFR codes please indicate which have and which have not in the respective columns.				

General recommendations on cross cutting issues

Transparency

59. Monaco provided emissions data for the whole period 1990-2019. Monaco did not provide activity data for all categories where emissions have been reported in the Annex I NFR table. During the review Monaco provided the missing activity data to the ERT. The ERT commends Monaco for it and recommends Monaco to include it within the reporting template in the next submission.

60. The NFR tables provided by Monaco contain emissions data, or use notation keys where estimates are not available for all source categories within the industrial processes sector. Monaco uses the notation key NO for numerous source categories.

61. The IIR provided by Monaco gives detailed information regarding the methodologies used to estimate emissions. Monaco uses methodologies recommended by the 2016 EMEP/EEA Guidebook for almost all emission calculations within the industrial processes sector.

62. During the S3 review, Monaco provided additional information concerning the methodologies to the ERT. The ERT commends Monaco for it and encourages the party to include relevant text in the next IIR.

63. Monaco provided a generally transparent emission inventory for the industrial processes sector. Information regarding methodologies used, emission factors and activity data were made available to the ERT before and during the review. The ERT recommends Monaco to include additional information provided during the review in the next submission to ensure that the inventory is fully transparent.

Completeness

64. Monaco has reported emissions for the whole period 1990-2019 and for all pollutants. Where emissions or activity data have not been reported, Monaco uses notation keys.

65. The ERT considers the inventory for industrial processes sector reported by Monaco to be complete.

Consistency including recalculation and time series

66. Monaco uses consistent methodologies over the time series that are described in the IIR. Recalculations are also described in the IIR and are consistent over the time series.

67. The ERT considers therefore the inventory for industrial processes sector reported by Monaco to be consistent over the time series.

Comparability

68. Monaco uses methodologies recommended by the 2016 EMEP/EEA Guidebook for all emission calculations within the industrial processes sector. Reporting guidelines recommended to use methodologies presented in latest EMEP/EEA Guidebook (2019) , the ERT does not consider Monaco's inventory for the industrial processes sector to be fully comparable.

Accuracy and uncertainties

69. The ERT found possible underestimates as explained below in the source category specific recommendations section.

70. Monaco provides information on general QA/QC procedures in its IIR. The ERT noted that Monaco has not implemented category specific QA/QC procedures within the industrial processes sector. The ERT encourages Monaco to implement category specific QA/QC procedures for the industrial processes sector.

Condensable

71. Monaco did not provide any information on the condensable component of PM for the industrial processes sector. The ERT did not find any information of whether $PM_{2.5}$ includes or excludes the condensable component in the IIR. The ERT recommends Monaco to include such information in the next submission.

Improvement

72. The ERT noted that Monaco includes an improvement plan for almost all subsectors within the industrial sector. The improvement plans include the use of 2019 EMEP/EEA Guidebook methodologies for the industrial processes sector. The ERT recommends Monaco to implement the planned improvements for the next submission.

Sub-Sector Specific Recommendations

Category issue 1: 2A5b- Construction and demolition

73. The ERT noted in Monaco’s IIR that the party uses the 2016 EMEP/EEA Guidebook methodology to estimate emissions from 2A5b. The ERT noted that Monaco has included in its improvement plan to use the 2019 EMEP/EEA Guidebook methodology for the next submission. The ERT recommends Monaco to implement its improvement plan for the next submission.

74. The ERT noted in the IIR reported by Monaco that AD "floor area built and destroyed" has been used in the calculation of emissions from 2A5b. No information regarding how this AD is collected has been provided in the IIR. During the review, Monaco provided the ERT with information regarding the collection of AD. The ERT commends Monaco for it and recommends Monaco to include this information in the IIR for the next submission to improve the transparency of its inventory.

75. The ERT noted that particle emissions from 2A5b have been calculated for residential building and non-residential building separately. At the end of the review Monaco provided the ERT with a time-series with AD for both activities as requested. The ERT estimated particle emissions reported by Monaco with the provided AD and the reported emission factors. The particle emissions estimated by the ERT were two times higher than the emissions reported by Monaco. The ERT recommends therefore Monaco to recalculate particle emissions from 2A5b for the next submission.

Category issue 2: 2.D.3.b- Road paving with asphalt - BC

76. The ERT noted in the IIR that Monaco uses 2016 EMEP/EEA Guidebook methodology to estimate emissions from 2D3b. The ERT noted that Monaco has included in its improvement plan to use the 2019 EMEP/EEA Guidebook methodology for the next submission. The ERT recommends Monaco to implement its improvement plan for the next submission.

77. The ERT noted in the IIR that Monaco uses abatement factors to estimate particle emissions from 2D3b. No information regarding these abatement factors are provided in the IIR. During the review, Monaco provided the ERT with justifications for the use of the abatement factors. The ERT commends Monaco for it and recommends Monaco to include this information in the IIR for the next submission to improve the transparency of its inventory.

78. The ERT noted in the IIR Monaco uses an EF for BC emissions equal to 5.7% of $PM_{2.5}$. The ERT used AD and emissions from the submitted NFR table I to estimate an IEF for BC emissions from 2D3b. It amounted to 0.0000000057%. During the review Monaco explained that this is due to an error of conversion in the calculation of BC emissions and provided the ERT with a corrected dataset for BC emissions for the whole time series. The ERT recommends Monaco to report the corrected time series with the next submission.

SOLVENTS

Review Scope

Pollutants Reviewed		SO_2, NOx, NMVOC, NH_3, PM_{10} & $PM_{2.5}$		
Years		1990 – 2019		
Code	**Name**	**Reviewed**	**Not Reviewed**	**Recommendation Provided**
2D3a	Domestic solvent use including fungicides	X		X
2D3d	Coating applications	X		X
2D3e	Degreasing	NO		
2D3f	Dry cleaning	X		X
2D3g	Chemical products	X		
2D3h	Printing	X		X
2D3i	Other solvent use	X		
2G	Other product use	X		X
Note: Where a sector has been partially reviewed (e.g. some of the NFR codes please indicate which have and which have not in the respective columns.				

General recommendations on cross cutting issues

Transparency

79. Monaco provided emissions data for the whole period 1990-2019. Both emissions and activity are provided for most of the categories within the solvent sector for the reported time series.

80. The NFR tables provided by Monaco contain emissions data or use notation keys where estimates are not available for all source categories within the solvent sector. Monaco uses the notation key NO for numerous source categories.

81. Monaco did not provide activity data for all categories where emissions are reported in the NFR table. During the review Monaco provided the missing activity data to the ERT. The ERT commends Monaco for it and recommends Monaco to include it in the next submission.

82. The IIR provided by Monaco gives detailed information regarding the methodologies used to estimate emissions. Monaco uses methodologies recommended by the 2016 EMEP/EEA Guidebook for almost all emission calculations within the solvent sector.

83. During the review, Monaco provided additional information concerning the methodologies to the ERT. The ERT commends Monaco for it.

84. Monaco provided a generally transparent emissions inventory for the solvent sector. Information about methodologies used, emission factors and activity data have been made available to the ERT before and during the review. The ERT recommends Monaco to include additional information provided during the review in the next submission to ensure that the inventory is fully transparent.

Completeness

85. Monaco has reported emissions for the whole period 1990-2019 and for all pollutants. Where emissions or activity data have not been reported, Monaco uses notation keys.

86. The ERT considers the inventory for solvent sector reported by Monaco to be complete.

Consistency including recalculation and time series

87. Monaco uses consistent methodologies over the time series, which are described in the IIR. Recalculations are also described in the IIR and are consistent over the time series.

88. The ERT therefore considers the inventory for the solvent sector reported by Monaco to be time series consistent.

Comparability

89. Monaco uses methodologies recommended by the 2016 EMEP/EEA Guidebook for almost all emission calculations within the solvent sector. As it is recommended to use 2019 EMEP/EEA Guidebook methodologies, the ERT does not consider Monaco's inventory for the solvent sector to be fully comparable.

Accuracy and uncertainties

90. The ERT did not identify any over- or under-estimates. The ERT noted that Monaco provides information on general QA/QC procedures in its IIR.

91. Nevertheless, the ERT noted in the IIR that Monaco has not implemented category specific OA/QC procedures within the solvent sector. The ERT encourages Monaco to implement category specific OA/QC procedures for the solvent sector.

Condensable

92. Monaco did not provide any information on the condensable component of PM for the solvent sector. The ERT did not find any information of whether $PM_{2.5}$ includes or excludes the condensable component in the IIR. The ERT recommends Monaco to include such information in the next submission.

Improvement

93. The ERT noted that Monaco includes an improvement plan for almost all subsectors within the solvent sector. The improvement plans include the use of 2019 EMEP/EEA Guidebook methodologies for the sector. The ERT recommends Monaco to implement the planned improvements for the next submission.

Sub-Sector Specific Recommendations

Category issue 1: 2D3a- Domestic solvent use including fungicides

94. The ERT noted in the IIR that Monaco uses the 2016 EMEP/EEA Guidebook methodology to estimate emissions from 2D3a. The ERT noted that Monaco has included in its improvement plan to use the 2019 EMEP/EEA Guidebook methodology for the next submission. The ERT recommends Monaco to implement its improvement plan for the next submission.

Category issue 2: 2D3d- Coating - NMVOC

95. The ERT noted in the IIR that Monaco estimates emissions from coating applications based on paint consumption from construction and building. No information regarding how AD is collected are provided in the IIR. During the review, Monaco provided the ERT with information regarding the collection of AD. The ERT commends Monaco for it and recommends Monaco to include this information in the IIR for the next submission to improve the transparency of its inventory.

96. During the review Monaco provided the ERT with information regarding "Coating application" activities occurring within the country. The ERT encourages Monaco to include this information in the IIR for the next submission to improve the transparency of its inventory.

Category issue 3: 2D3f- Dry cleaning – NMVOC

97. The ERT noted in the IIR that Monaco collects annual activity data and other information from dry cleaning to determine the AD used in the estimations. No information regarding how data is collected are provided in the IIR. During the review, Monaco provided the ERT with information regarding the collection of data. The ERT commends Monaco for it and recommends Monaco to include this information in the IIR for the next submission to improve the transparency of its inventory.

98. The ERT noted in the IIR that Monaco estimates NMVOC emissions from dry cleaning using two different abatement factors within the times-series. No justification for the use of abatement factors has been provided in the IIR. During the review, Monaco provided the ERT with information regarding the use of abatement factors. The ERT commends Monaco for it and recommends Monaco to include this information in the IIR for the next submission to improve the transparency of its inventory.

Category issue 3: 2D3h- Printing - NMVOC

99. The ERT noted in the IIR that Monaco collects ink consumption from printing industries. No information regarding how data is collected are provided in the IIR. During the review, Monaco provided the ERT with information regarding the collection of data. The ERT commends Monaco for it and recommends Monaco to include this information in the IIR for the next submission to improve the transparency of its inventory.

Category issue 4: 2G- Other product use

100. The ERT noted in the reported NFR Annex I that Monaco reported NO for AD from category 2G. The ERT also noted that Monaco reported emissions from this category. During the review, Monaco provided the ERT with AD used in the estimation of emissions from the sector 2G. The ERT commends Monaco for it and recommends Monaco to report AD for category 2G in the next submission.

101. The ERT noted in the IIR that Monaco uses country specific (CS) emission factors (EFs) to estimate emissions from use of tobacco. The ERT noted that CS EFs have been used with the help of CITEPA. Nevertheless, the ERT did not find any information in the IIR for the source of those EFs. During the review Monaco provided the ERT with information regarding the source of the EFs. The ERT commends Monaco for it and recommends Monaco to include this information in the IIR for the next submission to improve the transparency of its inventory.

AGRICULTURE

Review Scope

Pollutants Reviewed		SO_2, NOx, NMVOC, NH_3, PM_{10} & $PM_{2.5}$		
Years		1990 – 2019		
Code	**Name**	**Reviewed**	**Not Reviewed**	**Recommendation Provided**
3B1a	Dairy cattle		NO	
3B1b	Non-dairy cattle		NO	
3B2	Sheep		NO	
3B3	Swine		NO	
3B4a	Buffalo		NO	
3B4d	Goats		NO	
3B4e	Horses		NO	
3B4f	Mules and asses		NO	
3B4gi	Laying hens		NO	
3B4gii	Broilers		NO	
3B4giii	Turkeys		NO	
3B4giv	Other poultry		NO	
3B4h	Other animals		NO	
3Da1	Inorganic N-fertilizers (includes also urea application)	x		
3Da2a	Animal manure applied to soils		NO	
3Da2b	Sewage sludge applied to soils		NO	
3Da2c	Other organic fertilisers applied to soils (including compost)		NO	
3Da3	Urine and dung deposited by grazing animals		NO	
3Da4	Crop residues applied to soils		NO	
3Db	Indirect emissions from managed soils		NO	
3Dc	Farm-level agricultural operations including storage, handling and transport of agricultural products		NO	
3Dd	Off-farm storage, handling and transport of bulk agricultural products		NO	
3De	Cultivated crops		NO	
3Df	Use of pesticides		NO	
3F	Field burning of agricultural residues		NO	
3I	Agriculture other		NO	
11A	Volcanoes		NO	
11B	Forest fires		NO	
Note: Where a sector has been partially reviewed (e.g. some of the NFR codes please indicate which have and which have not in the respective columns.				

102. Due to the unique nature of Monaco's geography as a city state, agricultural practices within the country are limited to activity occurring within NFR 3Da1. The data presented for this sector was deemed to be sufficient, and as a result the ERT have no recommendations to make for the Agriculture sector in Monaco.

WASTE

Review Scope

Pollutants Reviewed		SO_2, NOx, NMVOC, NH_3, TSP, PM_{10} & $PM_{2.5}$, BC, CO, Heavy metals, POPs		
Years		1990 – 2019		
Code	**Name**	**Reviewed**	**Not Reviewed**	**Recommendation Provided**
5A	Solid waste disposal on land	x		
5B1	Biological treatment of waste - Composting	x		
5B2	Biological treatment of waste - Anaerobic digestion at biogas facilities	x		
5C1a	Municipal waste incineration	x		x
5C1bi	Industrial waste incineration	x		x
5C1bii	Hazardous waste incineration	x		x
5C1biii	Clinical waste incineration	x		x
5C1biv	Sewage sludge incineration	x		
5C1bv	Cremation	x		x
5C1bvi	Other waste incineration	x		
5C2	Open burning of waste	x		x
5D1	Domestic wastewater handling	x		
5D2	Industrial wastewater handling	x		x
5D3	Other wastewater handling	x		
5E	Other waste	x		x
Note: Where a sector has been partially reviewed (e.g. some of the NFR codes please indicate which have and which have not in the respective columns.				

General recommendations on cross cutting issues

Transparency

103. The ERT commends Monaco for the improvement of the transparency of the wastewater treatment chapter. However, the ERT notes that other chapters in the waste sector have not been improved as recommended by the 2017 CLRTAP S3 in-depth review. For example, no information regarding waste incineration is provided. The ERT encourages the party to include a comprehensive description of the emission sources and to document the methodology, activity data and emission factors used to calculate emissions in the IIR of the next submission.

Completeness

104. The ERT noted that the time-series of the emissions is complete for those categories where emissions are reported, and commends the Party for it. As emissions are reported only from categories that concern wastewater handling, the ERT recommends Monaco to calculate and report emissions from the other waste sector subcategories. Alternatively, the party should provide an explanation in the IIR in cases where these activities do not occur in Monaco, for the next submission.

Consistency, including recalculation and time series

105. The ERT commends Monaco for including information regarding time series consistency and recalculations in the wastewater-handling subsector. The Party does not provide sufficient information about other subsectors. The ERT encourages the party to provide information regarding waste incineration such that the consistency can be fully assessed in future.

Comparability

106. The ERT considers the waste sector inventory to be comparable with other reporting Parties as Monaco has reported the emission inventory following the reporting requirements and submitted it in the requested NFR2014 format.

Accuracy and uncertainties

107. The ERT commends Monaco for the inclusion of an uncertainty analysis, which includes the wastewater handling subsector. The ERT recommends Monaco to estimate and report uncertainties from the other subsectors, especially waste incineration, even if it is allocated in the energy sector to help inform the improvement process and to provide an indication of the reliability of the inventory data.

Condensable

108. Monaco provides no information about the condensable component of particulate matter in the IIR. The ERT recommends the party involve this information in the next submission of the IIR.

Improvement

109. The ERT commends the party for its improvement in improving transparency of the wastewater-handling subsector. The ERT notes Monaco's intention to obtain the data of reconstruction methods used by the wastewater-handling operators. The ERT encourages Party to implement planned improvements.

Potential Technical Corrections

110. The ERT did not specify any potential technical corrections for the waste sector inventory of Monaco.

Sub-Sector Specific Recommendations

Category issue 1: 5C Waste incineration – All pollutants

111. The ERT notes that emissions in the categories 5C1a, 5C1bi, 5C1bii and 5C1biv are reported as NO, but the IIR states in table 27 that the emissions are reported in category 1A1a. Monaco responded that for 5C1a and 5C1biv the notation IE should have been used, for the other categories Monaco confirm that the notation key NO used is correct. The ERT recommends the party to use the correct notation keys in the next submission and record it correctly in the IIR.

112. The ERT noted that categories 5C1biii and 5C2 are reported as IE, but no information about the activity data, emission factors and methodology is included in the IIR. Monaco responded that the notation key NO should have been used for 5C2 and it will be used in the next submission. For category 5C1biii, clinical waste is collected separately and transferred to France (thus, it is not incinerated). Hence, an extremely low residual quantity of waste remains in the share of incinerated waste. In that regard, Monaco has decided to use the same methodology for municipal waste. The ERT recommends the country correct the notation key and report emissions for 5C1biii it in the next submission of IIR along with a detailed description of the methodology and activity data.

113. The ERT notes that in the IIR, emissions for cremation use the notation key 'NE', but in the NFR table, the notation key 'IE' is used. It is not common practice that the energy from this source is used in public heating systems. Monaco responded that emissions from cremation are not estimated, the correct notation key for this submission is 'NE'. Monaco plans to implement emissions calculations for this category in the next submission. The ERT recommends that Monaco follow this plan and include the estimation of this category in the next submission.

114. The ERT notes the lack of transparency in IIR concerning this subsector. The activity data and methodology description should be recorded in the IIR even if the emissions are allocated in the energy sector. The party responded that for activity data, Monaco used the tonnage of municipal waste and sewage sludge, and the annual volume of gas emitted from the incineration. In the case of the Tier 1/2 method used, the emission factors are obtained from the EMEP/EEA 2019 Guidebook (Chapter 5C1a Table 3-1 and 5C1b Table 3-2 for waste and sewage sludge respectively). In the case of a Tier 3 method, concentrations measured for each of the concerned pollutants are applied to the annual volume of gas emitted from the incineration plant to determine the respective emissions. The ERT recommends the party to include detailed descriptions of activity data and calculation methods in the next submission of the IIR.

Category issue 2: 5D – NMVOC

115. The ERT notes that although the IIR indicated that a Tier 1 emission factor is used for this category and emissions are included within 5D1, in the reporting template, notation key NO was used. The party responded that the discrepancy is due to the fact that Monaco's wastewater have domestic characteristics (DCO/DBO5 >2,5). In order to be consistent with the occurrence of emissions from industries in other sectors, the correct notation should be IE and should be corrected in further submissions. The ERT recommends Monaco to correct the emission factors and record them in the IIR in the next submission.

Category issue 3: 5E Other waste – all pollutants

116. The ERT notes that Monaco reports emissions in category 5E as not estimated (NE) even when the Tier 2 methodology is available for this source. This source contains emissions from fires involving cars, houses and industrial/apartment buildings. These data can be obtained mostly from the fire offices in other European countries. Monaco responded that they take note of the ERT's remark, to assess the

implementation of a Tier 2 methodology in this category. The ERT recommends the party to obtain the activity data and report emissions from this source in the next submission.

LIST OF MATERIALS PROVIDED BY MONACO TO ERT

1. Monaco Stage 1 report 2021
2. Monaco Stage 2 S&A report
3. Monaco IIR 2021
4. Annex_I_Emissions_reporting_template 2021.xlsx
5. Annex_V_Gridded_emissions_template_report 2021_V1.xlsx
6. Annex_VI_LPS_emissions_template_report 2021_V1.xlsx
7. MONACO S3 ReviewReport-2017.pdf
8. Extended checks

LIST OF ADDITIONAL MATERIALS PROVIDED BY MONACO DURING THE REVIEW

9. Responses to the question raised by ERT during the review ("Clever space" platform at Umweltbundesamt website)
10. Supplementary data regarding activity in sector 2A5b.
11. Supplementary data regarding emissions of BC in sector 2D3b.
12. Supplementary data regarding emissions in sector 2G.

ANNEX I POTENTIAL TECHNICAL CORRECTIONS

130. No technical corrections have been proposed by the ERT during the review.