Review Comments by Governments on the Second Order Draft of Volume 3 of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

Comment ID	Volume	Chapter	From line	To line	Comment	Country	Response	Authors notes
6908	3	3	5	5	There are no the phrase like "Parts in brackets – comments from Authors/issues that may be refined" in Chapter 6 or "Bracketed text – characterization of guidance as new, updated, and/or elaborated" in Chapter 7.	Republic of Korea	Noted	The refinement Final Drafts have been formatted in a manner consistent with IPCC task-force recommendations, in order to highlight to users: (i) where text has been updated; (ii) where there is new guidance; and (iii) where there has been no refinement.
6906	3	3	154	154	It wolud be better to add revised or newly added contents first (in front of introduction) like Chapter 6.	Republic of Korea	Accepted with modification	Across the 2019 Refinement, the changes to text, tables and so on are detailed within the Mapping Tables. Where appropriate in the IPPU Final Drafts, text is included in individual sections of text to assist users to understand the refinements made, to help inventory compilers in cross-referencing with the 2006 Guidelines.
6486	3	3	188	192	The difference in labels between table 3.3 (new) and table 3.3 (updated) is not clear enough. Why are they not table 3.3 and 3.4?	United Kingdom (of Great Britain and Northern Ireland)	Noted	At this stage the authors adopted the agreed conventions in order not to change the numbers of the tables of the whole volume 3 and be able to easily identify what has been new and what has been updated.
868	3	3	556	557	Missing unit on the emission factors of "0.019" and "0.04". Please add the unit of "kg HFC-23/kg HCFC-22" after "0.019" and "0.04".	Thailand	Accepted	We agreed with the commenter and have added the appropriate units for the emission factor.
1806	3	3	730	739	In lines 730-732, 766-768, and 777-780, please check the formulas (3.41A), (3.42) and (3.43), and it is suggested to reformulate the text on the right of the formula as a formula.	China	Accepted	We reviewed Equations 3.41A, 3.42, and 3.43 as suggested by the commenter. We reviewed Equation 3.41A for accuracy and updated the text that describes the units. We reviewed Equations 3.42 and 3.43 for accuracy and did not find errors. For each of these equations, we removed the text note from the right hand of the formula and added it to the description of the variables below the equations.
4700	3	3	915	916	To have a generalized GHG EF specified for fluorochemical production, without the F-gas specified seems to be inconsistent with 8.2.6 in Volume 1, and lowers transparency. Is it possible for instance to provide EFs for each of the F-gas species shown in Table 3.28B instead?	Japan	Noted	While we agreed with the reviewer that it is desirable to develop a specific emission factor for each fluorinated GHG, we also note that the dataset that was used to provide the default emission factor does not have sufficient detail to enable such a calculation. We anticipated that use of the default emission factor in Table 3.28A along with use of the representative composition in Table 3.28B in essence provides fluorinated GHG default emission factors. For example, the default emission factor value of 0.04 kg fluorinated GHG emissions/kg fluorochemical produced, times the production value in kg fluorochemical produced, times 0.12 perfluorocyclobutane from Table 3.28B would provide a de facto default emission factor for perfluorocyclobutane of 0.0048 kg perfluorocyclobutane/kg fluorochemical produced. If the inventory compiler has some information regarding the type of fluorochemical manufacturing that is occuring, either limited or full information, they could use that information to estimate the particular fluorinated GHG being emitted in conjunction with the default EF, or use the default EF and the information in Table 3.28B to assume a chemical composition for the emission. The inventory compiler could also use a Tier 2 or 3 approach.
870	3	3	947	958	Numbers indicated emission factors in the whole paragraph are not clear without unit. Are these numbers in percent or kg emission/kg produced?Adding unit after each number would greatly clarify the content in this paragraph.	Thailand	Accepted	We agreed with the commenter and have added the appropriate units, kg emitted/kg produced, for all EFs in this section.

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7402	3	3	1060	1736	It is well explained that combustion related emissions should be reported under 1.A.1.b, leakage under 1.B.2.iv-v and all process related emissions under 2.B. However, there is still a high chance of misinterpretation regarding the allocation of emissions from refineries with integrated chemical industries and some processes need to be explained in more detail. In the 2006 Guidelines and also in the refined guidelines, the allocation of stored refinery products is not straight forward. In chapter 4 Volume 2 line 1951, it is stated that only fuels should be reported under 1.B.2.a.v, and in Volume 3 e.g. under 3.9.2.2 (page 3.74 in 2006 Guidelines) storage of feedstock is part of methanol production. Other production processes provide neither emission factors nor methods for feedstocks. Countries with both refineries and chemical industries will need to apply a complex reporting system with this differentiation, while others with chemical industry only would underestimate their emissions. If countries produce products dedicated for export (e.g. naphtha or LPG), emissions cannot be reported with the refined guidelines. A second incomprehensible aspect is asphalt blowing. This aspect used to be part of chapter 3 (page 5.14) – now it is included under 1.B.2.a.iv (Volume 2, chapter 4, line 1931). It should be clear where to report emissions from asphalt blowing in order to avoid double counting. For both aspects, we recommend providing a graphical presentation, where to report such emissions.	Germany	Noted	Reallocated to Energy
7574	3	3	1090	1092	In earlier guidelines, there were no mention, that CO2 emissions from biological feedstocks in IPPU sector have to be reported as a memo item. This need to report the CO2 emissions from use of biomass as feedstocks in the IPPU sector as a memo item does not appear to be included in the original draft Table of Contents /Chapter Outline as attached to the Terms of Reference for the 2019 Refinement either.	Finland	Rejected	It is within the scope of hydrogen production, which is within the TOC.
5626	3	3	1090	1092	Recommend editing this sentence from lines 1090 to 1092 related to biomass use. "Emissions of CO2 from thermochemical processes like steam reforming and gasification using biomass as feedstock should be accounted for in a memo item, and not included in national totals." Recommend removing "and not included in national totals" because it is already included in national totals from the AFOLU chapter in carbon stock changes. Suggested sentence: "Emissions of CO2 from thermochemical processes like steam reforming and gasification using biomass as feedstock should be accounted for in a memo item only to avoid double counting."	United States of America	Accepted with modification	The revised text makes even closer reference to the AFOLU chapter.
7572	3	3	1212	1241	Box 3.18: If there is still no evidence that CH4 and N2O emissions will occur from hydrogen production, this box (or related information) should be placed in an appendix.	Finland	Rejected	The box is describing an exclusion due to negligible amounts and scarce scientific basis, while the scope of the appendix is suggestions for further methodological development.
5628	3	3	1381	1382	Recommend editing this sentence from lines 1381 to 1382 related to biogenic use for hydrogen production, "If the feedstock is biogenic, the CO2 emission should be allocated to a memo item and not included in national totals". Recommend editing to read as: "If the feedstock is biogenic, the CO2 emission should be allocated to a memo item to avoid double-counting as these emissions are already captured in national totals."	United States of America	Accepted with modification	The revised text makes even closer reference to the AFOLU chapter.
5630	3	3	1433	1434	Remove "and exclude it from national totals."	United States of America	Accepted with modification	Changed from "national totals" to "the Hydrogen production sector".

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5632	3	3	1470	1470	Remove "and exclude it from national totals."	United States of America	Accepted with modification	Changed from "national totals" to "the Hydrogen production sector".
5634	3	3	1500	1500	Remove "and exclude it from national totals."	United States of America	Accepted with modification	Changed from "national totals" to "the Hydrogen production sector".
5636	3	3	1601	1602	Remove "excluded from national totals and"	United States of America	Accepted with modification	Changed from "national totals" to "the Hydrogen production sector".
5638	3	3	1611	1611	Remove "excluded from national totals and"	United States of America	Accepted with modification	Changed from "national totals" to "the Hydrogen production sector".
5640	3	3	1623	1623	Remove "excluded from national totals and"	United States of America	Accepted with modification	Changed from "national totals" to "the Hydrogen production sector".
6912	3	4	5	5	There are no the phrase like "Parts in brackets – comments from Authors/issues that may be refined" in Chapter 6 or "Bracketed text – characterization of guidance as new, updated, and/or elaborated" in Chapter 7.	Republic of Korea	Noted	The format of how to highlight updates, new guidance and no refinements will be done consistent with IPCC task-force recommendations
6910	3	4	198	199	It wolud be better to add revised or newly added contents first (in front of introduction) like Chapter 6.	Republic of Korea	Accepted	Review of changes included before introduction. However, this will also be summarised in the Mapping Table.
6766	3	4	251	251	Some recommendations/clarifications for energy experts should be provided in this section how to keep (preserve) fuel balance for energy sector in case when production activity data are used for estimation emissions from 1A1c category and fuel combustion AD are used for all other categories in the sector 1A. The use of methodology suggested in the section 4.2.2.1 of Vol.3 Ch.4 SOD Refinements 2019 for estimation of emissions in category 1A1c will lead to increase of difference between Reference and Sectoral approaches in Energy sector.	Russian Federation	Rejected	The coke production is a fuel transformation (it is not only a combustion for firing the coke ovens). Tier 1b addresses coking coal AD to be used for CO2 estimates along with coke production AD for a simplified carbon balance which assumes that 100% of COG is burned onsite for energy recovery and that all coke oven by-products are transferred offsite.
872	3	4	297	298	What would be the meaning of gray shade in Table 4.1 A? It is unclear.It would be more explicit with symbol (or "X") than gray shading.	Thailand	Accepted	This shaded parts include description of "NO" emissions. NO - not occured.
6768	3	4	300	301	There are three tiers for CO2 and two tiers for CH4. It is not clear which tier should be used for CH4 In case is tier 2 is used for CO2. Estimates for CO2 and for CH4 will be incomparable in this case because of the different AD used for different tiers.	Russian Federation	Accepted with modification	Regarding CH4 decision tree a new one will be included in FD.
6770	3	4	305	305	Figure 4.8 does not provide decision tree for CH4 emissions from coke production. It provides decision tree for CH4 emissions from iron and steel production. So decision tree for CH4 emissions from coke production is missed and it is not clear how to choose the proper tier for CH4 emissions estimation from coke production	Russian Federation	Accepted with modification	Regarding CH4 decision tree a new one will be included in FD.
874	3	4	343		Two equations are on the same line causing confusion for readers.Add a new line for ECH4, energy = CO• EFCH4 separating the two equations.	Thailand	Accepted	The equations were separated in FD, however the equation 4.1 is for CO2 and the equation 4.1a is for CH4.
5200	3	4	484	484	Add the same sentence as for the Tier 1 method: "Total emissions are the sum of Equations 4.9, 4.10 and 4.11."	France	Accepted with modification	
5202	3	4	512	512	To avoid confusion with the blast furnace for the iron production, replace "blast furnace" by "ignition furnace" in the sentence: "COG: quantity of coke oven gas consumed in ignition furnace in sinter production (…)"	France	Accepted with modification	FD text was changed to: quantity of coke oven gas consumed in ignition furnace for sinter production.

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1808	3	4	524	739	In lines 524-528, 730-731, and 735-739, because coke oven gas, blast furnace gas and converter gas power generation are typical energy activities, it is suggested that their emissions be calculated and reported in the energy activity inventory.	China	Rejected	The Chapter 2 "Stationary combustion" from the Volume 3 is providing the explanation that the reporting of emissions from gases obtained from processing feedstock and process fuels obtained directly from the feedstock follows the principle stated in Section 1.2 of Volume 3. In summary, if the emissions occur in the IPPU source category which produced the gases emitted they remain as industrial processes emissions in that source category. If the gases are exported to another source category in the IPPU sector, or to the energy sector, then the fugitive, combustion or other emissions associated with them should be reported in the sector where they occur. Inventory compilers are reminded to discriminate between emissions from processes where the same fossil fuel is used both for energy and for feedstock purposes (e.g. synthesis gas production, carbon black production), and to report these emissions in the correct sectors. The information for clarification of emissions to be split between Energy and IPPU is provided in the Box 1.1, Introduction to the IPPU Chapter.
5204	3	4	572	572	Add the sentence: "Total emissions are the sum of Equations 4.12, 4.13 and 4.14."	France	Accepted with modification	FD text was changed to: Total emissions are the sum of Equations 4.12, 4.13 and 4.14. for the processes that occur in the country.
5206	3	4	636	636	Why are there 2 rows for the BOF? We may assume that the EF of 1.39 (VS the current one in GL 2006: 1.46) is the new EF proposed for the 2019 Refinement. But, if we do not mistake, the EU ETS benchmark value under the EU ETS phase 3 (2013-2020) Decision 2011/278/UE, annex I, Table 1, is 1.328 allowances/t (i.e. t CO2/t) and not 1.39 (in the annex I: row "Hot metal" which includes the BOF).	France	Accepted with modification	Table 4.1 has the oldest EF deleted. New references has been found and aA value of 1.58 has been now included
876	3	4	655		EFCH4 for coke production has wide range, 1-80 g CH4/tonne of coke produced (Table 4.2).Is it possible to make sub-category of coke production process to provide alternative of selecting appropriate EF, e.g., old technology process, 1970s technology, BAT process, with/without offgas-recirculation technology, etc.	Thailand	Accepted with modification	The upper value has been considered for Tier1, that is coherent with other new value reported by Japan.
7576	3	4	655	656	Default emission factor for CH4 emissions from coke production: According to the reference given for the default emission factor, the factor is from a single plant and therefore could not be used as default. Please use more comprehensive references for calculation of a default emission factor or state that no default can be given.	Finland	Accepted with modification	The upper value has been considered for Tier1, that is coherent with other new value reported by Japan.
6914	3	4	679	680	Tier2 material specific carbon contents are updated but, In energy sector carbon emission factors are not changed, so it need to consider the revision EF in energy sector for consistency. Especially emission factors of new guidance for fugitive emissions from coke production in energy sector(Volume3, Chapter4, Line 2796~2797) are different with IPPU sector eventhough emission source is same e.g) Blast Furnace Gas (IPPU) 0.17tC/ton -> 0.243tC/ton(Updated) (Energy) 2.47TJ/Gg * 70.8kg/GJ / 10^3 = 0.17tC/ton(not updated)	Republic of Korea	Accepted with modification	The Table 4.3 carbon contents for fuels has been leave as in 2006 Guidelines. For the rest of the process material, has been updated.

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5210	3	4	737	743	The split (export (à Energy) VS internal needs (à IPPU)) seems to be very tricky to do for the operators. But I am waiting for their feedback on that question.	France	Noted	The Chapter 2 "Stationary combustion" from the Volume 3 is providing the explanation that the reporting of emissions from gases obtained from processing feedstock and process fuels obtained directly from the feedstock follows the principle stated in Section 1.2 of Volume 3. In summary, if the emissions occur in the IPPU source category which produced the gases emitted they remain as industrial processes emissions in that source category. If the gases are exported to another source category in the IPPU sector, or to the energy sector, then the fugitive, combustion or other emissions associated with them should be reported in the sector where they occur. Inventory compilers are reminded to discriminate between emissions from processes where the same fossil fuel is used both for energy and for feedstock purposes (e.g. synthesis gas production, carbon black production), and to report these emissions in the correct sectors. The information for clarification of emissions to be split between Energy and IPPU is provided in the Box 1.1, Introduction to the IPPU Chapter.
4702	3	4	746	746	The method of treating coke use as energy-use is adopted in many countries. This method was originally developed by World Steel Association in 2007 and was published as International standard ISO14404 in 2013. Furthermore, the IEA energy statistics manual also defined that "all cokes should be treated as transformation use in the blast furnace. ~Never report the use of coke in blast furnace as "non-energy use" ".Thus, the method of treating coke use as energy-use has been widely adopted in the world, including in private companies, national governments and international organizations. As stated in paragraph 721, it is difficult to calculate CO2 emissions for the Energy Sector and the Industrial Processes Sector separately without any ambiguities. Taking into account the above, the following sentence should be added to the end of the "RELATIONSHIP TO THE ENERGY SECTOR" section in order to request Parties which do not follow the allocation rule described in paragraph 730 to 745 due to their national circumstances and data availability to provide clear explanation on which emissions are reported under which category. "The clear explanation on the allocation of emissions should be provided in order to make sure that there is no double counting and omissions when the emissions from iron and steel production are not reported as described above."	Japan	Accepted with modification	The Chapter 2 "Stationary combustion" from the Volume 3 is providing the explanation that the reporting of emissions from gases obtained from processing feedstock and process fuels obtained directly from the feedstock follows the principle stated in Section 1.2 of Volume 3. In summary, if the emissions occur in the IPPU source category which produced the gases emitted they remain as industrial processes emissions in that source category. If the gases are exported to another source category in the IPPU sector, or to the energy sector, then the fugitive, combustion or other emissions associated with them should be reported in the sector where they occur. Inventory compilers are reminded to discriminate between emissions from processes where the same fossil fuel is used both for energy and for feedstock purposes (e.g. synthesis gas production, carbon black production), and to report these emissions in the correct sectors. The information for clarification of emissions to be split between Energy and IPPU is provided in the Box 1.1, Introduction to the IPPU Chapter.
5642	3	4	747	750	The addition of Figure 4.8a is useful to map how to allocate CO2 emissions between Energy and IPPU for integrated Iron and Steel facilitates, but this figure is difficult to follow the flow of emissions through the process and whether they are under IPPU or Energy. While the figure is helpful, further revisions could be made to further clarify. This could even be expanding Figure 4.8a to take up an entire page, similar to Figure 4.1 between lines 245 and 246, which would allow more space to see the flow of emissions to be allocated.	United States of America	Accepted with modification	The Figure 4.8 was modified to make it more clear and accessible.

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5208	3	4	748	748	In the Figure 4.8a(new): Change « LDG » into « BOF » in order to be consistent with the overall document, where LDG is not used. For the Power Plant box, for 1 and 2: after "Energy", add: "(electricity and/or heat production)". For the black box on "Heat (hot rolling mills (…)": delete the brackets and add "Heat used for rolling mills (…)" to avoid any confusion with the "Energy produced" in the black box "Power Plant" (for which the allocation of the CO2 emissions depends on the use of the energy).	France	Accepted with modification	The comment is mostly excepted excluding the changing of the naming from "LDG" to "BOF". We should also consider the naming BOFg in this case because we are dealing with a gas.
878	3	4	847		The uncertainty of Tier 1 (±40%) is likely to exceed this number if compliers use the lower end default of 1 and the upper end of 80 g CH4/tonne of coke produced from Table 4.2.Provides EF for sub-category of coke production process based on technology used with data from the industry in Europe, US., Japan, India, China.	Thailand	Accepted	The uncertainty for Tier 1 was recalculated.
5644	3	4	932	933	The sentence at lines 932-933 reads in part: "countries should make every effort to us higher Tier methods because emission rates can vary greatly, and the uncertainty associated with Tier 1 factors is very high." This is true for most countries, but as indicated by the decision tree (Figure 4.12), Tier 1 is not the best approach for countries where the PFPBmw technology prevails. Therefore recommend inserting a sentence reading "The sole exception is countries where the cell technology is Point-Feed Prebake without fully automated anode effect intervention strategies, where use of higher Tier methods is likely to result in less accurate emissions estimates."	United States of America	Accepted	Included in text
5646	3	4	957	958	Recommend inserting "identified as" between "typically" and "emission" for consistency with previous paragraph.	United States of America	Accepted	Changed in text
5648	3	4	973	976	These lines contradict the decision tree, which recommends use of the Tier 1 method for the PFPBmw technology even if process data are available. Assuming that the decision tree is correct, recommend making two changes. In line 975, insert "generally" between "uncertainty associated with higher Tier methodologies is" and "significantly lower than that for Tier 1," In line 976, insert a new sentence after "if this is a key category": "The only exception is countries where the cell technology is Point-Feed Prebake without fully automated anode effect intervention strategies, where use of higher Tier methods is likely to result in less accurate emissions estimates, as discussed below."	United States of America	Rejected	The decision tree was slightly modified in the final draft, but the main purpose of the comment still applies. However, there was no modification to the text because the reason we recommend to use Tier 1 for "technologies without fully automated anode effects termination strategies" is based on the inconsistent AE definition within this type of technologies which made it impossible to define a representative Tier 2 coefficient for this category (as described in Table 4.16). FInally, if data is available, and EF specific for the facility is available, it is recommended to use Tier 3 in the decision tree.
5650	3	4	975	976	Recommend replacing "Tier 2 and Tier 3 are strongly recommended" with "it is good practice to use Tier 2 and Tier 3"	United States of America	Accepted	Changed in text
5652	3	4	985	986	For clarity, recommend deleting "focus the methods with reference to" and replacing with "focus on"	United States of America	Accepted	Changed in text

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5654	3	4	1000	1005	It is unclear whether this section is or is not recommending that Tier 3 measurements be made at facilities with low HVAE frequency. Lines 1000-2002 read "For high performing facilities with low HVAE frequency, the Tier 3 method will likely not provide a significant improvement in the overall facility GHG inventory in comparison with the Tier 2 Method to estimate emissions from HVAE." However, lines 2002-1003 appear to contradict this statement: "However, the impact of LVAE emissions may still be significant and Tier 3 methods are recommended to correctly assess the GHG inventory of individual facilities." Please clarify this one way or the other.	United States of America	Accepted	Reference to high performing facilities was removed due to the contradiction between HVAE and LVAE recommendations.
5656	3	4	1027	1028	To ensure this sentence is consistent with the decision tree (Figure 4.12), recommend adding "or when the cell technology is Point-Feed Prebake without fully automated anode effect intervention strategies." The authors should then explain this exception, e.g., drawing on Marks & Nunez, 2018a: "Application of the Tier 2 and Tier 3 methods to Point-Feed Prebake without fully automated anode effect intervention strategies is likely to lead to inaccurate results. [Following two sentences are from pages 1520-21 of Marks & Nunez, 2018a:] Process data for anode effect frequency and duration [in the PFPBmw technology] [is] either not available or not comparable to data [for other technologies]. In some instances, cell voltage increases in excess of 8V, the voltage most commonly used to define anode effect trigger voltage [for other technologies], are not recorded as an anode effect [for the PFPBmw technology] unless the duration exceeds two minutes. Given that PFC emission rates are typically highest during the first two minutes of an anode effect, this definition prevents capture of the most relevant process data."	United States of America	Accepted with modification	Have included some wording to be consistent and provide a high level overview of rationale with reference to Marks and Nunez 2018a for further details.
5658	3	4	1030	1057	Recommend either combining Equations 4.25 and 4.25(a) for HVAE and LVAE or explaining why they and their associated coefficients are presented separately (e.g., to permit use of Tier 1 LVAE calculations in association with Tier 2 or 3 HVAE calculations for previous years).	United States of America	Accepted with modification	Have included some wording to explain coefficients are presented to allow for flexibility in the adoption of different Tiers for HV and LV.
5660	3	4	1073	1080	Multiple papers (Marks & Nunez, 2018, Dion, et Al 2018) show that much of the CF4 production during anode affects occur within the first 1-2 minutes (the non-linearity is pointed out on line 1125, but not otherwise discussed). However, many facilities do not consider anode effects to have occurred unless they exceed a certain amount of time, e.g. 15 - 90s (Referred to as "twinkle" AEs in Wong et Al 2015). It would be useful to emphasize the importance of counting short duration anode effects.	United States of America	Noted	There is reference throughout the chapter that anode effect definitions differ. We have specified the duration 'typically' associated with AEs and have provided a separate technology class for those facilities that typically define and approach AEs using different criteria (PFPB MW)
5662	3	4	1132	1152	The Tier 2b approach by Marks and Nunez does not include a formula for calculating C2F6 emissions. It is unclear how to calculate C2F6 emissions using this method.	United States of America	Accepted	Guidance has now been provided for C2F6 emissions in Tier 2b. This will be calculated using the ratio of C2F6/CF4 multiplied by HVAE-CF4 emissions, as per Tier 2a slope and overvoltage methods.
5670	3	4	1141	1143	Recommend including a second equation in Equation 4.27A to cover C2F6 emissions.	United States of America	Accepted	Guidance has now been provided for C2F6 emissions in Tier 2b. This will be calculated using the C2F6/CF4 ratio, multiplied by HVAE-CF4 emissions, as per Tier 2a slope and overvoltage methods.
5672	3	4	1141	1143	Recommending simplifying Equation 4.27A by combining the two multiplied "AEDi" terms and adding "1" to the exponent "K2."	United States of America	Accepted	The correction was done.

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5668	3	4	1141	1160	Recommend that authors either choose one of the two Tier 2b/3b equations (4.27A or 4.27B) or that they develop guidance explaining how inventory compilers should choose between them based on country- or facility-specific circumstances. Equation 4.27A may be somewhat simpler than Equation 4.27B in that it uses default constants (values for K1 and K2) rather than requiring the facility or inventory compiler to calculate these constants; however Equation 4.27A requires three sets of values (total of 6) whereas Equation 4.27B requires only four values of C1, C2, C3, and C4.	United States of America	Rejected	There is too little indications on the range/and level of accuracy of each equations to recommend one equation rather than the other for specific context. However, we've added the level of uncertainty associated to the different Tier 2b methodology (legacy and modern smelters) in order to help and make more informed decision.
5664	3	4	1141	1161	Equations 4.27A and 4.27B seem to have excellent agreement in terms of CF4 produced (assuming 4.27B is in grams, not kilograms) as a function of AED at 300 kA (if you use Faraday's law to convert kA to the theoretical MP); however, the results differ significantly at other line currents (or other equivalent t Al per cell per day). This is largely due to the fact that 4.27A has a linear relationship with line current, whereas 4.27b does not (it's parabolic and peaks at ~ 290 kA). Dion et Al 2008A indicates that a linear relationship is likely not accurate, at least for high amerage smelters. It would be useful if guidance was given as to what range of line currents (or metal production/cell-day) each equation should be used (is one more accurate at low amperages and the other at high amperages? and is there a range where neither is suitable?). From Dion 2018b, it seems like the g/t Al of CF4 produced for a particular AED is dependent on the metal production per day (i.e. Amerage of the technology) and thus, using the Marks & Nunez approach for all technologies would be inappropriate (as the g CF4 per t Al are independent of technology type). Currently the approaches are presented independent of any guidance about which equation to use, but the choice of equation may result in drastically different estimated emissions.	United States of America	Rejected	There is too little indications on the range/and level of accuracy of each equations to recommend one equation rather than the other for specific context. However, we've added the level of uncertainty associated to the different Tier 2b methodology (legacy and modern smelters) in order to help and take a more accurate decision.
5666	3	4	1141	1161	It is unclear if the equations for Tier 2B are considered valid for all technology types for which you can use a Tier 2 method. It seems unlikely that these equations would be accurate for all technology types given the range of slope coefficients given in Table 4.16. Please add guidance regarding for which technology types Tier 2b is appropriate.	United States of America	Accepted	Guidance on which technology types the methods apply to has been included.
880	3	4	1151	1152	New guidance for estimating HVAE emissions in Tier 2b method seems unclear when it involves the emission rate coefficients (K1, K2) in Equation 4.27A without citing Table 4.16A at the end.Add "(see Table 4.16A)" at the end of line 1151.	Thailand	Rejected	Reference for equation 4.27A to Table 4.16a is done in the line above the equation box. (regarding value of K1 and K2) Reference for equation 4.27b to equation 4.27d is done in the line before the equation box. (For calculation of C1,C2,C3 and C4)
882	3	4	1157	1174	Similar concerns for the new guidance on the distinction of emission rate coefficient (C1 vs. C2, and C3 vs. C4) in Equation 4.27B.Add "(see Equation 4.27D" at the end of line 1171	Thailand	Rejected	Reference for equation 4.27A to Table 4.16a is done in the line above the equation box. (regarding value of K1 and K2) Reference for equation 4.27b to equation 4.27d is done in the line before the equation box. (For calculation of C1,C2,C3 and C4)
5674	3	4	1157	1278	Equation 4.27B appears to be in grams not kilograms (based on using the coefficients starting on line 1267), as indicated in line 1165.	United States of America	Accepted	Corrected the equation
5676	3	4	1170	1170	Recommend clarifying definition of "MP" by removing "technology" after "cell." "Cell technology" could be read to encompass the entire potline or smelter.	United States of America	Accepted	Line was edited and a footnote was added to give additionnal explanations.

Comment ID	Volume	Chapter	From line	To line	Comment	Country	Response	Authors notes
5678	3	4	1177	1204	Box 4.2A appears to include guidance. My understanding is that boxes are not supposed to include guidance, but to provide examples. If the authors wish to retain the guidance, it should be removed from the box.	United States of America	Accepted	Box has been retained for definitions / description of a cell start-up. Guidance has been removed from the box and is now a new guidance sub-section.
5680	3	4	1177	1204	Box 4.2A includes potentially helpful guidance on accounting specifically for cell startups, but this guidance needs to be better integrated into the guidance in the remainder of the section. For example, the authors should explain (or point to references that explain) how "cell startup" is defined. They should also explain how to avoid either double-counting or underestimating HVAE and LVAE emissions that occur during cell startups and at other times. The current guidance in Box 4.2A does not mention LVAE emissions at all, but lines 1211 through 1213 below the box indicate that startups have unusually high LVAE/HVAE ratios. This indicates that ignoring LVAE emissions during cell startups could lead to significant underestimates of emissions.	United States of America	Accepted	Box now defines cell start ups, and note on not double-counting start-up emissions with normal operation emissions. Box also includes a brief description of LVAE emissions. Guidance is now provided outside the box, including available Tier methods to account for cell start up emissions, both HVAE and LVAE
5682	3	4	1177	1204	The guidance regarding developing emission factors for cell startup should address whether it is worthwhile to develop such factors if the facility is using the Tier 2b or 3b methods, which account for anode effect duration.	United States of America	Accepted	Wording has been adjusted that suggests Tier 2b-3b non linear method for Startup HVAE emissions is on equal footing to Tier 3d facility specific total emissions for cell start-up
5684	3	4	1203	1204	The statement "Such modifications to the detection threshold should be specific to each facility, based on historical data" is unclear. Do the authors mean "Facilities should use the same voltage threshold to apply EFcsu as they used to develop it"?	United States of America	Accepted	Clarification has been provided, the same detection threshold for AE during cell start-up should be the one used for accounting of cell start-up emissions
5686	3	4	1210	1213	The authors should clarify whether straight (i.e., unweighted) averages are used for the emission factors or whether weighted averages are used. Both "average" and "weighted average" are used currently, leading to confusion.	United States of America	Noted	We have removed T2 ratio which differed in its approach so this is no longer an issue.

Comment ID	Volume	Chapter	From line	To line	Comment	Country	Response	Authors notes
5688	3	4	1210	1213	The authors either should use averages (straight or weighted) to estimate default emission ratios for LVAE emissions or should better justify their use of alternative statistics (e.g., the median). The draft currently states, "The median is used for select technology classes where the weighted average was skewed due to a small number of very high LVAE/HAVE ratios in the dataset which were reflective of unusual conditions e.g., start up." However, in one of the source papers for the section (J. Marks and Nunez, P., "Updated Factors for Calculating PFC Emissions from Primary Aluminum Production," Light Metals), the authors of the paper state, "if the intended use [of the ratios] is to calculate a collective national or global inventory, the average ratio may be the better alternative [than the median]" (p. 1523). The goal of the Refinement is to provide guidance for developing national inventories, indicating that the average should be used. In general, as long as the sample set (aluminum smelters whose emissions were measured) is representative of the modeled set (aluminum smelters in general), an average should be used. Outliers often exist in both sample sets and modeled sets. In this case, the unusual conditions cited (cell startups) are likely to exist in all aluminum smelters at one time or another. In order to justify using a statistic other than the average for an EF, the authors need to demonstrate that startups are overrepresented in the sample set relative to the modeled set. Even if startups are overrepresented, the best solution may be to calculate a weighted average EF, giving less weight to the measurements reflecting cell startups, rather than a median	United States of America	Noted	We have removed T2 ratio which differed in its approach so this is no longer an issue.
5690	3	4	1211	1212	Instead of using the median ratio or the average ratio from Marks & Nunez for Table 4.16B, you should use the ratio of the average AE related EF to average LVAE EF. This method would result in a ratio of 1.15 for Legacy PFPB and 1.64 for Modern. This would be more representative of the data than a median of the ratios or an average of the ratios. This would result in an overestimate for many individual smelters but result in the correct total for all smelters combined.	United States of America	Rejected	We considered this approach however the uncertainties for T2 would still be >T1 due to the inclusion of the HVAE element in its calculation and the range of the underlying data.
5692	3	4	1211	1212	To remove an outlier and instead use the median for the LVAE/HAVE value in Table 4.16B, justification needs to be given for why the value is being discounted, i.e. why is it non-representative? Outliers should be kept unless there is reason to believe that it is not representative (and if so, the reason for their removal explained). One possible explanation provided for these outliers exists in Dion et Al 2018a. In that paper, it is explained that high ratios exist at some facilities due to large decreases in HVAE emissions. As these lower HVAE emissions (or similar data) were presumably used when determining the EFs for HVAEs, the correspondingly high ratios should not removed here	United States of America	Noted	We have removed T2 ratios and this is no longer an issue. We have not removed any 'outlier' data in the calculation of the Efs included.
6288	3	4	1218	1230	A question in relation to equation 4.27c - if an emission ratio is applied to HVAE emissions to derive LVAE emissions, is it necessary to multiply the result by metal production (MP)? When this approach is taken - emissions seem implausibly high? I would suggest the term Mp is not required in this equation	Australia	Accepted	The reviewer's comment was correct. MP has been removed.

Comment ID	Volume	Chapter	From line	To line	Comment	Country	Response	Authors notes
5694	3	4	1233	1240	In the decision tree, the decision diamond "Is there an automatic HVAE termination strategy" should be moved to immediately follow the Start box. If the answer to the question is "no," the action recommended is to calculate PFC emissions using the Tier 1 method, regardless of whether process data are available or whether the category is key. A "yes" answer would lead to the rest of the decision tree.	United States of America	Rejected	It is important to allow for these cell technologies the possibility to use Tier 3 if the data is available.
5696	3	4	1233	1240	In the decision tree, consider replacing the question "Is there an automatic HVAE termination strategy" with "Do facility tracking systems for anode effects detect and record them as soon as the cell voltage exceeds 8 volts?" The discussion in Marks & Nunez, 2018a (Updated Factors for Calculating PfC Emissions from Primary Aluminum Production) implies that it is a "no" response to the latter question rather than the former that makes use of a Tier 1 approach necessary for PFPBmw.	United States of America	Accepted with modification	An additionnal box was added in the decision tree to account for this scenario.
5698	3	4	1235	1236	The Decision Tree (Figure 4.12) currently allows you to by-passes the question "Is this a key category" if process data is available but still ends up possibly recommending a Tier 1 method. A Tier 1 method is inconsistent with good practice for key categories but would be possible with this decision tree.	United States of America	Accepted	Decision tree was modified to take this into consideration.
5700	3	4	1247	1248	The values listed in Table 4.15 for CF4 from HVAE are the values listed in Marks & Nunez 2018 as the TOTAL CF4 from LVAE and HVAEs. Since Table 4.15 separates out LVAEs from HVAEs, the values for HVAEs should be from column E in Marks & Nunez or you are double counting LVAEs.	United States of America	Accepted	Changed in table
5702	3	4	1247	1248	The value for C2F6 for PFPB-MW seems low, as it's much lower than the average C2F6/cF4 ratio of 0.073 (Marks & Nunez 2018)	United States of America	Rejected	Tier 1 C2F6-HVAE emission factor value of 0.005 kg C2F6/t Al in Table 4.15 for PFPB_MW is correct. The 0.073 value quoted by the reviewer refers to the Tier 2 coefficient/ ratio of C2F6/CF4 in the Marks & Nunez 2018 publication, not to Tier 1 emission factors here
5706	3	4	1247	1248	In the source paper for Table 4.15 (Marks & Nunez 2018a), the paper authors observe that performance improvements and technology changes have made the Tier 1 default emission factors in the 2006 IPCC Guidelines out of date. The authors of section 4.4 apparently rely on this conclusion in their decision to replace the 2006 Tier 1 defaults with those published in the source paper. Rather than replacing the 2006 factors, however, the authors should provide guidance on how to use them, along with the updated factors, to estimate emissions over the entire time series (e.g., back to 1990). For example, the authors could recommend that inventory compilers apply the new factors after 2010 and the old factors from 1990-2005, linearly interpolating between 2005 and 2010. The Refinement must provide guidance for estimating emissions over the entire time series.	United States of America	Accepted with modification	A specific table was added to the refinements in order to specify which coefficient to use, for which periods.
5708	3	4	1247	1248	In Table 4.15, in the first column under the headings "HVAE" and "CF4," default CF4 EFs are provided for HVAE. These factors are the same as the values shown in column C of Table 1 in the source paper (Marks & Nunez 2018a). However, the source paper indicates that the values in column C represent total emissions from both HVAE and LVAE (page 1520, second column). The source paper includes a different column for HVAE-only emission factors, column E. The section authors should ensure they are drawing from the correct column of the source paper.	United States of America	Accepted	Changed in table

Comment ID	Volume	Chapter	From line	To line	Comment	Country	Response	Authors notes
5704	3	4	1247	1284	In Tables 4.15, 4.16, and 4.16B, the source paper is identified as Marks & Nunez 2018B, which is identified in the endnotes as "New Algorithm for Calculating CF4 Emissions from High Voltage Anode Effects" in: Light Metals, Phoenix. For all three tables, the correct source paper appears to be Marks & Nunez 2018A, "Updated Factors for Calculating PFC Emissions from Primary Aluminum Production." In: Light Metals, Phoenix, AZ.	United States of America	Accepted	There was indeed an inversion in the reference.
5710	3	4	1254	1255	The values in Table 4.16 for PFPB-L do not match the Marks & Nunez 2018 paper. If a different source was used, it should be noted	United States of America	Accepted	Changed in table
5712	3	4	1254	1255	In the source paper for Table 4.16 (Marks & Nunez 2018a), the paper authors observe that technology changes have made the Tier 2 default slope factors in the 2006 IPCC Guidelines out of date. The authors of section 4.4 apparently rely on this conclusion in their decision to replace the 2006 Tier 2 defaults with those published in the source paper. Rather than replacing the 2006 factors, however, the authors should provide guidance on how to use them, along with the updated factors, to estimate emissions over the entire time series (e.g., back to 1990). For example, the authors could recommend that inventory compilers apply the new factors after 2010 and the old factors from 1990-2005, linearly interpolating between 2005 and 2010. The Refinement must provide guidance for estimating emissions over the entire time series.	United States of America	Accepted with modification	A specific table was added to the refinements in order to specify which coefficient to use, for which periods.
5714	3	4	1254	1255	In Table 4.16, the first value in the column (SCcf4 for PFPBL), 0.127, does not match the corresponding value in the source paper (Marks & Nunez 2018a, Table 3), 0.111. Instead, it appears to be a simple average of the 2006 IPCC slope factor of 0.143 and the 0.111 value provided in Marks & Nunez. This may be appropriate if the difference between the 0.143 2006 slope factor and the 0.111 value simply reflects different sample sets rather than a trend. However, if the difference between the slope factors reflects a trend (as seems likely given the technological changes cited in Marks & Nunez), then 0.111 factor should be adopted for some set of recent years while the 0.127 factor should be retained for some set of earlier years.	United States of America	Accepted	0.111 value adopted in table to reflect latest data
5716	3	4	1261	1262	In Table 4.16A, the source paper is identified as Marks & Nunez 2018A, "Updated Factors for Calculating PFC Emissions from Primary Aluminum Production," in: Light Metals, Phoenix, AZ. The correct source paper appears to be Marks & Nunez 2018B, which is identified in the endnotes as "New Algorithm for Calculating CF4 Emissions from High Voltage Anode Effects" in: Light Metals, Phoenix.	United States of America	Accepted	Citations have been corrected
5718	3	4	1261	1270	Table 4.16A needs to be expanded to include the uncertainties associated with the constants K1 and K2 for the three categories of anode effect duration. Uncertainties should also be provided for the constants C1 through C4 in Equation 4.27D.	United States of America	Accepted	The uncertainties associated to the Tier 2b methodologies were added to the document.
5720	3	4	1283	1284	It seems like this should reference Marks & Nunez 2018A instead of Marks & Nunez 2018B. I think there are multiple instances where these references are mixed up.	United States of America	Accepted	There was indeed an inversion in the reference.

Comment ID	Volume	Chapter	From line	To line	Comment	Country	Response	Authors notes
5722	3	4	1283	1284	Table 4.16B includes median LVAE/HVAE values for the PFPBL and PFPBM technologies rather than average values for these technologies. This is a very consequential decision as the median value for PFPBL is 7 times smaller than the average value, while the median value for PFPBM is 5 times smaller than the average value (Marks & Nunez, 2018a). The average should be used unless the sample populations of smelters for each technology differ fundamentally from the general populations of smelters for each technology.	United States of America	Noted	We have removed T2 - no longer an issue.
5724	3	4	1294	1312	This section needs to be expanded to address the new Tier 2b and 3b methods, which require process data on the duration of each HVAE and on either line current or production for cells where HVAEs occur.	United States of America	Accepted	Activity data section has been updated to describe data requirements for HVAE, LVAE and cell start-up emissions.
5726	3	4	1313	1314	Given the inclusion of a new source in this section of the Refinement (LVAE emissions), it would be prudent and reasonable to include one or two sentences in the "Completeness" discussion advising that inventory compilers account for this source. Even if edits to the Completeness discussion were not identified in the original TOC, they are easily justified as edits to maintain consistency with the other parts of the aluminum section.	United States of America	Accepted	"Completeness" discussion for Aluminium has been updated, adressing the addition of LVAE emissions and those from cell start-ups improve overall completeness for total PFC emissions.
5728	3	4	1317	1332	This guidance should also address how to ensure time series consistency while transitioning from using the current Tier 2 and Tier 3 slope factor approaches (renamed Tier 2a and Tier 3a in the SOD) to the new Tier 2b and Tier 3b approaches based on anode effect duration. Using the methods in parallel for three years, as recommended for the overvoltage and slope methods in lines 1333 through 1338, may be a good solution.	United States of America	Accepted with modification	There was not any clear solution suggestion but it was refered to the similar "parallel" approach to ensure consistency.
5730	3	4	1329	1332	This guidance to use the Tier 2 slope factors from the 2006 Guidelines through 2018 should be emphasized by also including it above Table 4.16, and by expanding Table 4.16 to include columns for the slope factors from the 2006 Guidelines, along with the years for which they should be used (1990-2018).	United States of America	Accepted with modification	A specific table was added to the refinements in order to specify which coefficient to use, for which periods.
5732	3	4	1333	1338	The suggestion to use the Tier 3 overvoltage and slope models in parallel for three years is a good one.	United States of America	Noted	
5734	3	4	1341	1345	Suggest including "alumina feeding strategy" in the list of factors that can affect the applicability of Tier 3 slope factors to previous or later years.	United States of America	Accepted	Added alumina feed control strategy as another factor that affects application of past Tier 3 coefficients or emission factors
5736	3	4	1347	1351	Recommend referencing Volume 1, Chapter 5 guidance on time series consistency, as well.	United States of America	Accepted	Added reference to Vol 1, Chapter 5 at start of section 4.4.2.7
5738	3	4	1356	1358	The guidance "to backcast the LVAE PFC emissions, for national inventories, by using the respective Tier 2 coefficient specific to each category up to 2007" is unclear. Is the advice to estimate past emissions back to 2007, e.g., between the current inventory year and 2007? If so, recommend changing "up to 2007" to "back to 2007."	United States of America	Accepted	A specific table was added to the refinements in order to specify which coefficient to use, for which periods.

Comment ID	Volume	Chapter	From line	To line	Comment	Country	Response	Authors notes
5740	3	4	1363	1369	This discussion states that, due to the high uncertainty of LVAE PFC emissions from individual smelters, the Tier 2 approach should not be used to backcast LVAE emissions from a small number of smelters. However, the same logic could be used to argue against using the Tier 2 approach to estimate LVAE emissions for the current inventory year from a small number of smelters. It is always the case that, when default emission factors are based on data showing high variability, the resultant uncertainties in the emissions of the population will be higher (in relative terms) for smaller populations than for larger populations. The uncertainty associated with the estimate for smaller populations is nevertheless preferable to the underestimate that would result from not making the estimate at all. If the authors mean that the Tier 2 LVAE/HVAE ratios may not be applicable to all years because the underlying measurements reflect significant process and technology changes that have occurred since 1990, then the authors should suggest an alternative to applying the Tier 2 LVAE/HVAE ratios to years before 2007, e.g., using Tier 1 LVAE EFs. Ignoring LVAE emissions for years before 2007 will lead to incomplete, inconsistent estimates.	United States of America	Rejected	It was proposed to neglect LVAE prior to 2006 because the process conditions that favors LVAE has changed over time and it is very unlikely that the level of LVAE emissions were as high as 2010 and up. In addition, the IAI AE survey demonstrate a clear downward trend in reported HVAE up to the year 2010, this corroborates the fact that LVAE were not as important in comparison to the total PFC emissions from a facility, thus LVAE were most probably immaterial. Finally, there is no data available to reasonably determine a pre-2006 LVAE EF, thus it is preferable to ignore those emissions than to blindly guess a number.
5742	3	4	1365	1369	Instead of omitting LVAE emissions in historical data, it would be preferable to take a conservative approach for accounting for these emissions. Perhaps it would be appropriate to use one of the lower LVAE/HVAE ratios as a default for pre-2007 data?	United States of America	Rejected	It was proposed to neglect LVAE prior to 2006 because the process conditions that favors LVAE has changed over time and it is very unlikely that the level of LVAE emissions were as high as 2010 and up. In addition, the IAI AE survey demonstrate a clear downward trend in reported HVAE up to the year 2010, this corroborates the fact that LVAE were not as important in comparison to the total PFC emissions from a facility, thus LVAE were most probably immaterial. Finally, there is no data available to reasonably determine a pre-2006 LVAE EF, thus it is preferable to ignore those emissions than to blindly guess a number.
5744	3	4	1365	1369	Can you clarify what you mean by 'historical data'? Do you mean pre-2007? Earlier on line 1358, the guidance encouraged national inventories to account for LVAE PFC emissions 'up to 2007' (I assume you mean back to 2007) and for pre-2006, not to calculate LVAE emissions, but this is unclear.	United States of America	Accepted	The text was modified and a table was added to clarify time-consistency concerns.
5746	3	4	1381	1399	Should this guidance, which addresses the uncertainties of EFs for CO2, be grayed out? CO2 emission factors are not being addressed in the Refinement.	United States of America	Accepted	Section greyed out
5748	3	4	1400	1418	This discussion should address the uncertainties associated with use of the 2b and 3b methods relative to the 2a and 3a methods.	United States of America	Accepted	The uncertainties associated to the Tier 2b methodologies were added to the document.
5750	3	4	1419	1420	This sentence is unclear. Are the authors trying to say that the absolute uncertainty associated with LVAE emissions based on the Tier 2/3 methods is higher than that associated with HAVE emissions? Or are they referring to the relative uncertainty?	United States of America	Accepted with modification	Changed wording in text to clarify
5752	3	4	1489	1490	To address the data requirements of the Tier 2b and 3b methods, Table 4.17 needs to be expanded to include separate columns for Tiers 2a, 2b, 3a, and 3b; and rows for the duration of each anode effect, the line current for each anode effect, and the daily aluminum production of cells that experience anode effects.	United States of America	Accepted	Table 4.17 has been updated to include all data requirements for new methods in 2019 Refinements

Comment ID	Volume	Chapter	From line	To line	Comment	Country	Response	Authors notes
6776	3	4	1563	1565	There is no CO2 emission from soda ash and potash production. These two by-products reduce CO2 emission from alumina production. It is not also clear how to split CO2 emissions between alumina and cement production. Obviously, using of belite mud in cement producing industry reduces CO2 emissions from cement production. However, no methodology is provided to estimate this CO2 emission reduction. This issue should be considered in the Guidlines.	Russian Federation	Noted	Cement production is not a part of alumina production. It is external process that use belite mud as a raw material. So Cement production shall use the appropriate methodology for cement production considering carbonate content in raw materials. The primary intention to use belite mud in cement production is waste utilization to reduce environmental impact but not for GHG emissions reduction. The appropriate text has been changed to give more clear explanation about by-product process CO2 emissions calculation.
6778	3	4	1644	1645	The proposed Tier3 approach is very complicated and requires a lot of additional data and technological parameters. It seems to be very time and resource consuming. Implementation of Tier3 methodology may be very difficult or impossible for inventory compilers. (It is stated, that frequent (annual?) calculations of emissions could be burdensome even for some plants (line 1733)). However, in the absence of Tier2 approach it will be mandatory for national inventory compilers to use Tier3 in case alumina production is a key category of national inventory. To solve this problem a Tier2 methodology should be developed. The Tier 2 methodology may be similar tothe Tier1 but using national or plant specific Emission Factors. Emission Factors for Tier 2 methodology may not be provided in the text, they can be developed by Parties or obtained (in future) from the IPCC EFDB taking into account national circumstances of Parties.	Russian Federation	Accepted	A Tier 2 method shall be the same like Tier 1 method but country specific emission factors shall be used instead of World-wide emissions factors.
6772	3	4	1663	1664	The statement that Tier 1 method is based on the site specific data is contrdictory to the description of this methodology below. In fact, the proposed Tier 1 is based on the country specific activity data and the default EFs. As it formulated in the Terms of Reference for production of a Methodology Report to refine the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: "Tier 1 approaches are simple methods that can be applied by all countries in all circumstances." Tier1 approach cannot be based on site specific information.	Russian Federation	Rejected	Because each country (one of three) has one or maximum two plans operated with similar technology it is impossible to avoid usage of site specific data for Tier 1 emissions factor calculation. If any other country in future will apply one of the technology with sintering the Tier 1 coefficient can be applied.
6774	3	4	1674	1687	Taking into account that in the table 4.17A (lines 1860 -1861) two different Emission Factors are provided for two different technologies, the equation 4.27e (lines 1675 - 1677) should be rewrited as follows: CO2 Emissions = MAl2O3 * Sbs *EFbs +MAl2O3 *Snp*EFnp +MLime*EFLime, here Sbs - mass fraction of alumina produced by Bayer-sintering (BSS and BSP) technology, EFbs - Emission Factor for Bayer-sintering (BSS and BSP) technology, Snp - mass fraction of alumina produced by Nepheline - sintering process (NP), EFnp - Emission Factor for Nepheline - sintering process (NP). The other variables of the equation are the same as in lines 1680 - 1687.	Russian Federation	Accepted	The Formula has been modified as it was porposed.
5754	3	4	2371	2372	In table 4.28, using 'kg/tonne RE Metal' instead of the current 'g/tonne RE metal' would be more consistent and comparable with the aluminum section of the chapter.	United States of America	Rejected	To our understanding, there is no standard unit for emission factors across the IPCC guidelines and there is no need to be consistent with aluminium. Other metal industries use t CO2/t metal, or g CO2/ t production, etc. Use of kg/t metal units for PFC emission factors for Rare Earths would result in many decimal places for C2F6 and C3F8 in particular. Ultimately, the output is in kg PFC emisisons, which is consistent wtih aluminium.

Comment ID	Volume	Chapter	From line	To line	Comment	Country	Response	Authors notes
5756	3	4	2371	2372	The EF for C2F8 for RE alloys using the ratio from Cai 2018 of 0.03/109.43 *the CF4 EF of 146.1 results in a value of 0.04, not 0.05.	United States of America	Rejected	The C3F8 emission factor of 0.05 was calculated using original raw data values from the Cai et al. 2018 study, rather than rounded values found paper itself, in order to minimise rounding errors. Using C3F8/CF4 ratio = 0.000318 (instead of just 0.00031), when multiplied by EF_CF4 of 146.1, this gives EF_C3F8 of 0.0465 g/t Al, which was then rounded up to 0.05 g/t Al, to the nearest 2 decimal places. In any case, the scale of C3F8 emissions to Total CO2e PFC emissions is <0.05%, so there is effectively no difference between an EF_C3F8 value of 0.05 vs. 0.04.
5758	3	4	2371	2372	In Cai et al. 2018 it is noted that automated feeding resulted in a 40% reduction in the measured emission factor from 2014. Based on this information, it seems like it would be better to adopt similar terminology to the Aluminum chapter and have an emission factor technologies that have the automated feeding and a separate one for those which do not. Cai presents three different classes: low amperage technology, high amperage technology and high amperage with automatic control technology. If there is not enough data for all three categories, it still is likely to be appropriate to separate those that have automatic control technology from those that do not, especially as the current data set is not presented as a globally representative data set in terms of technology types. Another option would be to weight the EF data to resemble the global percentage of tons of RE manufactured using automatic control technology to make it more representative. The guidelines state that "many rare earth technologies currently do not use automated computer control systems to detect anode effects" (lines 2265-2266) but much of the Cai 2018 data used to develop EFs is from a facility that has automated control systems.	United States of America	Rejected	There is insufficient emissions factor data to support adoption of separate technology classes within the rare earths guidance. Furthermore, the 'automation upgrades' in the Cai et al 2018 paper were unclear and vague on details of what was implemented to achieve lower emissions, that would then justify and enable a separate technology class to be described. However, further guidance has been added noting the potential for further automation and technology development to reduce PFC emissions from rare earths production. In this case, it is good practice to employ Tier 3 facility specific methodologies.
6916	3	6	5	5	Why are these phrases of "Parts in brackets – comments from Authors/issues that may be refined" in Chapter 6 and "Bracketed text – characterization of guidance as new, updated, and/or elaborated" in Chapter 7 different? It would be better to unify the patterns if there are no special reasons.	Republic of Korea	Accepted	The discussion of changes to each section or chapter has been harmonized in the Final Draft.
884	3	6	215		Chemical formula format of "NF3", "C4F6"	Thailand	Accepted	Change made on final draft
6488	3	6	215	215	Subscript the numbers in all of the chemical formulae	United Kingdom (of Great Britain and Northern Ireland)	Accepted	Change made on final draft
886	3	6	241		Chemical formula format of "NF3", "C3F8"	Thailand	Accepted	Change made on final draft
6490	3	6	241	243	Subscript the numbers in all of the chemical formulae	United Kingdom (of Great Britain and Northern Ireland)	Accepted	Change made on final draft
5760	3	6	241	244	It is unclear what this sentence means. It seems to be missing words.	United States of America	Accepted	Change made on final draft
888	3	6	242		Chemical formula format of "NF3", "C3F8", "N2O"	Thailand	Accepted	Change made on final draft
890	3	6	243		Chemical formula format of "N2O"	Thailand	Accepted	Change made on final draft
892	3	6	252		Chemical formula format of "N2O"	Thailand	Accepted	Change made on final draft
6492	3	6	252	255	Subscript the numbers in all of the chemical formulae	United Kingdom (of Great Britain and Northern Ireland)	Accepted	Change made on final draft
894	3	6	253		Chemical formula format of "N2O"	Thailand	Accepted	Change made on final draft
896	3	6	260		Chemical formula format in "BOX 6.1"	Thailand	Accepted	Change made on final draft

Comment ID	Volume	Chapter	From line	To line	Comment	Country	Response	Authors notes
6494	3	6	260	260	Subscript the numbers in all of the chemical formulae	United Kingdom (of Great Britain and Northern Ireland)	Accepted	Change made on final draft
6496	3	6	263	263	Subscript the numbers in all of the chemical formulae	United Kingdom (of Great Britain and Northern Ireland)	Accepted	Change made on final draft
6498	3	6	267	268	Subscript the numbers in all of the chemical formulae	United Kingdom (of Great Britain and Northern Ireland)	Accepted	Change made on final draft
6500	3	6	272	272	Subscript the numbers in all of the chemical formulae	United Kingdom (of Great Britain and Northern Ireland)	Accepted	Change made on final draft
6502	3	6	274	274	Subscript the numbers in all of the chemical formulae	United Kingdom (of Great Britain and Northern Ireland)	Accepted	Change made on final draft
898	3	6	377		Chemical formula format of "N2O"	Thailand	Accepted	Change made on final draft
6504	3	6	461	461	Subscript the numbers in all of the chemical formulae	United Kingdom (of Great Britain and Northern Ireland)	Accepted	Change made on final draft
6506	3	6	525	527	Subscript the numbers in all of the chemical formulae	United Kingdom (of Great Britain and Northern Ireland)	Accepted	Change made on final draft
6508	3	6	530	530	Subscript the numbers in all of the chemical formulae	United Kingdom (of Great Britain and Northern Ireland)	Accepted	Change made on final draft
5762	3	6	594	717	The addition of Tier 2C - process type and wafer size specific emission factors - is a significant improvement over the previous guidelines. However, it would be useful to specify if the "Adapting Tier 2 Methods to Account for Technological Change" section is meant to modify Tier 2C, if applicable, or could be used in combination with any Tier 2 method, which is implied.	United States of America	Noted	This was clarified in the final draft.
6510	3	6	633	635	Subscript the numbers in all of the chemical formulae	United Kingdom (of Great Britain and Northern Ireland)	Accepted	Change made on final draft
6512	3	6	638	638	Subscript the numbers in all of the chemical formulae	United Kingdom (of Great Britain and Northern Ireland)	Accepted	Change made on final draft
5764	3	6	695	700	In lines 695-700, facilities are given the option to use a default of 0.8 for 1-U for new gases or process types, but the decision tree indicates that they should take measurements. It would be useful to provide guidance for when the 0.8 default is acceptable (e.g. for low gas consumption volumes of the new gas or like in the case of the new substrate type described in lines 710-716, for the first year of use).	United States of America	Accepted	Added a sentence saying that defaults of 0.8, 0.15 (for CF4) and 0.05 (for C2F6) are acceptable when gas usage for the new GHG and process type combination is below 1% of facility-wide gas usage.
5766	3	6	696	697	The caveat "and when the use of the input gas(es) does not result in the formation of greenhouse gases as process byproducts (e.g. formation of CF4 from F2, COF2 chamber cleaning or from CF3I-based etch processes)" should be deleted. The possibility of byproduct generation from low-GWP input gases is adequately addressed by the assumption that 20% of the gas mass is transformed into CF4 and C2F6 byproducts.	United States of America	Accepted with modification	Removed caveat and updated the option for using a default of (1-U)=0.8 and BCF4=0.15 and BC2F6=0.5 in text.
6514	3	6	697	697	Subscript the numbers in all of the chemical formulae	United Kingdom (of Great Britain and Northern Ireland)	Accepted	Change made on final draft

Comment ID	Volume	Chapter	From line	To line	Comment	Country	Response	Authors notes
5768	3	6	718	1117	The refinement of the Tier 3 method (to the new Tier 3a), including the addition of criteria for similarity among recipes, is a significant improvement to the guidance, as is the addition of the Tier 3B method . These refined and additional methods will allow facilities to develop emission factors that are more accurate for their facilities and allow them to more easily show reductions in the GHGs due to changes in process conditions.	United States of America	Noted	
5770	3	6	720	726	If Tier 3a uses the same equations as Tier 2c, then the equations referenced should be equations 6.10 to 6.13, not 6.7 to 6.10. (See both line 721 and line 726).	United States of America	Accepted	Change made on final draft
900	3	6	802		Misuse label of the equation number.Change "EQUATION 6.13 (NEW)" in page 6.24, line 802 to "Equation 6.14 (NEW)" because the number "6.13" already exit in page 6.20, line 657.	Thailand	Accepted	Change made on final draft
6516	3	6	1194	1194	Subscript the numbers in all of the chemical formulae	United Kingdom (of Great Britain and Northern Ireland)	Accepted	See comment 6508
6918	3	6	1217	1226	To reduce the uncertainty of estimation, the emission factors need to move the decimal point of the left by changing the unit such as 0.00003kgCH2F2/kgSF6 -> 0.03kgkgCH2F2/tonSF6	Republic of Korea	Rejected	Does not reduce uncertainty to change the units.
902	3	6			Tier 3B Method use subscript "j" to represent the "stack system" in equations 6.14 and 6.15 but equations 6.16-6.18 use "s" to describe the same notation. It may confuse the reader.Is it possible to use the same notation for the same description in the same section?	Thailand	Noted	Addrssed in the final draft.
6920	3	7	83	84	It wolud be better to add revised or newly added contents first (in front of introduction) like Chapter 6.	Republic of Korea	Noted	The refinement Final Drafts have been formatted in a manner consistent with IPCC task-force recommendations, in order to highlight to users: (i) where text has been updated; (ii) where there is new guidance; and (iii) where there has been no refinement.
7578	3	7	190	191	Table 7.3B includes data only from Article 5 Parties. Please add similar data from Non-Article 5 Parties because the share between different sub-applications can vary considerably. Especially the share of Commercial Refrigeration can be considerably higher in many countries.	Finland	Accepted	
6518	3	7	292	292	The link to the HFC guidance sheets on the Ozone Secretariat website doesn't work. The Secretariat is building a new website and the link will need to be updated.	United Kingdom (of Great Britain and Northern Ireland)	Accepted	
7582	3	7	541	544	Please extend Table 7.9 to include more subcategories also in other categories than Mobile A/C. If possible, the equipment types could also be separated according to their power/capacity. In addition, we suggest that an appendix would be created where examples from different countries could be gathered on the different subcategories/equipment with the national/country-specific emission factors.	Finland	Accepted with modification	It is difficult to find a common matrix for different equipment types in different regions. In order to provide the readers with more possibilities than only table 7.9, we have included three tables in Appendix X showing emissions factors from German, Californian and Japan studies.
7580	3	7	566	623	The reported data according to Article 19 of Regulation (EC) No 517/2014 (F-gas regulation) should be added as an example of a useful data source for the inventory data for EU member states. The data is accessible via the EU's F-gas Portal.	Finland	Rejected	Data from the EU f-gas Portal is not publically availalbe.
6520	3	7	576	576	Suggest saying 'Countries that have ratified the Kigali amendment to the Montreal Protocol will have to report consumption and production data annually.'	United Kingdom (of Great Britain and Northern Ireland)	Accepted with modification	The sentence now specifies that consumption includes production, import and export
6922	3	8	5	5	There are no the phrase like "Parts in brackets – comments from Authors/issues that may be refined" in Chapter 6 or "Bracketed text – characterization of guidance as new, updated, and/or elaborated" in Chapter 7.	Republic of Korea	Accepted	Change made on final draft

Comment ID	Volume	Chapter	From line	To line	Comment	Country	Response	Authors notes
6924	3	8	69	70	It wolud be better to add revised or newly added contents first (in front of introduction) like Chapter 6.	Republic of Korea	Accepted	Change made on final draft
7584	3	8	444	484	Some estimates of the share of this emission source from the total F-gas emissions of a country could be presented in this chapter in order to estimate whether this could be a key category in some countries. When no default emission factors are available the inclusion of this emission source to the inventory can be a very demanding task bearing in mind the often very limited resources for the inventory work in many countries. The description of the methodological framework needs to be kept in the appendix until default emission factors become available.	Finland	Rejected	The format for including this new source category to Chapter 8 was discussed and agreed to with the IPCC Task Force Bureau. The description of the methodological framework is already in the Appendix.
5772	3	Appendix	1	5	Does the IPCC plan to address reabsorption of CO2 through carbonation within the cement industry, which is previous discussed in the 2006 IPCC Guidelines? This would require revision to Volume 3 Chapter 2, or perhaps adding discussion/methodology into an appendix similar to Fluorinated Compounds Emissions from Textile, Carpet, Leather and Paper	United States of America	Noted	No action can be taken because comment is out of scope of 2019 Refinement. This was not included as part of IPCC refinement mandate. The authors thank the reviewer for highlighting this issue, which we note as potentially of interest for future IPCC research.
7108	3	Cover page			See our comment to Vol 1, Ch. 8, line 110-118.	Norway	Accepted	The authors thank the reviewer for highlighting these new F-gas observations. The electronics authors recognize PFTBA as a popular heat transfer fluid used in electronics manufacturing. Although the compound's GWP and atmospheric lifetime have not been published in the peer-reviewed scientific literature, research by the manufacturer, as well as the compound's perfluorinated structure, indicate that it has a very long atmospheric lifetime and a 100-year GWP near 10,000. Guidance on estimating emissions of this and other fluorinated liquids is provided in Chapter 6 of the Refinement. Research into the other compounds indicates that they are used in a variety of applications, some of which are addressed in the 2006 IPCC Guidelines. For example, PFPHP is used in cosmetics and medical applications, whose emissions of perfluorinated compounds are addressed in Volume 3, Section 8.3 of the 2006 Guidelines (Use of SF6 and PFCs in Other Products). The authors will note the other substances as potentially of interest for future IPCC research.
9216	3	3	1397	1483	The method for estimating CO2 emissions from H2 production should be similar to that for CO2 from ammonia production (both use steam methane reforming). The emission estimation method for ammonia production includes a carbon oxidation factor (COF), but not that method for H2 production. Suggest to include such factor in the method for H2 production. The current method assumes 100% oxidation.	Canada	Rejected	It is not assumed to be 100% oxidation, but all other production processes for hydrogen is accounted for in other sectors. Hence, including them in the hydrogen sector would lead to double counting.
9218	3	6	525	530	Does the factor AB(i, CF4) assume that there is NF3 or F2 exhaust formed with all types of process gas consumed? Or is this factor only considered if NF3 or F2 is the process gas? Is there a summary of AB(i, CF4) default values located somewhere in the document (I could not find these values in Table 6.3 for a Tier 2A methodology)? There are two default values provided in line 529 and 530 but I cannot see where these values were referenced. There is another version of this same statement as Note 6 of Figure 6.4 (lines 1253-1257). PLease clarify.	Canada	Noted	The authors clarified the procedure to account for CF4 formation within abatement systems and introduced a new equation (6.6B to be relabeled 6.7) with an option to use default values for AB(i,CF4) as indicated in the definition of equation 6.6B.