Review Comments by Experts 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	Expert	Response	Authors notes
7546	3	0			During the review exams, we learned, that the 'IPCC guidance has been structured so that any country, regardless of experience or resources, should be able to produce reliable estimates of its emissions and removals of these gases. In particular, default values of the various parameters and EFs required are supplied for all sectors, so that, at its simplest, a country needs only supply national AD. The apporach also allows countries with more information and resources to use more detailed country-specific methodologies while retaining compatibility, comparibility and consistency between countries.' However, the way the guidance is proposed now is not fulfilling this statement. Some of the parts in the IPPU are written in very difficult and hard-to-understand ways, which will not help the countries to report and understand the processes in easy way.	Eva Krtkova	Noted	Through the IPCC report preparation process for the IPPU Volume refinement, the Lead Authors, Co-ordinating Lead Authors and Review Editors have together sought to ensure that the guidelines are sufficiently detailed, clear and consistent, to provide a range of methods for countries to apply. We acknowledge that some IPPU source methodologies are more complex than others, reflecting the range of parameters that are necessary as inputs to generate emission estimates. We consider the output in the Final Drafts to be proportionate and consistent across the IPPU Volume, reflecting current scientific knowledge for each source category, and considering the range of methods required to enable reporting where resources for national inventory compilation may be more limited.
1432	3	3	192	193	Edit Table 3.3 footnotes -- "Old (pre-1975) plants means that the EF is to be used for all process technologies that were installed before 1975 and that are still operating."	Robert Lanza	Accepted	
1434	3	3	192	193	"** Applies to all single-pressure plants using all levels of N2O abatement measures… these abatement measures include all levels of abatement..." The application of single EF to all levels of abatement for single pressure plants (whether low, medium, or high pressure) suggests that the effectiveness achieved by each level of abatement is the same for all types of single pressure plants and for all types of abatement. Similarly for dual pressure plants, the EFs are the same regardless of the level of abatement technology applied. The rationale for this assumption should be explicitly addressed in the footnote and/or text of this section.	Robert Lanza	Noted	The number of acid nitric plants in the world is reduced and there is no a variety of both process technologies combined with the different levels of abatement (secondary catalyst is the most common abatement type). The implied emissions factors in most of the countries show similar values independently of the single pressure technology and the level of abatement. In addition, a breakdown of EFs by level of abatement would correspond to a level of detail of a tier 3. From the measurements done to Joint Implementation and Clean Development Mechanism projects (monitoring reports are available on the registers of UNFCCC website), it appears that there are no big differences among low, medium and high single pressure plants final emission factor when using different abatement technologies (although the most common one is secondary catalyst). On the contrary, it appears to be that these final emission factors are more dependent on the age of the technologies (at least they are very high in developing countries). The EF proposed is very conservative as this is the approach followed by the IPCC Guidelines in all categories for tiers 1 and 2. For the dual pressure technology only the difference in the EF resulting from measurements in both dual L/M and dual M/H was taken into account (1 kg N2O per tonne HNO3) and applied to the conservative factor of 2.5. The implied emissions factors from the Annex I inventory submissions confirmed the order of magnitude of the EFs proposed.
368	3	3	798	967	Equipment Leaks: This is unnecessarily over-complicated. The extent of this leakage is alreadfy included in process efficiencies if Tier 2 methodology is followed. Consequently, as a minimum, the good practice should be to assess the extent of these emissions to establish whether or not they are significant. The methodology should then be appropriate with appropriate default factors. Currently the methodology is opaque, relies heavily on work by USEPA that is over 20 years old and many of the important parameters are missing. So much space in the Guidelines for such a relatively unimportant loss process gives a false emphasis.	Archie McCulloch	Rejected	A discussion of equipment leaks is an important addition to the methodology as these emissions can be a significant component of overall production and transformation process emissions, and the degree of emphasis in section 3.10 is appropriate. In general, where data are available, the emissions from equipment leaks do vary from facility to facility. The equipment leak emissions on average are 25 to 40 percent of the total production process emissions (median values vary from 10 to 40 percent over time). We also note that as facilities begin to improve control of process vents and process vent emissions decrease, the relative percentage of equipment leaks has increased over time.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
368 (c'd)								We agreed with the commenter that equipment leak emissions are inherently included in the calculation under Tier 2. We also agreed that the leak determination framework is dated, however, there is no reason to believe that the framework is not correct. For example, the general approach for estimating equipment leak emissions based on the Correlation Approach or the Unit-specific Correlation Approach continue to be an appropriate approach. Moreover, there is no reason to believe that the leaking of fluorochemical gases through chemical manufacturing piping, valves, flanges, and seals would be significantly different than the leaking of more traditional organic chemicals for which the equipment leak protocol was derived. We note that under a Tier 3 methodology, measurement or process knowledge of the actual F GHG component is made or used. With respect to the commenter suggestion that default factors for equipment leaks should be used, these would be appropriate for Tier 1, however, for Tier 3 a site-specific measurement is appropriate, as reflected in use of the Screening Approach, Correlation Approach, or Unit-Specific Correlation Approach. Commenters indicated that the methodology is complicated and opaque. We agreed that the equipment leak methodology may be complicated, especially if the inventory compiler does not have experience in estimating equipment leak emissions. The discussion included in the guidance is a streamlined version of the approaches outlined in the U.S. EPA Equipment Leak Protocol document, and inventory staff may refer to the Protocol document for more information (the reference to the original EPA document is included in section 3.10).
370	3	3	807	808	The assumption that the USEPA data, for organic compounds in general, can be applied directly to fluorinated chemicals needs to be substantiated in some way.	Archie McCulloch	Accepted	Additional text has been included in the section discussion. We agreed that the equipment leak approaches were developed primarily for estimating volatile organic compound emissions. In addition, we also noted that the equipment used for production of chemicals that emit VOCs and the equipment used for production of fluorochemicals that emit fluorinated GHGs are similar. The choice of equipment component used is mostly based on the physical state of the chemical (gas, liquid) and the temperature and pressure of the process stream. For a given set of physical parameters, differences in the chemical properties between hydrocarbon and fluorochemicals are not expected to significantly affect the leak rate from valves, flanges, seals, etc. In addition, the U.S. EPA Equipment Leak Protocol document does include some information on speciating emissions, non-VOCs, and inorganics that may be helpful in developing an appropriate approach. We do emphasize, however, that the measurement principle for the monitoring equipment must be capable of detecting fluorinated compounds. Fluorinated compounds typically have dramatically different response factors than hydrocarbons, and in some cases, have little to no response on analytical equipment commonly used for hydrocarbon leak detection. Appropriate analytical principles must be used for measurement of fluorochemicals.
372	3	3	842	847	Parameters need to be subscripted	Archie McCulloch	Accepted	The appropriate subscripts have been added to the variable definitions for Equation 3.43B.
1650	3	3	854	854	"+/-10 percent" here?	Robert Lanza	Rejected	We are not clear on what the reviewer referred to on this line of the draft document, and because there was no clear context for the comment, we were not able to respond to the comment.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
374	3	3	867	868	The regression equation is not mentioned anywhere in the text, either before or after the intercept and slope appear in this equation. At the very least, this needs a reference.	Archie McCulloch	Accepted with modification	In the paragraph before Equation 3.43C, the Unit-Specific Correlation Approach is discussed, including the need for measurements and data gathering necessary to develop the correlation between the screening value and the mass emission rate (i.e., the correlation or relationship developed between the screening value and the mass emission rate <u>is</u> the regression equation). What the reviewer may be suggesting is that the values of the slope and intercept should be provided somewhere in the guidelines. The values of the slope and intercept should be evaluated at the facility, process, unit, etc. and are not provided in the guidelines. To help clarify that the regression equation <u>is</u> the correlation, the term "regression equation" has been added to the discussion. We also included an additional note for each definition of the regression variables, i.e., for the intercept (B0) and slope (B1), to link them back to the measurements, data gathering, and correlation.
376	3	3	867	869	Parameters need to be subscripted	Archie McCulloch	Accepted	The appropriate subscripts have been added to the variable definitions for Equation 3.43C.
382	3	3	871		Presumably the Beta parameters are from the unspecified regression equation.	Archie McCulloch	Accepted with modification	In the paragraph before Equation 3.43C, the Unit-Specific Correlation Approach is discussed, including the need for measurements and data gathering necessary to develop the correlation between the screening value and the mass emission rate (i.e., the correlation or relationship developed between the screening value and the mass emission rate <u>is</u> the regression equation). What the reviewer may be suggesting is that the values of the slope and intercept should be provided somewhere in the guidelines. The values of the slope and intercept should be evaluated at the facility, process, unit, etc. and are not provided in the guidelines. To help clarify that the regression equation <u>is</u> the correlation, the term "regression equation" has been added to the discussion. We also included an additional note for each definition of the regression variables, i.e., for the intercept (B0) and slope (B1), to link them back to the measurements, data gathering, and correlation.
2752	3	3	917	918	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Accepted	We agreed with the commenter and have added the appropriate citation format.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
378	3	3	939	940	It cannot possibly be "good practice to assume that the mass emitted consists of the fluorinated GHGs listed in Table 3.28b in the proportions provided". The substances that escape from equipment are process (and product) specific. Application of the Guidelines as written would suggest emissions of NF3 or PFC-14 from a plant producing HFC-134a, which is nonsense.	Archie McCulloch	Noted	We anticipated that use of the default emission factor in Table 3.28A along with use of the default representative composition in Table 3.28B in essence provides a fluorinated GHG default emission factor. For example, the default EF value of 0.04 kg fluorinated GHG emissions/kg fluorochemical produced times the production value in kg fluorochemical produced times 0.12 perfluorocyclobutane would provide a de facto default emission factor of 0.0048 kg perfluorocyclobutane/kg fluorochemical produced. We anticipated that the default representative composition provided in Table 3.28B would be used when the compiler does not have understanding of the fluorinated GHG emitted from fluorochemical production in the country, region, or facility. We fully agreed with the commenter that the fluorinated GHG emitted from equipment is specific to the process and product. We would not want to suggest that a fluorinated GHG be reported as emitted in the inventory when it is known not to be. We agreed that when the emissions are well understood or even when partially understood, this knowledge should be used to determine the specific fluorinated GHG to include in the inventory. In instances where it is known based on process knowledge that a particular fluorinated GHG would not be emitted, it would be inappropriate to include that GHG in the emissions estimate, as would leaving off a fluorinated GHG that was known to be emitted. We anticipated that the compiler would use the best information available.
378 (c'd)								When the default emission factor is used to determine if the source is a key category, the inventory compiler would need to apply a GWP to the mt emissions. In this instance, an alternative to using an assumed chemical composition, as would be done with Table 3.28B, is to provide a representative default GWP. This would need to be determined based on industry, facility, and process knowledge about the country-specific emission profiles.
2914	3	3	954	954	Lack comma in bibliographic citation	Poot-Delgado Carlos Antonio	Accepted	We agree with the commenter and have added the appropriate citation format (added comma after O'Connell).

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
380	3	3	966	967	"When less is known about the plant and processes, it is good practice to use the default emission factor in Table 3.28a." is only acceptable if the uncertainty in the default factor is reduced. Currently the range is from 0.001 to 0.2. Furthermore, the description of the method to calculate this shows that it is the factor for TOTAL emissions from the chemical plant, the risk of double counting should be recognised in the text.	Archie McCulloch	Accepted with modification	Use of the default emission factor provided in Table 3.28A for "all other fluorochemicals" is for a Tier 1 emission estimate. As the commenter noted, the emissions from multiple emission sources such as process vents, equipment leaks, and container venting are included in the default emission factor. When using the Tier 1 default emission factor, an inventory compiler will be able to include the emissions from each of these emission sources and would not need to estimate these using another approach. It is not anticipated that another approach would be necessary for estimating the emissions for these sources and therefore doublecounting of emissions is unlikely. If additional information is available on the production processes and container venting, then perhaps another tier to estimate emissions would be appropriate. The Tier 1 methodology encompasses a default emission factor (for all other fluorochemicals) that was developed for production and transformation processes of different types, products, and facilities, and therefore tends to have a higher uncertainty. While the uncertainty for applying the default emission factor to a single facility is high, use of the factor in the inventory across multiple facilities gives a lower level of uncertainty, as discussed in the section. We would like to note that the 2006 Guidelines does not present the uncertainty for the previous default emission factor (0.005), and there is no way of knowing whether the uncertainty for that value is any better or worse than the new refined default emission factor presented for the 2019 Refinements Guidelines. With respect to the reviewer's concern regarding double counting emissions, we added a note to the discussion that when the Tier 1 calculation is conducted, the default emission factor is multiplied by the total mass of fluorinated chemical produced. It is not anticipated that there would be any double counting in this instance.
7468	3	3	1060	1736	Some statements are reiterated several times enlarging the chapter 3.11 and makes it difficult to extract new information. E.g. the statement to ensure that no gaps and double counting occur or that it is good practice to estimate emissions from hydrogen production by using the methodological guidance in Vol. 3 IPPU if hydrogen is produced as an intermediate product in industries (refineries, ammonia, methanol). I propose to concentrate this statements at one place and to highlight it.	Jens Reichel	Rejected	Essentially all the text is needed, as the text will be used as a method reference, and not be read as a book. Hence, the information is placed together with the details so that it is likely to be read when it is needed. One sentence in the introduction to section 3.11.2.1 has been removed as a response to the comment.
7474	3	3	1063	1064	This phrase defines the general scope of the new section 3.11 but table 3.29 (lines 1156 - 1157) also defines exclusions from that. I propose to concentrate a clear scope with all exceptions at the beginning of that section.	Jens Reichel	Rejected	The next paragraph (lines 1065 - 1069) defines the exceptions. This is considered sufficient for an introduction.
3988	3	3	1072		Replace "does" with "do"	Andrea Tilche	Accepted	
2916	3	3	1075	1075	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Accepted	The text has been modified.
2918	3	3	1084	1084	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Accepted	The text has been modified.
3506	3	3	1090	1092	In earlier guidelines there have not been mentioned that emissions from biological feedstocks in IPPU sector have to be reported in memo item. This need to report use of biomass as feedstocks in 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.	Pia-Kristiina Forsell	Rejected	It is within the scope of hydrogen production, which is within the TOC.
3990	3	3	1095		"for example" should be written in full	Andrea Tilche	Accepted	
1436	3	3	1107	1107	Edit "… activity data may not be sufficient to enable separate…"	Robert Lanza	Accepted	

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
1438	3	3	1109	1111	Text Box 3.16 refers to the circumstances under which emissions from hydrogen production would be reported under Refineries or under Ammonia Production; the text in this section should refer to Text Box 3.16 to provide guidance on when emissions from hydrogen production are to be reported under these processes and when emissions from hydrogen production are to be reported under Chemical Industry/Hydrogen Production. This is not only a matter of "national circumstances" as is referred to in Line 1109	Robert Lanza	Rejected	The reference to Text Box 3.16 is considered clear enough. Moreover, the reference to "national circumstances" is deliberately leaving some space for interpretation, in order to make the guidance pragmatic for the inventory compilers.
1440	3	3	1136	1137	Edit "… Hydrogen gas not defined as pure is defined as a "gas mixture" that contains compounds other than H2.	Robert Lanza	Accepted	
1442	3	3	1139	1139	Syngas and other gas mixtures may be produced by other means besides partial oxidation (see technologies listed in Table 3-29)	Robert Lanza	Accepted	Text is revised into: "...produced by technologies partially oxidising the feedstock."
1444	3	3	1171	1171	"Current sector" refers to the Hydrogen Production part of this chapter?	Robert Lanza	Accepted with modification	No, the sector of the main product. Text revised accordingly.
7470	3	3	1182	1195	The rules for reporting recovered CO2 as emission of the Hydrogen production sector or not should be in alignment with the rules of reporting recovered CO2 in ammonia production (Vol. 3 chapter 3.2 Box 3.1 on p. 3.14 of the 2006 IPCC guidelines).	Jens Reichel	Accepted	Two changes have been made throughout the chapter: 1) The requirement to document the subsequent emissions in other sectors and/or the permanent storage to be allowed to subtract the recovered CO2 from the hydrogen sector is now withdrawn. 2) The text now specifies that the emissions should be allocated to the downstream manufacturing sector.
1446	3	3	1183	1183	Edit "… permanent storage, or may be emitted to the atmosphere."	Robert Lanza	Accepted with modification	Revised according to the idea in the review comment, but more elaborated to increase clearity.
1448	3	3	1187	1188	Edit "… if emissions from the downstream sector are not…"	Robert Lanza	Accepted	
1450	3	3	1190	1190	Edit "… If the downstream emissions are not reported in the corresponding sectors…"	Robert Lanza	Accepted	
3992	3	3	1191		"emission" should be "emissions"	Andrea Tilche	Accepted	
3994	3	3	1194		Some words are missing in the sentence. I do not understand "emission the Hydrogen"	Andrea Tilche	Accepted	"emissions in the Hydrogen"
1452	3	3	1194	1195	Edit "… permanent storage should be transparently described and must be documented in accordance with IPCC Guidelines." According to IPCC Guidelines permanent storage of CO2 is to be documented in order to be credited with reducing CO2 emissions from CO2-emitting processes. If the permanent storage is not adequately documented, no subtraction of CO2 emissions from the process should occur.	Robert Lanza	Accepted	
3996	3	3	1205		"for example" should be written in full	Andrea Tilche	Accepted	
3504	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 information) is better to put in an appendix.	Pia-Kristiina Forsell	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.
1454	3	3	1217	1217	For process combustion sources referred to here, why would N2O emission factors and CH4 emission factors for combustion sources in the Energy Chapter not be applicable here? It is understandable that activity data and emission factors for fugitive emissions of CH4 from these processes may be difficult to obtain, but it should be feasible to characterize the process combustion sources.	Robert Lanza	Rejected	It is in line with the other chemical industry sectors not to include emissions of CH4 and N2O from combustion of fuel derived from the feedstock.
1456	3	3	1229	1229	"… maximum of 2% is reported…" Ths refers to 2 percent of the feedstock? Or 2 percent of the product? Or 2 percent of some other metric?	Robert Lanza	Accepted	The percentage refers to the produced gas. The text has been revised accordingly.
1458	3	3	1233	1233	Edit "… used as a fuel in the production process, in which case CO2 emissions are produced."	Robert Lanza	Accepted with modification	Revised according to the idea in the review comment, but more elaborated to increase clearity.
2920	3	3	1245	1246	Lack comma in bibliographic citation	Poot-Delgado Carlos Antonio	Accepted	The text has been modified.
1460	3	3	1259	1259	Edit "…itself and also in combustion…"	Robert Lanza	Accepted	
1462	3	3	1260	1260	Edit "… efforts are being made…"	Robert Lanza	Accepted	

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
3998	3	3	1262		"for example" should be written in full	Andrea Tilche	Accepted	
1464	3	3	1264	1265	"… and partial oxidation technologies (Table 3.29)…" Partial oxidation technologies are not referred to in Table 3.29. Suggest that this be explained in the text	Robert Lanza	Accepted	Reference to Table 3.29 is removed.
1466	3	3	1266	1266	Edit "…(except for a small residue…)	Robert Lanza	Accepted	
1468	3	3	1270	1270	Text here should explain that syngas processes are not covered in this section, and explain why they aren't covered.	Robert Lanza	Accepted	Explanation is given in the end of the paragraph.
4000	3	3	1272		"e.g. sold" - not clear	Andrea Tilche	Accepted	Revised into "(e.g. sold for use in a downstream sector)"
1470	3	3	1283	1283	Edit "… the CO2 emissions should be…"	Robert Lanza	Accepted	
2922	3	3	1290	1291	The text of the flow diagram is not distinguished	Poot-Delgado Carlos Antonio	Accepted	Figure updated in a clearer version.
1472	3	3	1296	1296	The text (note) here should explain how emissions from combustion of gas to produce steam should be reported.	Robert Lanza	Rejected	Figures 3.18 and 3.19 are for showing the most common methods for producing hydrogen gas, not for showing how to report the emissions. This guidance is given elsewhere in Ch. 3.11.
1474	3	3	1316	1316	Edit "… the ratio of consumed feedstock carbon atoms to produced CO2 molecules is 1:1."	Robert Lanza	Accepted	
2924	3	3	1319	1319	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Accepted	The text has been modified.
1476	3	3	1327	1327	See comment under Line 1270; this explanation should be moved forward in the text	Robert Lanza	Accepted with modification	Text is revised in accordance with comment id 1468, but is not moved as it belongs under the sub-title "Partial oxidation technologies"
1478	3	3	1336	1336	Edit "… the feedstock may be natural gas…"	Robert Lanza	Accepted	
1480	3	3	1339	1449	Edit "… Surplus hydrogen might be separated from the syngas and purified…"	Robert Lanza	Accepted	
2926	3	3	1340	1340	check chemical formula	Poot-Delgado Carlos Antonio	Rejected	CO is correct.
1482	3	3	1340	1340	Edit"… ratio in the syngas for downstream use."	Robert Lanza	Accepted with modification	Revised according to the idea in the review comment, but more elaborated to increase clarity.
2928	3	3	1345	1346	Verify bibliographic citation format of source	Poot-Delgado Carlos Antonio	Accepted	The text has been modified.
1484	3	3	1351	1352	Edit "… splitting, do not emit direct GHG emissions but do have emissions arising…"	Robert Lanza	Accepted with modification	Changed into "...splitting, are without GHG emissions in the hydrogen production process." This aviods using the term "direct emissions", which may be confusing. Emissions arising from producing the electricity, production equipment, etc. is not part of the hydrogen sector. This is in line with the overall principles in the GL and should not need mentioning.
1486	3	3	1359	1359	Edit "…Methane and CO2 being produced are parts of the fermentation gas product…"	Robert Lanza	Accepted	
1488	3	3	1366	1366	Edit "… or hydrogen production capacity…"	Robert Lanza	Accepted	
1490	3	3	1371	1371	This reference is circular; "either of the methodolgical approaches" would be two approaches, the parentheses (ammonia, methanol, and hydrogen) refer to three approaches;	Robert Lanza	Accepted	"...either" is replaced with "...one".
1492	3	3	1371	1371	Suggest including text describing how the ammonia and methanol methodologies are to be used in this case.	Robert Lanza	Accepted	Generic guidance has been provided. The paragraph has been moved to the end of the introduction to Ch. 3.11.2.1.
4002	3	3	1378		There is a typo "insofar" - it seems.	Andrea Tilche	Accepted	
1494	3	3	1385	1386	"Recovered CO2 from the process is typically..." The methodology should account for the possibilty that CO2 produced by the H2 production process could be vented directly to the atmosphere and not be stored or used in a downstream process.	Robert Lanza	Rejected	This guidance is about recovery. If the CO2 is vented directly to the air, it is not recovered.
1496	3	3	1386	1386	Edit " … permament storage."	Robert Lanza	Accepted	
1498	3	3	1426	1426	Edit "… in Ch. 1. vol. 1…"	Robert Lanza	Accepted	
1500	3	3	1426	1426	"Guidelines(5)" -- footnote 5 does not appear on this page.	Robert Lanza	Noted	After revising other parts of the text, it now does.
1502	3	3	1457	1457	"CO2 recovered" The methodology should account for the possibilty that CO2 produced by the H2 production process could be vented directly to the atmosphere and not be stored or used in a downstream process.	Robert Lanza	Rejected	If the CO2 is vented directly to the air, it is not recovered.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
1504	3	3	1463	1463	"whether internal or external energy sources are used…" Suggest adding text here explaining how GHG emissions from internal energy sources and external energy sources are to be reported.	Robert Lanza	Rejected	Box 3.16, which is referrenced in the end of the paragraph, is explaining this.
7472	3	3	1480	1484	It is possible that inventory compiler gets information about the produced hydrogen amount in m3 instead of tonnes. Than a uniform conversion factor from m3 to tonnes should be used that is also published in the updated IPCC guidelines.	Jens Reichel	Rejected	Hydrogen production in tonnes gives the absolute amounts. Volume to mass conversion should follw national standards. This is in line with general GL principles. One sentence added to the text to clarify this.
1506	3	3	1493	1493	"CO2 recovered" The methodology should account for the possibilty that CO2 produced by the H2 production process could be vented directly to the atmosphere and not be stored or used in a downstream process.	Robert Lanza	Rejected	If the CO2 is vented directly to the air, it is not recovered.
7478	3	3	1508	1508	The possibility to use a Tier 2 method if plant specific factors are not available does it include also the ecxeption of the Tier 2 method in line 1472 to use the Tier 1 method?	Jens Reichel	Noted	Line 1472 revised: "...are not available and hydrogen production is not a key category". Now the exception in line 1514 is in line with the general GL methodology, and any further explanation is considered not necessary.
2930	3	3	1567	1568	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Accepted	The text has been modified.
1508	3	3	1567	1568	"Mixed waste gasification" is there a ratio of biogenic / non-biogenic waste content being assumed here for this EF? If so the EF table should include a footnote noting that the the waste is assumed to contain x percent biogenic material and y percent nonpbiogenic material.	Robert Lanza	Noted	The ratio of biomass/non-biomass is not specified for the carbon content factor in the reference material (Wallman et al., 1998).
1510	3	3	1592	1595	This text should be moved forward into the introduction to the hydrogen production section.	Robert Lanza	Rejected	Box 3.16 on double counting says the same thing, just with another wording. The box is referenced in the introduction. This is considered sufficient.
1512	3	3	1593	1593	Edit "… if the fuel is derived from the feedstock…"	Robert Lanza	Accepted	
1514	3	3	1621	1622	Edit "… if the fuel is derived from the feedstock…"	Robert Lanza	Accepted	
4004	3	3	1674		"for example" should be written in full	Andrea Tilche	Accepted	
4006	3	3	1676		"for example" should be written in full	Andrea Tilche	Accepted	
1516	3	3	1682	1685	If the permanent storage of CO2 is not properly documented the amount of CO2 assumed to be recovered and stored (and subtracted) should be zero for the purposes of inventory calculations, and there would be no reason to include a non-zero factor in the uncertainty analysis in this case. Only CO2 storage that is properly documented should be credited as a subtraction at any point in the inventory process, including in the uncertainty analysis. If the permanence of the CO2 storage is not properly documented there should be no uncertainty whatsoever in the assumption that the subtraction is zero in this case. Suggest deleting the 20 percent assumption here.	Robert Lanza	Noted	The principle for accounting for recovery has been changed, according to review comment 7470. Hence, the basis for this review comment is no longer there.
1518	3	3	1687	1687	Edit "… Where the activity data are obtained…"	Robert Lanza	Accepted	
1520	3	3	1721	1721	Edit "… specific data are required…"	Robert Lanza	Accepted	
7476	3	3	1728	1735	The mentioned requirements for reporting and documentation are very unspecific for traceability or review. Please list some specific requirements as a common base like it is the case for nitric or adipic acid. Also the requirement to describe where in the inventory other hydrogen production is reported according to the scope of the section 3.11.	Jens Reichel	Accepted	Elaborated text has been provided.
1522	3	3	1732	1732	Edit "… process data are considered…"	Robert Lanza	Accepted	
7458	3	3			regarding storage of mineral oil products used for chemical industry as feedstock, in Vol 2 Chap.4 is a reference to the IPPU sector but I couldn't find where to report those emissions (except for ethylene on page 3.74 in 2006 GL- unchanged text) - please also provide a typical emission factor for major feedstocks	Jens Reichel	Noted	No action can be taken because comment is out of scope of 2019 Refinement. The page 3.74 in 2006 GL is in the sub sector 3.9 Petrochemical and carbon black production (no refinement)

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
4642	3	3			The use of flaring in the chemical industry is not described at all. It would be very relevant to describe the types of chemical industry where flaring is most frequently occurring and provide guidance on how to estimate and where to report emissions. Noting that the flaring in the energy sector currently is for oil and natural gas production/treatment and hence does not necessarily covers the possible flaring associated with all types of chemical industry.	Ole-Kenneth Nielsen	Noted	No action can be taken because comment is out of scope of 2019 Refinement. The flaring in the chemical industry is descibed in the sub section 3.9 Petrochemical and carbon black production. And noted that the most of CO_2 emissions from flaring are deducted in the carbon mass balance because the corresponding emissions are estimated with the methodology described in Chapter 4 Volume 2
292	3	4	207	207	This line is shaded but there's a stylistic change in subparagraph marks. It would be better to use the IPCC 2006 version.	Sergii Shmarin	Rejected	The shading is meaning that the parts were not revised.
1524	3	4	245	245	Figure 4.1 does not illustrate other carbon-containing materials that may be used in iron and steel production including limestone/dolomite, that woul be included in the mass balance method. Can the figure e edited to add other inputs to the iron and steelmaking process?	Robert Lanza	Rejected	The limestone and dolomite consumption for iron and steel production CO2 emissions have to be accounted in Lime production category. This is why the Figure 4.1. will not be changed in this 2019 Refinement.
1526	3	4	255	255	Edit "but not GHG emissions"	Robert Lanza	Accepted	GHGs → GHG emissions
4008	3	4	257		The verb "occur" should replace "occuring" - it seems.	Andrea Tilche	Accepted	occuring → occure
1528	3	4	257	258	Edit "where GHG emissions occur. The term coking..."	Robert Lanza	Accepted	
1530	3	4	258	258	Edit "a thermal distillation process"	Robert Lanza	Noted	
1532	3	4	259	260	Edit "volatile matter from the coking coal, in the form of gases or liquids, to produce coke. Related to the treatment…	Robert Lanza	Accepted	
1534	3	4	261	261	Edit "including coal tar and light oil"	Robert Lanza	Accepted	like→including
4010	3	4	268		There is a typo "under in"	Andrea Tilche	Accepted	
1536	3	4	271	271	Edit "Fugitive emissions consist of"	Robert Lanza	Accepted with modification	comprise → consist
1538	3	4	278	278	Flaring may occur for other reasons besides emergencies and consumer maintenance.	Robert Lanza	Accepted	The text was changed to "among other reasons" in line 278 and Table 4.1A (line 298).
2356	3	4	297		Table 4.1 It is stated that the European EF includes CO as it eventually oxidises to CO2. This could be interpreted as being inconsistent with how emissions are reported, since CO is reported separately as indirect greenhouse gas emissions.	Ingrid Mawdsley	Accepted with modification	CO gas is leaked to some extent from the process, so human has detector in case of approaching body of facilities/BF etc. but amount of emissions are limitted.
1540	3	4	298	298	Flaring may occur for other reasons besides emergencies and consumer maintenance; also there may be circumstances in which COG is vented to the atmosphere without being flared; suggest editing Table 4.1a to account for the possibility of venting of uncombusted COG and non-emergency/maintenance flaring of COG.	Robert Lanza	Accepted with modification	The COG vented to the atmosphere occurs in very seldom situations. Being so, the LA´s concluded that the GHG emissions associated to this are negligeble. This was addressed in the FD text.
294	3	4	303	304	Sentence "If the category is key, it is good practice to estimate emissions using a Tier 2 or Tier 3 approach." seems to be excess because it just duplicates the general principles described in Volume 1.	Sergii Shmarin	Accepted	The phrase has been deleted.
1542	3	4	308	308	Edit "data are available"	Robert Lanza	Noted	
4012	3	4	315		There shoud be a comma - it seems.	Andrea Tilche	Noted	
1544	3	4	321	321	Edit "For Tier 1 this assumption is the..."	Robert Lanza	Noted	
4014	3	4	324		Replace "an" with "a"	Andrea Tilche	Noted	
296	3	4	327	327	"...measurement data is…". Please, change "is" to "are".	Sergii Shmarin	Noted	
4016	3	4	329		Table 4.1B - row two fifth column the verb "occurred" is not correct	Andrea Tilche	Accepted with modification	The text has been changed in FD from occurred → conducted
298	3	4	329	330	There is no any comment or limitation for Tier 3a. For example, if we have/use installation-specific Carbon content in coke and other parameters are country-specific, which method is used?	Sergii Shmarin	Rejected	This explanation has been done in decision tree Figure 4.6.
1546	3	4	330	330	Under Tier 1b table cell Edit "...described in the Energy volume should be conducted, as this would be a double counting."	Robert Lanza	Accepted with modification	The text has been changed in FD from occurred → conducted

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
1548	3	4	330	330	Is ISO 14404 being used as the QA Standard for the entire iron and steel and metallurgical coke section? If so the section would merit from including a brief description of the provisons of the ISO 14404 QA requirements.	Robert Lanza	Accepted with modification	The line would be modified without refering to QA standard of ISO 14404.
1550	3	4	331	332	Edit "Tier 1 and Tier 3 methodologies to estimate CH4 emissions are provided for emissions from quenching toweres and stacks. The Tier 1a method uses default emission factors. The Tier 3 method uses measurements."	Robert Lanza	Accepted	Redraft in line 484
300	3	4	331	332	It's strange that there are tiers 1 and 3 for CH4 but tier 2 is not presented. Probably, tier 2 could be approach based on county specific data on CH4 emissions per unit.	Sergii Shmarin	Accepted	Tier 2 por CH4 in IPPU I&S has been included
8550	3	4	331	334	The methodology to estimate CH4 fugitive emissions in Section 4.3.3 Chapter 4 Volume 2 does not include a tier 2 method, but the decision tree of this section includes a description of the tier 2 method. The description should be consistent with Volume 2.	Takuji Terakawa	Accepted	Tier 2 por CH4 in IPPU I&S has been included
4018	3	4	338		Remove "for" after apply	Andrea Tilche	Noted	
1552	3	4	338	338	Edit "the amount of coke produced (tonnes) in the country…"	Robert Lanza	Noted	
1554	3	4	339	339	"the following equation is used" --- The Equation 4.1 text box actually contains two equations (one for CO2 and one for CH4) that should be separated.	Robert Lanza	Accepted	The equations from CH4 and CO2 will be separated in FD.
302	3	4	340	343	Equation 4.1. Let me propose you to change the abreviation "CO" because it looks a little bit confused like CO is Carbon monoxide". One more thing. Indices 2 and 4 for CO2 and CH4 have the same size as for the capital letters (C, H, O).	Sergii Shmarin	Accepted	The FD text will reflect the changes proposed.
2478	3	4	340	343	It is better to describe the two equations in 2 separate paragraphs. For example Equation 4.1(a) and Equation 4.1(b).	Mingshan Su	Accepted	The equations were separated in FD, however the equation 4.1 is for CO2 and the equation 4.1a is for CH4.
1556	3	4	352	352	Suggest establishing a convention to use the terms "coking coal" rather than "metallurgical coal" or vice versa, throughout the document	Robert Lanza	Accepted	Coking coal is commonly used. Metallurgical coal was changed to it in FD text.
2486	3	4	362	362	metallurgical coal should be coking coal	Mingshan Su	Accepted	Coking coal is commonly used. Metallurgical coal was changed to it in FD text.
1558	3	4	362	363	Suggest establishing a convention to use the terms "coking coal" rather than "metallurgical coal" or vice versa, throughout the document	Robert Lanza	Accepted	Coking coal is commonly used. Metallurgical coal was changed to it in FD text.
1560	3	4	363	363	Edit "tonnes C / tonne coke"	Robert Lanza	Accepted	FD text changed according comment made
2660	3	4	363	363	"tonnes C / tonnes coal"should be "tonnes C / tonnes coke".	Xiangzheng Deng	Accepted	FD text changed according comment made
2488	3	4	363	363	tonnes C / tonnes coal should be tonnes C / tonnes coke	Mingshan Su	Accepted	FD text changed according comment made
1562	3	4	366	366	Edit ..."appropriate where national…"	Robert Lanza	Accepted	FD text changed according comment made
304	3	4	367	367	I propose to change the word "are" in "national statistics...are available" to "...is available".	Sergii Shmarin	Rejected	Statistics are plural, therefore "are" is correct, not "is"
1564	3	4	368	369	Edit "The following equation is used with a country-specific carbon content." [tabme 4.3 does not contain country-specific carbon contents; table 4.3 contains material-specific carbon contents/	Robert Lanza	Accepted with modification	FD text changed according comment made
308	3	4	370	384	There is no such a parameter as Cx (or index x) in the equation 4.2 but at the bottom of the narrative they are presented. Please, fix it and unify.	Sergii Shmarin	Accepted with modification	x means general expression for materials, a brief explanation has been added
306	3	4	373	383	The units have been changed from tonnes to kg without necessary reasons compared with IPCC 2006. It can lead to potential mistakes in compilers' activity and complicate the filling of CRF-reporter.	Sergii Shmarin	Accepted	FD text changed according comment made
1566	3	4	377	377	Suggest establishing a convention to use the terms "coking coal" rather than "metallurgical coal" or vice versa, throughout the document	Robert Lanza	Accepted	Coking coal is commonly used. Metallurgical coal was changed to it in FD text.
1568	3	4	382	382	The section would benefit from identfying examples of "b" byproducts including coal tar, light oil, etc."	Robert Lanza	Accepted	Examples added

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
1570	3	4	382	383	Edit "and either transferred off site to other facilities or flared (kg)"	Robert Lanza	Accepted	
1572	3	4	386	386	Edit "are estimated as fugitive emisons using the methodology…	Robert Lanza	Accepted	
310	3	4	392	392	The word "installation" is used in the Table 4.1b but later instead of it the word "plant". Probably, it would be better to unify it.	Sergii Shmarin	Accepted	The text revieved to esure the consistency
1574	3	4	394	397	Edit so that there are three bullet points, not two" 1) For CO2, monitoring of direct sources; 2) for CH4, monitoring of direct sources; and 3) For CO2, carbon mass balance approach…"	Robert Lanza	Accepted	
1576	3	4	398	398	Edit "all direct individual sources"	Robert Lanza	Accepted	
4020	3	4	399		Put "for" after word "account"	Andrea Tilche	Noted	
1578	3	4	401	402	Line 330 refers to QA practices included in ISO 14404; Is ISO 14404 being used as the standard for QA, or recommendations in Volume 1, Chapter 6, or both? The section would benefit from a summary of the relevant requriements of ISO 14404 if the standard is being applied to this section.	Robert Lanza	Accepted with modification	The line 330 would be modified without referring to QA standards of ISO 14404.
312	3	4	407	407	Symbol "2" in "…CO2 emissions" is written as a big symbol.	Sergii Shmarin	Noted	
1580	3	4	407	408	Is there a similar flowchart for CH4 emissions?	Robert Lanza	Accepted	The decision tree for CH4 would be provided similar to CO2.
1582	3	4	407	408	Edit "country-specific carbon contents available?"	Robert Lanza	Noted	
314	3	4	407	408	There is a number of mistakes presented in the different blocks of the figure 4.6. Some of them are: too many symbols ")" or not enough "("; no gaps between the words; change "are" to "is" or "content" to "contents" etc.	Sergii Shmarin	Accepted	
4022	3	4	410		Put "this" instead of this "these" and replace "outline" with "outlines"	Andrea Tilche	Noted	
1584	3	4	410	412	Edit to add Figure numbers to the Figure titles in the text: "Figure 4.7: Decision Tree for Estimation of CO2 Emissions…" "Figure 4.8: Decision Tree for Estimatiing CH4 emissions…"	Robert Lanza	Accepted	
316	3	4	410	412	Could you please unify the category/activity title: "Iron & Steel Production" or "Iron and Steel Production"	Sergii Shmarin	Noted	
4024	3	4	411		Replace "&" with "and"	Andrea Tilche	Accepted	
1586	3	4	413	415	Why is only uncertainty for sinter production noted here? Are pellet production and DRI production equally relevant to the same relianc o assumptions?	Robert Lanza	Accepted	The uncertainty for pellet production and DRI production is equally relevant to the same for sinter
318	3	4	418	418	Symbol "2" in "…CO2 emissions" is written as a big symbol.	Sergii Shmarin	Accepted	
320	3	4	420	421	There're points (".") in the end of the figure blocks. But for the new schemes this symbol is not presented. Please, unify.	Sergii Shmarin	Noted	
322	3	4	423	423	Symbol "4" in "…CH4 emissions" is written as a big symbol.	Sergii Shmarin	Accepted	
1588	3	4	436	436	Edit "production in blast furnaces that is not…"	Robert Lanza	Accepted with modification	
1590	3	4	438	438	Edit "take into account emissions from both iron production and steel production."	Robert Lanza	Accepted	
1592	3	4	441	441	Edit "separately estimate the emissions from national sinter production and national pellet production using Equations 4.7 and 4.8.	Robert Lanza	Accepted	
324	3	4	446	464	Symbol "2" in "…CO2 emissions" is written as a big symbol.	Sergii Shmarin	Accepted	
1594	3	4	477	477	Edit "…is appropriate where the inventory complier has access to national…"	Robert Lanza	Accepted	
7552	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."	Coralie Jeannot	Accepted with modification	The FD text was changed to: Total emissions are the sum of Equations 4.9, 4.10 and 4.11. for those processes that occur in the country.
7554	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 (…)"	Coralie Jeannot	Accepted with modification	FD text was changed to: quantity of coke oven gas consumed in ignition furnace for sinter production.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
1596	3	4	516	518	These other materials are not shown in Figure 4.1, suggest that they be included in the Figure.	Robert Lanza	Accepted with modification	FD text was change to address comment 1596 and anthracite was defined as one of the Pma. However figure 4.1 will not be changed as it is out of the scope of 2019 IPCC Refinement.
2480	3	4	524	528	Since electricity generation is a typical energy sector activity the "emissions from the combustion of blast furnace gas, coke oven gas and converter gas" "to produce electricity in an internal power plant to cover the internal needs" is better to be reported under Energy Sector.	Mingshan Su	Rejected	The Chapter 2 "Stationary combustion" from the Volume 3 explains 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.
2350	3	4	529	531	The paragraph can be interpreted as all emissions from combustion of fuels are to be reported in IPPU. However, fuels (e.g. part of the natural gas) may also be used solely for energy purposes. This is the case in Sweden.	Ingrid Mawdsley	Accepted with modification	FD text changed accordingly to comemnt and a note added in order to clarify that NG has a double role in this type of DRI technology (heat and reducing agent).
1598	3	4	544	544	Edit "defalut carbon contents from Table 4.3"	Robert Lanza	Accepted	FD text changed accordingly to comment
1600	3	4	545	545	Edit "production is a key category."	Robert Lanza	Accepted	FD text changed accordingly to comment
2352	3	4	565	569	It would be helpful to inventory compilers if it was also mentioned whether CH4 emissions from pellets production specifically are relevant or not.	Ingrid Mawdsley	Accepted with modification	There is a paragraph "the possible existance of relevant emissions when anthracites is used"
1602	3	4	570	571	Edit: Unclear from this sentence whether the text is indicating tht CH4 and N2O emissions are "possibly small" or that N2O emissions (but not CH4 emissions) are "possibly small." Can we be concise and state that the CH4 and N2O emissions are expected to be negligible?	Robert Lanza	Accepted with modification	The phrase was deleted as the emissions from flaring will be addressed in a new item in IPPU at the same time it isconsistent with the fugitive emissions text from coke production in the Energy chapter.
326	3	4	570	571	Probably, the word "insignificant" is more appropriative than "small".	Sergii Shmarin	Accepted with modification	The phrase was deleted as the emissions from flaring will be addressed in a new item in IPPU at the same time it isconsistent with the fugitive emissions text from coke production in the Energy chapter.
7556	3	4	572	572	Add the sentence: "Total emissions are the sum of Equations 4.12, 4.13 and 4.14."	Coralie Jeannot	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.
2354	3	4	586	589	Explanation of "DRI" in Equation 4.14 is missing.	Ingrid Mawdsley	Rejected	The X from EFX is DRI
1604	3	4	594	595	Edit: "…and provides a discussion of carbon contents to be used…"	Robert Lanza	Noted	
1606	3	4	603	603	Edit "…recovery of chemicals, and all byproducts are burned."	Robert Lanza	Accepted with modification	FD text was changed
328	3	4	609	609	Term "organic liquids" seems to be in a contradiction with line 36 of the Glossary because coal tars and light oils are a part of coal/coke mass balance having a fossil fuel nature. From the other hand organic liquids are a particular case of organic matter. Otherwise, the Glossary needs clarification.	Sergii Shmarin	Accepted	FD text was changed accordinly to the comment in IPPU sector.
1608	3	4	610	610	Edit "...one-third of the coke oven gas..."	Robert Lanza	Accepted	
4026	3	4	612		I do not understand the use of the word "European"	Andrea Tilche	Accepted with modification	This word is a part of the name of reference
330	3	4	612	612	I propose to add word "ones" after "…European".	Sergii Shmarin	Accepted with modification	This word is a part of the name of reference

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
1610	3	4	615	616	Edit "factor, not including advanced energy…." under "Source" column."	Robert Lanza	Accepted with modification	FD text was changed
332	3	4	615	616	It's better to unify the number of rounding in, for example, 0,5103 tCO2 / t coke and 0,517 tCO2 / t. Moreover, points (".") should be used instead of commas (for all the table).	Sergii Shmarin	Accepted with modification	The Table 4.1 text was incorporated in FD text and the table now presents only 1 CO2 EF for coke production.
1612	3	4	615	616	"lowered to 0.30 tCO2/t coke" -- can we include this emission factor in the "Emission Factor" column as a separate emission factor rather than incuding the emission factor under the "Source" column? The emission factor would be easier for readers to find if it was in the "Emission Factor" column.	Robert Lanza	Accepted with modification	The emission factor column includes the mean value. For more detailed information on the lower EF please look to the source column.
1614	3	4	615	616	"EU Average CO2 Factor…" -- can we include this emission factor in the "Emission Factor" column as a separate emission factor rather than incuding the emission factor under the "Source" column? The emission factor would be easier for readers to find if it was in the "Emission Factor" column.	Robert Lanza	Accepted with modification	The emission factor column includes the mean value. For more detailed information on the lower EF please look to the source column.
1616	3	4	615	616	Edit "up to 20 years old" and "more than 20 years old"	Robert Lanza	Accepted with modification	FD text was changed
1618	3	4	615	616	Edit "…non-recovery byproduct process."	Robert Lanza	Accepted with modification	FD text was changed
1620	3	4	615	616	This table may merit including region-specific emission factors for coke production rather than including only one average emission factor	Robert Lanza	Accepted with modification	The emission factor column includes the mean value. For more detailed information on the lower EF please look to the source column.
334	3	4	615	637	It would be better to mention References in other way. Now, the table looks not friendly use. Moreover, phrases are not aligned and there is too much empty space left. This table has to be modified…a lot.	Sergii Shmarin	Accepted with modification	FD text was changed
1622	3	4	623	624	This table may merit including a specific emission factor for "carbonate-containing ores" rather than only a single emision factor if there are suffcient supporting data to establish a range of values (a factor of two is referred to), rather than including this discussion under the "Sources" column in the table.	Robert Lanza	Accepted with modification	The emission factor column includes the mean value. For more detailed information on the lower EF please look to the source column.
1624	3	4	623	624	This table may merit including region-specific emission factors for sinter production rather than including only one average emission factor	Robert Lanza	Accepted with modification	The emission factor for sinter production has been added.
7558	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).	Coralie Jeannot	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
1626	3	4	636	637	Do the two emission factors for BOF in this table represent regional differences? If so there should be modifying text in the "Steelmaking method" column indicating how (where) each of these emission factors should be applied.	Robert Lanza	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
1628	3	4	636	637	Is the "global average" value still needed here? This value dates from the distribution of iron and steel production techologies that was extant in 2004. This is likely obsolete in 2019; suggest deleting this value	Robert Lanza	Accepted	Global average has been deleted
4640	3	4	655	656	It is not helpful to have a default EF listed as a range of 1-80 g/tonnes as is the case for CH4 from coke production. Without any further guidance, what is the user supposed to do with this? If no better knowledge is available the geometric mean could be listed as the default EF and the uncertainty would then reflect the large range. This has not been corrected between the FOD and SOD.	Ole-Kenneth Nielsen	Accepted with modification	The upper value has been considered for Tier1, that is coherent with other new value reported by Japan.
1630	3	4	655	656	A range of 1-80 is quite large; can this range be qualified in some manner?	Robert Lanza	Accepted with modification	The upper value has been considered for Tier1, that is coherent with other new value reported by Japan.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
3508	3	4	655	656	Default emission factor for CH4 emissions from coke production; according to the source of emission factor, the factor is from a single plant and therefore could not be used as default.	Pia-Kristiina Forsell	Accepted with modification	Japanese EF literature was also used.
4028	3	4	659		The "not" should be replaced with "no"	Andrea Tilche	Accepted	
1632	3	4	659	659	Edit "…if there is no information…"	Robert Lanza	Accepted	
1634	3	4	674	675	Use of default values would be inconsistent with the definition of a Tier 3 method, which depends on monitoring data. Suggest modifying or deleting this discussion that suggests default factors would be used in a Tier 3 method	Robert Lanza	Accepted with modification	There are two options for tier 3: (1) using the monitoring data, (2) using facility specific data for carbon content and input/output data for carbon mass balance. The text in FD was modified to clarify this situation.

3404	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)
						Eunae Seo	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 (same values than in SOD)

336	3	4	679	680	Could you please unify abbreviation "KG" and "kg" and rounding level after point, for example, three symbols after point. In "The amount of CO2 emissions from charcoal can..." symbol "2" became too big for some reason despite the fact that this part is shaded.	Sergii Shmarin	Accepted	
338	3	4	682	682	Strange symbols are presented in my monitor between the numbers in 4.2.2.4.	Sergii Shmarin	Noted	
1636	3	4	717	717	Edit "...sintering, ironmaking, blast furnace steelmaking…"	Robert Lanza	Accepted	
340	3	4	729	729	The word "is" is excess for "...as is shown in Figure 4.8a, according to:" or the word "it" before "is" would be appropriative.	Sergii Shmarin	Noted	
2482	3	4	730	731	Combustion of blast furnace gas, coke oven gas and converter gas for sintering is mainly for energy purpose and it is better to be reported in Energy sector.	Mingshan Su	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.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
2484	3	4	735	739	The emissions from the combustion of blast furnace gas, coke oven gas and converter gas to produce electricity in an internal power plant should be reported in Energy sector even if the electricity is produced to cover the internal needs since producing electricity is for energy purpose and it is a typical energy sector activity.	Mingshan Su	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.
7562	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.	Coralie Jeannot	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.
342	3	4	747	747	Symbol "2" in "...CO2 emissions" is written as a big symbol.	Sergii Shmarin	Noted	
7560	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).	Coralie Jeannot	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.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
1638	3	4	748	749	The note "natural gas, fuel oil, etc, for combustion to be reported under ENERGY" in Figure 4-8a is inconsistent with the text in Line 786-787 that reads "…besides blast furnaces, often using natural gas or coal instead of coke, and these carbon sources should be accounted for in the same manner as coke becase they are being used for the same purpose." Natural gas, coal, fuel oil, and etc., that are being used in the ironmaking process (whether in a blast furnace or other type of ironmaking process) for the same purpose as coke (i.e., as a reducing agent) should be reported in the same manner as the use of coke is reported. See also Figure 4.1 that illustrates direct coal injection into the blast furnace. Fuel oil, natural gas, coal and etc. that is combusted for the purposes of energy, e.g., to generate electricity for export, would be reported under Energy, but the Figure 4-8a footnote as written could mislead the reader as to the distinction between reporting emissions to Energy and reporting emissions to IPPU. Suggest editing the footnote for clarification.	Robert Lanza	Accepted with modification	The note in Figure 4.8a should not be consistent with the text in lines 786-787 because of difference between the processes. The lines 786-787 refer to the direct reduction but not the Figure 4.8a. The Figure 4.1 modified with deletion of the footnote.
4030	3	4	754		Remove the word "has" - it seems.	Andrea Tilche	Noted	
4032	3	4	776		I do not understand "as in the last one"	Andrea Tilche	Noted	
1640	3	4	776	776	The phrase "as in the last one" is unclear; is this phrase referring to the ISO 14404 standard? Or to the 2019 refinement?	Robert Lanza	Noted	
4034	3	4	808	809	I do not see the figures 4.2-4.5	Andrea Tilche	Rejected	The Figures 4.2 - 4.5 are out of scope of the 2019 Refinement. These Figures are in the chapter "4.2.1 Introduction" in the text of IPCC 2006 Guidelines.
4036	3	4	813		Remove "d" in the word "used"	Andrea Tilche	Accepted	
1642	3	4	813	813	Edit "...a real flux of these gases…"	Robert Lanza	Accepted with modification	
4038	3	4	818		Replace the word "choose" with "choosing"	Andrea Tilche	Accepted	
1644	3	4	820	820	Footnote: Suggest defining the term "converted gas" earlier in the section rather than in a footnote at the end of the section.	Robert Lanza	Accepted	The explanation for "Converted gas" provided at the beginning of the chapter.
1646	3	4	845	845	"+/-10 percent" here?	Robert Lanza	Noted	
1648	3	4	845	845	"+/- 5 percent" here?	Robert Lanza	Noted	
344	3	4	850	851	How can be the range of uncertainties the same for tier 1 and tier 2 especially for simple linear equation? If it is so, there is no sence to apply a higher level methoodology because it will not make any influence on common national one. Of course, it can be a key category, but the common rules exist to stimulate countries to make their common uncertainty as low as possible based on priority weak points.	Sergii Shmarin	Accepted	The uncertainty for Tier 1 was recalculated.
8862	3	4	864		In Section 4.3 (Ferroalloy production), it is recommended that IPCC provides methodologies to account for relevant GHG emissions from production of Fe-Vanadium, Fe- Molybdenum and Fe-Titanium alloys.	Mingming Wang	Noted	No action can be taken because comment is out of scope of 2019 Refinement
7864	3	4	867	1492	Section 4.4 Primary Aluminium Production - General information: Many countries proposed CO2 reduction for years to come and are placing or had placed regulations about GHG emissions and requirements (for example taxes and cap and trade). Year baselines are different and reduction objectives could be different too. There could free allowance given by government based on regulated targets. The change proposed could impact the compliance of those regulations and free allowance. We welcomed the proposition to develop a consistent time series but the method must be accurate to avoid any uncertainty increasing.	Christine Dubois	Noted	

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
7918	3	4	867	1492	General comments: it is important to have the most accurate PFC inventory. Including LVAE will be important. But based on the fact - there is no specified sampling method for LVAE, - that only 40% of the aluminum production is targeted, - that the actual data we have for LVAE varies enormously without understanding why, - that the uncertainty are high, - there is no information for smelter using overvoltage to backcast their past result which will be important for GHG cap and trade regulation and - that work is a first step to include LVAE, would it be possible to add this section as a work in progress or actual information and integrate a transition phase to eventually add LVAE PFC emission in the inventory when we will have a sampling method having LVAE PFC included and have more data to consider in the Tier 2 to reduce the uncertainty?	Christine Dubois	Noted	
8668	3	4	867	1492	General comment to PFC accounting	Henrik Åsheim	Noted	The guidelines and EFs are a snap shot of current understanding and so will always have an expiration date - processes/industry is not static . The EFDB is a useful resource to use to keep EFs as up to date as possible. The guidelines are not intended to be as prescriptive as to push users to higher tiers with penalty factors.
7466	3	4	868	870	The intention to use the updated sub-chapter 4.4 in conjunction with the old 4.4 Chapter 4, Volume 3 of the 2006 IPCC guidelines where relevant makes it complex to understand the requirements for GHG emission reporting according to the IPCC guidelines. Please rework the sub-chapter in that way that the new sub-chapter 4.4 can be used instead of the old one.	Jens Reichel	Accepted	An explanatory section at the start of updated chapter 4.4. has been provided summarising with bullet points, the main changes between 2006 IPCC GL's and 2019 IPCC Refinements. This clarifies that (1) Updates have been made to PFC emissions accounting from primary aluminium smelting and (2) New guidance has been given to CO2 emissions accounting from alternative alumina refining processes. However, for CO2 emissions from primary aluminium smelting, users should instead use the 2006 IPCC GL's (sections 4.4.2.1 and 4.4.2.2).
7494	3	4	868	870	It is specified that the DRAFT 2019 Refinement should be used in conjunction with the 2006 IPCC Guidelines. In order to avoid confusion in the future use of the final 2019 IPCC, the inchanged portion of 2006 IPCC should be integrated in the 2019 IPCC. In this way, only one document can be referred in 2019.	Nadia Morais	Accepted with modification	A new explanatory section makes it clear that 2006 IPCC GLs should only be used for CO2 emissions accounting from primary aluminium smelting (outside scope of 2019 IPCC refinments Table of Contents). In all other sections / cases, the 2019 IPCC Refinments should be used in place of the 2006 IPCC GLs.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
7866	3	4	889	903	There is new technology types defined in the 2019 refinement. It is indicated that the growth in technology without fully automated anode effect intervention strategies for PFC GHG emissions has risen from <30% in 2006 to >60% in 2017. in the document "updated factor for calculation PFC emission from Primary aluminium production" indicate that this smelter count AE from 2minutes, below 2 min it is considered as "flash AE". This explain the new technology type "Modern Point-Fed Prebake without fully automated anode effect intervention strategies for PFC emission (PFPBmw). The division of PFPB Legacy and PFPB Modern based on the amperage is not clear. Why PFPB having automatic AE intervention capacity is now divided into 2 technologies as Legacy Point-Fed prebake (PFPB L) and Modern Point-Fed Prebake (PFPB M)? The PFC emission are measured per tonne of aluminium, it includes the effects of amperage and current efficiency (see line 1083 in the document). Also, as the performance of AE will come from alumina injection, AE control automatic system and algorithm independently of the current, I don't understand why it is separated. Does the Tier 2 HVAE slope difference between smelters <350ka and >350ka come from their operation and equipment or from the the amperage? if this subcategory is created based on actual data, it might not be true in the near future with all the change that those smelter does to improve their operation. Alcoa has aluminum smelter operating with amp <350ka and >350ka, we see difference in the AE duration and PFC emission when there is difference with the control system and alumina injection. For smelter having similar alumina injection and similar automatic control system, we have similar AE manual killed, similar AE frequency and similar AE duration independly on the ka.	Christine Dubois	Noted	Separating Legacy from Modern based on amperage can be a bit arbitrary on the margins but the logic of separating the technology into two is driven primarily from the desire to add PFC emissions that are not associated with recorded anode effects into the emissions inventory. The "modern" cells typically have a larger number of anodes, and operate at higher amperage. These cells typically have a lower recorded anode effect frequency, one major factor being that voltage excursions that begin on one or two anodes don't always get propagated into a full anode effect with overall cell voltage exceeding 8V. These voltage excursions in a portion of the cell do, however, release PFC emissions. Therefore these "modern" high amperage cells have a different characteristic ratio of non-AE PFC emissions to AE emissions, that is, the high amperage modern cells typically have higher non-AE to AE emission ratios. Thus, a separate category is defined for those cells that characteristically have low AE emissions but high non-AE emissions.

Yes, the HAVE slope factors are based on actual measurement data, and, perhaps you may be right that these factors might change over time with changes in work practices. The suggested factors are averages of measured data and we know that high voltage PFC emission slope factors are dependent on anode effect duration. If practices change so that anode effect duration distribution changes toward shorter AEs the slope factor will increase – and, similarly, if the anode effect duration distribution tilts toward longer duration, then the slope factors will decrease. The best and most accurate emission factors will result from Tier 3 facility specific measurements, and, remeasurement if work practices and operations data change significantly.

Alcoa has been active in making measurements of emissions to determine facility specific slope factors and this is the most accurate method for PFC accounting. |
8636	3	4	892	892	...without fully automated anode… should perhaps be ...with fully automated anode…	Henrik Åsheim	Rejected	Current wording is correct
8638	3	4	894	903	Is it perhaps enough to divide PFPB in two types - one with and one without automatic AE detection and termination. Latest findings show that HVAE/LVAE is not specific to one or the other, rather it is more dependant on technology and process control.	Henrik Åsheim	Rejected	The logic of separating the technology into two is driven primarily from the desire to add PFC emissions that are not associated with recorded anode effects into the emissions inventory. The "modern" cells typically have a larger number of anodes, and operate at higher amperage. These cells typically have a lower recorded anode effect frequency, one major factor being that voltage excursions that begin on one or two anodes don't always get propagated into a full anode effect with overall cell voltage exceeding 8V. These voltage excursions in a portion of the cell do, however, release PFC emissions. Therefore these "modern" high amperage cells have a different characteristic ratio of non-AE PFC emissions to AE emissions, that is, the high amperage modern cells typically have higher non-AE to AE emission ratios. Thus, a separate category is defined for those cells that characteristically have low AE emissions but high non-AE emissions.
7868	3	4	932	933	I agree with the sentence: " to use higher Tier methods because emission rates can vary greatly, and the uncertainty associated with Tier 1 factors is very high" and it can be added that "and uncertainty associated with Tier 2 still high also".	Christine Dubois	Rejected	Uneccessary wording - uncertainties are clearly stated in the tables.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
7496	3	4	938	941	No refinement was made to the 4.4.2.1 section. However, new quantification formula was now used in the industry for CO2 emissions from prebaked anode consumption. Equation 4.21 substract the impurity (%S and %ash) form the net prebaked anode consumption to calculate CO2 emissions. Insted of that, the COMMISSION REGULATION (EU) No 601/2012, use directly the %C with the net prebaked anode consumption to calculate those emissions. The 2019 Refinement should add a new formula in option of Equation 4.21 to give the opportunity to use the %C.	Nadia Morais	Noted	No action can be taken because comment is out of scope of 2019 Refinement
7870	3	4	944	944	At the section 4.4.2.2 it is indicated no refinement. In the original document, the section of "Choice of emission factors for CO2 emission from primary aluminium production - Tier 2 and Tier 3 emission factors for CO2 emissions - CO2 emissions for Prebake cells (CWPB and SWPB)" still use the formula with %S and %ash in baked anodes to determine CO2 emission coming from anode consumption. A new formula could be add to the actual one to integrate regulation which asking emitter to use %C in the formula instead of % S and % ash to calculate CO2 coming from anode consumption. One of the regulation is the COMMISSION REGULATION (EU) No 601/2012. The request to comply should be integrated in the refinement 2019. The lab car be accredited for % C analysis as well as % S. Two formulas should be available in the IPCC 2019 document, one using %S and%ash and the other using %C in the baked anode. The table 4.11 can be updated adding %C as a alternative of the %S and %ash.	Christine Dubois	Noted	No action can be taken because comment is out of scope of 2019 Refinement
7872	3	4	947	958	The document is presenting new definitions as in box 4.2 for high and low voltage anode effect description. Similarly a new definition should be added to describe the ratio LVAE/HAVE that later is used to estimate low voltage emissions. Since the LVAE could be significant to best AE performer smelters, and there is no process correlation between both LV and HV PFC emissions, the term should be clearly defined as a first step to estimate low voltage emission. Tier 3 will be the only approach to account for both emissions.	Christine Dubois	Accepted with modification	We have removed the T2 ratio method for LVAE emission estimation but it remains an option for a T3 level, along with T3 direct measurement options.
7498	3	4	957	958	Add at the end of the BOX 4.2 : «The LVEA is a concept relatively new and no measurement protocol are actually available to improve consistency and alignment across the industry.»	Nadia Morais	Accepted with modification	Description that LVAE is a new concept is provided in the text body, instead of Box 4.2 as suggested.
4040	3	4	958		Replace the word "doesn't"with does not.	Andrea Tilche	Accepted	Changed in text
8566	3	4	965	965	"release both CF4 and C2F6 emissions" emissions is per definition released, should be rewritten	Ole Kjos	Accepted	Changed in text
7500	3	4	970	970	Change «because the information was not available» for «because the information and the methodology measurement was not available».	Nadia Morais	Accepted	Changed in text
7876	3	4	976	978	Tier 2 is also having a high uncertainty compared to Tier 3.	Christine Dubois	Noted	Tier 2 usually has higher uncertainty than Tier 3 as Tier 3 is site specific.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
7874	3	4	984	987	4.4.2.3 CHOICE OF METHOD FOR PFCS: it is written "In the 2006 IPCC Guidelines, two methods for calculating coefficients for HVAE PFCs were outlined: slope and overvoltage. The overvoltage method is not widely used anymore so this update will cover the methods with reference to the slope model only. If the overvoltage method is still used, it should be adopted at the Tier 3 level only". For country having GHG cap and trade including process emission, it will be difficult to backcast PFC emission and include LVAE for smelter using overvoltage it there is no indication for this method. We need to considered this method as the regulated target are based on past data. It will be difficult to backcast the emission from 2007 if there is no tier 2 factor for overvoltage. We may have historical data updated with LVAE CO2 emissions and some not as the Tier 2 factor won't be available.	Christine Dubois	Rejected	The overvoltage EF from the 2006 guidelines should be used for Tier 2 estimations from 1990 up to 2019. It is only for future estimations that Tier 2 estimates are not recommended. The total number of facilities using the overvoltage method is too low to determine an EF representative of the global industry for national inventories. However, the possibility remains to use Tier 3 EF for future estimations.
8760	3	4	988	998	Using HVAE as a proxy for process control and LVAE emissions is difficult to justify from a theoretical point, as these two phenomenas can ocurr independently of each other, this is reflected in the very high uncertainty (poor correlation) of the data on a matematical level. When looking at Dion et al TMS2018:, in figure 2, variations in LVAE/HAVE ratios is illustrated, and for almost all factories the upper level is more than 3x the lower level, wich suggests that even for individual facilities this is a poor correlation. For some of the plants measured it is difficult to see the span, but this is due to the scale of the y-axis, the variation is large when looking at relative difference between the lowest and highest level for each plant.	Ole Kjos	Noted	We have removed T2 HVAE/LVAE ratio due to the high uncertainties and have added other T3 options.
8640	3	4	990	998	It is true that most smelter do not gather any data that can reasonably calculate LVAE. However, it can be measured by a few different methods (absorbents, canister, high LOD FTIR, (QCL,) etc.), and long-term/continuous measurements should maybe be adressed as a top Tier option?	Henrik Åsheim	Accepted	A Tier 3e method has been provided for the option to account for facility-specific Total PFCs using direct measurements.
7878	3	4	991	995	IPCC or IAI should have a team who works on on a methodology to standardise the measurement of LVAE PFC emissions. In the 2019 refinement, PFC from LVAE will be added to HVAE but there is no indication how to measure it and add it during the PFC sampling. Industry will do the Tier 3 the best way they can do but there will be no common method. On air emission, having a specified sampling method, lab analysis reference and calculation is the key to national reporting. Also, as integrating LVAE PFC emissions is new, would it be possible to put a transition phase?	Christine Dubois	Noted	IAI will coordinate work on updated measurement protocol utilising expertise of member companies on LVAE measurements. A transition phase is not possible but the separation of LV and HV and wording around higher uncertainties and the 'first estimate' nature of LV are included so inventory compilers are aware of the challenges. The guidelines are for National and Global GHG inventories and site specific information on sampling etc will be covered in a separate protocol.
7502	3	4	992	992	Remove : «as data related to LVAE are not typically included»	Nadia Morais	Accepted	Changed in text
7880	3	4	996	998	The method proposed has an important uncertainty, for country having GHG regulation including GHG emission from process as PFC, it has an impact. The objective is to declare accurate GHG emission and the proposed method (divided PFPB legacy and modern and adding LVAE with HVAE) raised uncertainty.	Christine Dubois	Noted	In the 2006 guidelines,the Tier 2 slope and overvoltage coefficients were not calculated on the same basis. In the 2019 refinements, the recommendation was to use "range uncertainty" based on the impact that a tier 2 EF might have on the uncertainty of individual facilities. For this reason, the 2019 refinements values are correct. In addition, if you were to consider the old 2006 EF values, the level of "range uncertainty" would be similar.
7886	3	4	1000	1004	Adding the LVAE PFC emission for PFPB with full control system, represent an annual average carbon cost of US $150 000 for each Alcoa aluminium smelters operating in Québec/Canada where there is GHG cap. The average was done for 2007 to 2017 PFC emission and this cost estimation was done for 2018. Québec carbon cost increase each year of 5% + %indexation of the cost.	Christine Dubois	Noted	No action can be taken because comment is out of scope of 2019 Refinement

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
7884	3	4	1001	1015	When we do PFC sampling to get a Tier 3 factor, it is a picture of the operation when we did the PFC sampling. It is important that the operation is the picture of operation we have normally. As it is a PFC emission sampling of the PFC emission population, to ensure a good representation of the slope factor used and operations, it is important to validate key operating parameters such as the ratio of AEkilled manually/AEtotal, AE duration, AE duration-frequency. If there is a permanent changed, slope factor might be change too and need to be validate.	Christine Dubois	Noted	Details on sampling procedures are not for inventory guidelines but should be included in measurement protocol.
7882	3	4	1006	1009	It is indicated the high performing facilities are those that operate with less than 0,02min/cellday which is very low. It is not specified if it is for one pot, a potline weekly/monthly/annual result. Because AE may not be measured exactly based on the same parameters and since aluminium smelter may not have the same constraint like curtailment and power modulation period from power supplier, a suggestion would be to indicate the percentile on annual result. For example 10 or 20 percentile of annual AE. This will indicate that 10% or 20% of aluminium site is lower than this AE min/cellday.	Christine Dubois	Rejected	We have removed reference to high performing facilities.
7504	3	4	1045	1062	The information about the LVAE is interesting but since this concept is new and still developing, the sections about LVAE must be placed in a seperate section after le line #1292 : «Future opportunities».	Nadia Morais	Rejected	Inclusion of LVAE was mandated by IPCC based on existing literature/science - we have endeavoured to make explicit that this is a first attempt to estimate LVAE emissions at the national/global level.
8568	3	4	1048	1048	The uncertainty is claimed to be greater for tier 1, but this is not consistent with the uncertainty budgets in table 4.15 and 4.16. For all technologies, except PFPB(L), the uncertainties for LVAE is lower with tier 1 than tier 2. In addition the factors in table 4.16B (Tier2) have to be multiplied with the already uncertain HVAE CF4 estimates giving a high propagated uncertainty, while numbers from 4.15 (tier 1) is multiplied with the very accurate production tonnages of Al. There is therefore no reason to use Tier 2 on LVAE emissions, Tier 1 is more accurate, and simpler.	Ole Kjos	Accepted	We have removed Tier 2 due to the propagation of the uncertainties from HVAE.
7506	3	4	1087	1087	The 2019 Refinement introduce a new concept of letter with the «Tier» definition (ex: Tier 2A and Tier 3A) . Furter in the text we see Tier 2b and Tier 3b. Adding letter to «Tier» create confusion and gives the impression that «A» is better than «B». I suggest to remove the letter and simply indicate the Tier number like the 2006 IPCC for the Slope Coefficient and Overvoltage Coefficient who are both Tier 3 but have different equation number.	Nadia Morais	Rejected	This format is widely used across the guidelines - the numbering or lettering is not intended to rank which method is best but is merely a way to describe the many different methods available for inventory compilers to use depending on their needs e.g. the availability of data, key category etc. We have provided a table for clarity on the different methods proposed.
8642	3	4	1087	1087	There are very many different Tier 3s (and Tier 2s). There's Tier 3, Tier 3a and two different Tier 3b. If one should have this many options, perhaps it is better to name all with a sub-index.	Henrik Åsheim	Accepted	We have provided a summary table of the different methods and tiers proposed.
7508	3	4	1109	1109	Add HVAE to ECF4	Nadia Morais	Accepted	Changed in equation
7510	3	4	1111	1111	Add HVAE to EC2F6 and ECF4	Nadia Morais	Accepted	Changed in equation
7512	3	4	1115	1115	Correction of the units : kg CF4/t Al per (mV.day/cell-day*CE)	Nadia Morais	Rejected	No refinment has been made to the Overvoltage calculation method, and units are as per 2006 Guidelines.
7514	3	4	1116	1116	Correction of the units : mV/cell-day	Nadia Morais	Rejected	No refinment has been made to the Overvoltage calculation method, and units are as per 2006 Guidelines.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
7888	3	4	1122	1176	to measure PFC coming from HVAE, we have a method (Protocol for Measurement of Tetrafluoromethane (CF4) and Hexafluoroethane (C2F6) Emissions from Primary Aluminum Production US Environmental Protection Agency & International Aluminium Institute 2008) , I agree with the proposition of Tier 2b and Tier 3b as it is an option, not an obligation. This method increase PFC inventory accuracy when slope data are available and when data process can be extract to use this formula.	Christine Dubois	Noted	An update measurement protocol will be developed and published through IAI.
2932	3	4	1124	1125	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Noted	Format is in agreement with Environmental Conservation style.
7890	3	4	1130	1131	It is indicated that both approches quantify the PFC emission from individual HVAEs based on process parameters that are known or calculated by the cell control système. It is important to know that some system extract data for each pot but for a period of time which can be 4 hours or 12 hours for example. Thereby, for each pot, we will have the total AE duration for all AE occur during this period of time. As exemple, if the system extract data for 4 hours for pot number 1, we may have one AE at 35 sec. But we might have two AE with the total of 155 sec and we don't know the duration for each of the two AE.	Christine Dubois	Noted	In order to adequately use non-linear HVAE methodology, it is good practice that the cell control system allows for distinction between individual HVAE durations. In the case where a facility does not have the ability to dissociate individual HVAE parameters, another estimation methodology would be preferable.
7516	3	4	1131	1131	Add at the end of the sentence : «However, it's possible that the plant specific extraction data system from database don't give the information needed for the calculations».	Nadia Morais	Rejected	Uneccessary wording - if the data is unavailable then another method should be adopted. However, wording has been added that the Tier 2b/3b methods require the ability to extract individual HVAE data
2934	3	4	1132	1133	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Noted	Format is in agreement with Environmental Conservation style.
7518	3	4	1136	1136	Add at the end of the sentence : «No measurement protocol are available now to determine Tier 3 based on individual anode effect measurement»	Nadia Morais	Accepted with modification	Included wording to indicate absence of existing protocol but also plans for update in near future to support guidelines.
2936	3	4	1138	1138	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Noted	Format is in agreement with Environmental Conservation style.
8644	3	4	1138	1138	2018a and 2018b references of "Marks and Nunez" seems to have been switched throughout the document	Henrik Åsheim	Accepted	There was indeed an inversion in the reference.
7892	3	4	1138	1176	Having an exemple in annex could help to understand the formula 4.27A, 4.27B and 4.27D and make sure we put the correct data with correct unit. The formula 4.27A and 4.27B have been tested with fictitious data. Formula 4.27A seems to work but I was not able to get something from formula 4.27B and 4.27D. It is not clear how to use this formula. As it is for PFC emission from HVAE based on individual AE measurement, should both formula give similar PFC emission result?	Christine Dubois	Accepted	Examples of calculations for the tier 2b methodology were added in the worksheet for easier use of the equations.
8646	3	4	1154	1154	2018a and 2018b references of "Dion et al." seems to have been switched throughout the document	Henrik Åsheim	Accepted	There was indeed an inversion in the reference.
7894	3	4	1177	1204	There is no indication from when AE should be measured specifically for pot start. Some primary aluminium smelters is measuring AE from the moment the pot has power (without any bath or alumina), some will begin to measure when bath is added in the pot, others when alumina is added in the pot as example. This difference could be important when we calculate the annual AE (min/cellday). It could be nice to have guidelines when AE should begin to be measure for a pot start.	Christine Dubois	Accepted with modification	Start-up description (Box 4.2a) includes a definition of cell start-up and indication of when PFCs generation is expected to be possible - starting from the moment when anode beam is first raised and metal starts to be produced.
7896	3	4	1177	1204	This new box about high voltage anode effect following start-up of electrolysis cell was added and recommend that proposed Tier 2b non linear approach from equation 4.27 (A or B) would lead to more correct quantification of these data when no specific measurement data are available. Alcoa experience, not published, is that low voltage is also present during pot starts and therefore the most accurate approach is direct Tier 3 measurement during pot-start, not Tier 2b.	Christine Dubois	Accepted	Tier 3d method provides for a means to estimate total (LVAE + HVAE) emissions from cell start-up using facility-specific emission factors obtained during measuremnts. An alternative Tier 3e direct measurement approach is also provided as a separate method.
2938	3	4	1180	1181	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Noted	Format is in agreement with Environmental Conservation style.
2940	3	4	1182	1182	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Noted	Format is in agreement with Environmental Conservation style.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
2942	3	4	1189	1189	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Noted	Format is in agreement with Environmental Conservation style.
7520	3	4	1193	1194	START-UP : it's interesting to add the BOX 4.2A to the 2019 Refinement. The only thing I suggest to add is the possibility to use a Tier 3 Slope Coefficient or Overvoltage Coefficient specific for start-up in addition of the Tier 3 kg CF4/Cell start-up.	Nadia Morais	Accepted	Tier 3a OV or Slope Method has been added as a possible Tier 3 method for cell start up emissions, provided a separate coefficient is used for start-up vs. normal operations
7898	3	4	1195	1198	For one smelter, we now use a different slope for anode duration (min/cellday) for pot start-up. The two first day of operation, the AE duration are much longer. The total anode duration-frequency (min/cellday) of the first 2 days of pot operation is multiply by a slope ((kgCF4/mt)/(min/cellday)). The monthly PFC emission is the PFC summation of "normal pot operation" and "pot start", both using specific PFC slope in (kgCF4 or C2F6/mt)/(min/cellday). The formulain line 1195 to 1199 indicate that we have to use a factor based on kgCf4/cell start-up. Will it be possible to have the option of both?	Christine Dubois	Accepted	Tier 3a OV or Slope Method has been added as a possible Tier 3 method for cell start up emissions, provided a separate coefficient is used for start-up vs. normal operations
2944	3	4	1202	1203	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Noted	Format is in agreement with Environmental Conservation style.
7522	3	4	1206	1230	The information about the LVAE is interesting but since this concept is new and still developping, the sections about LVAE must be placed in a seperate section after le line #1292 : «Future opportunity».	Nadia Morais	Rejected	Inclusion of LVAE was mandated by IPCC based on existing literature/science - we have endeavoured to make explicit that this is a first attempt to estimate LVAE emissions at the national/global level.
7900	3	4	1206	1232	As specified in the document, all the technology named PFPB MW will not have LVAE CF4 emission, only a portion of technology are targeted which represent around 40% of the total aluminium production. In the table 4.15, there is no LVAE Tier 1 factor for PFPB MW. In the table 4.16B, there is no LVAE/HVAE ratio for PFPB MW also. The uncertainty of adding LVAE even using Tier 2 of table 4.16B is quit important for PFPB ROW. The uncertainty vary inside the range of +431 to -98%. As not all aluminum smelters are targeted, that the uncertainties are high, that there is no sampling method specified to integrate the LVAE emission and that proposition is a first step toward total emissions reporting, would it be possible to add this section as a work in progress or actual information and integrate a transition phase to eventually add LVAE PFC emission in the inventory when we will have a sampling method having LVAE PFC included and have more data to consider in the Tier 2 to reduce the uncertainty?	Christine Dubois	Rejected	PFPB MW T1 EFs already include LVAE component as the measurement data that underpins the EF was 'total emissions' i.e. HV and LV. Therefore LVAE will be accounted for >95% of aluminium production. Addressing LVAE emissions was specified in the IPCC mandate and the completeness of the inventory is improved even if this is associated with a high degree of uncertainty. These EFs and guidance are for National GHG inventories - the EFs are always an average of a variable dataset which leads to a certain degree of uncertainty if adopting at the facility level. We recognise the significant contribution that the addition of LVAE emissions may have on PFPB M classes and have provided options to users e.g. keep HVAE and LVAE separate for T2 or adopt T3 site specific options or T3C direct measurement which could be on a total emissions basis.
2946	3	4	1215	1215	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Noted	Format is in agreement with Environmental Conservation style.
8648	3	4	1221	1221	It seems a stretch to base LVAE on HVAE and let them follow each other linearly. With 0 HVAE one would also get 0 LVAE. In one of the supporting documents (Dion et al. LM2018 pp. 1457-1462) there is a plot of the LVAE/HVAE ratio for different smelter (Fig. 2) and the text suggests that there is little variation within one smelter. The scale on the y-axis can likely confuse a bit, but it seems to easily be a difference of 2-3 times within the smelter and a huge difference smelter to smelter.	Henrik Åsheim	Noted	We have removed T2 ratios and this is no longer an issue.
8650	3	4	1235	1235	Fig 4.12 indicates that for a high performing facility it doesn't matter if you calculate emissions from Tier 2 or Tier 3. Is not part of the point that Tier 3 is more accurate and should it not be an incentive to get there?	Henrik Åsheim	Accepted	Reference to high performing facility has been removed.
8758	3	4	1240	1240	Continuous measurements, and how to use such measurements in inventories, should be addressed. Development is ongoing, and more affordable instruments might very well be available long time before next review. A generic guide on how to report such measurements as part of the inventory could be written independent of technology.	Ole Kjos	Noted	An update measurement protocol will be published through IAI.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
8570	3	4	1247	1247	Footnote b in CF4 Uncertainty range does not make sense, just a typing error?	Ole Kjos	Rejected	Not a typing error - the EF is based on a single data point therefore a range cannot be provided.
8652	3	4	1247	1247	HVAE-CF4-EF_CF4 (kg/tonne Al). The values (0.029, 0.030, etc.) are taken from Total CF4 in the supporting document. It should perhaps be the AE related data.	Henrik Åsheim	Accepted	Changed in table
8654	3	4	1247	1247	LVAE-CF4-EF_CF4. The value from Legacy PFPB (0.016) is taken from "pre 2013" while the rest is "post 2013" and "post 2013" data is available	Henrik Åsheim	Accepted	Changed in table
7524	3	4	1247	1248	The information about the LVAE is interesting but since this concept is new and still developing, the right section in the table 4.15 about LVAE must be placed in a seperate section after le line #1292 : «Future opportunity».	Nadia Morais	Rejected	Inclusion of LVAE was mandated by IPCC based on existing literature/science - we have endeavoured to make explicit that this is a first attempt to estimate LVAE emissions at the national/global level.
7902	3	4	1250	1255	Table 4.16 shows the new Tier 2 slope factors for new grouping technology for calculation of high voltage PFC emissions using slope methodology and Table 4.16 b, shows the new Tier 2 slope factors for new grouping technology for calculation of low voltage PFC emissions based on median LVAE/HVAE ratios. Since the industry will need to report total PFC emissions, a new table should be added to combine both emissions to make it more clear. For example for PBPF Legacy, the combine slope will be 0.127 + 0.127 * 0.4 = 0.178	Christine Dubois	Accepted	Equation 4.24A added, for total PFCs as sum of all PFCs - HVAE, LVAE emissions and also any cell start up emissions
7904	3	4	1254		In the table 4.16 at the data for PFPB legacy, the SC CF4 is 0,127. In the publication of "Updated factors for calculating PFC emissions from primary aluminium production-table 3 Recommended upates to Tier 2 slope and RC2F6/CF4 coefficients for calculating HVAE CF4 emission factors, Jerry Marks and Pernelle Nunez" the data is 0,111 which is the PFPB outside China (ROW) Post 2013 Legacy PFPB ROW. The 0,127 is coming from the "Pre 2013 Legacy PFPB ROW" see Table 1 of J. Marks and P Nunez document. Why the data from Pre 2013 instead of Post 2013 was chosen for IPCC document?	Christine Dubois	Accepted	Changed in table
8656	3	4	1254	1254	Legacy PFPB data is from "pre 2013" while the rest is "post 2013". Post data available for all in original material.	Henrik Åsheim	Accepted	Changed in table
7906	3	4	1256	1278	The HAVE PFC emissions rate coefficients based on individual anode effect durations should be tested with a larger data set before being proposed in 2019 Refinement. Our experience from Alcoa smelters is that limited data is not consistent in each anode effect duration submitted, either overestimating or underestimating the emissions. Furthermore, these are only applied to high voiltage emiesions. We prefer to use Tier 3 direct measurements with canisters that will measure total emissions with repeats every three years. This will warranty accurate emissions and be better than these Tier 2b slope approach with limited time from plant personnel to calculate emissions of individual anode effect durations. The IAI should sponsor a study to improve both approaches and proposed which one will give more accurate numbers.	Christine Dubois	Accepted with modification	We acknowledege there will always be limitations with default coefficients and these guidelines are intended as National or Global inventory estimates and not for facility specific calculations where they will likely over/underestimate (except Tier 3). The Tier 2B approaches have been tested on aproixmately 3000 individual AEs over multiple facilities and measurement campaigns. We have added a direct measurement option to address your point on canister and total emissions reporting (which is a very accurate way to account for emissions). The IAI project nomination process is an open process to which anyone can submit a proposal for consideration of IAI funding - Alcoa is always welcome to submit such a proposal detailing a plan to improve the approaches.
7908	3	4	1257		in the table 4.16 at the data for PFPB legacy, the C2F6/CF4 is 0,114. in the publication of "Updated factors for calculating PFC emissions from primary aluminium production-table 3 Recommended upates to Tier 2 slope and RC2F6/CF4 coefficients for calculating HVAE CF4 emission factors, Jerry Marks and Pernelle Nunez" the data is 0,073 which is the Avg AE RC2F6/CF4 of the post 2013 legacy PFPB ROW. The 0,114 indicated in the IPCC document is the data of avg. AE RC2F6/CF4 for pre2013 legacy PFPB ROW (see table 1 of the "Updated factor for calculating PFC emissions from primary aluminium production"). Why IPCC chose pre 2013?	Christine Dubois	Accepted	Changed in table
2948	3	4	1258	1258	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Noted	Format is in agreement with Environmental Conservation style.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
8658	3	4	1261	1261	Second line of table. 6 s should possibly be 5s.	Henrik Åsheim	Accepted	Changed in text
8660	3	4	1261	1261	Last line of table. The formula for "0 s" AE should likely be divided by 1000 to match the rest of the formulas. This is also incorrect in the original material (a small mixup with g/kg). Otherwise a "0 s" AE would be counted as approximately 2500 s of 100 % CF4 production.	Henrik Åsheim	Accepted	The formula has been edited.
2950	3	4	1263	1263	Lack comma in bibliographic citation	Poot-Delgado Carlos Antonio	Noted	Format is in agreement with Environmental Conservation style.
2952	3	4	1266	1266	Verify bibliographic citation format in footnote	Poot-Delgado Carlos Antonio	Noted	Format is in agreement with Environmental Conservation style.
7526	3	4	1279	1284	The information about the LVAE is interesting but since this concept is new and still developing, the text and the table 4.16B about LVAE must be placed in a seperate section after le line #1292 : «Future opportunity».	Nadia Morais	Rejected	Inclusion of LVAE was mandated by IPCC based on existing literature/science - we have endeavoured to make explicit that this is a first attempt to estimate LVAE emissions at the national/global level.
8662	3	4	1284	1284	Uncertainties of Tier 2 LVAE for all but legacy PFPB is higher than the Tier 1 equivalent. This is before taking into account the uncertainties in HVAE as LVAE of Tier 2 is based on HVAE. This is unfortunate as it provides little incentive to move to a higher Tier.	Henrik Åsheim	Noted	We have removed T2 - no longer an issue.
7528	3	4	1290	1291	Move the sentence «For LVAE, facitity-specific ratios can be established based on direct measurement of HAE and LVAE for a period of time» after line 1292 in the proposed specific section for LVAE : «Futur opportunity». Add at the end of the sentence : «no measurement protocol are actually available to improve consistency and alignment across the industry».	Nadia Morais	Rejected	Inclusion of LVAE was mandated by IPCC based on existing literature/science - we have endeavoured to make explicit that this is a first attempt to estimate LVAE emissions at the national/global level. Have included a comment on the development of an industry protocol.
7530	3	4	1301	1301	Add at the end of the sentence : Tier 3 can also uses anode effecte overvoltage and current efficiency	Nadia Morais	Accepted	Included in text
8664	3	4	1303	1303	Missing "Tier" in front of "2"	Henrik Åsheim	Accepted	
7910	3	4	1352	1370	Smelter using overvoltage must have information on how to backcast their emission if we updated PFC emission. It is important for GHG regulation that our data will be as much accurate as possible	Christine Dubois	Accepted with modification	There was no direct correction to adress this specific issue. However, a table was added regarding time consistency to adress specifically which guidelines to use for each specific period. Indirectly, this issue should be covered by using the respective table.
2954	3	4	1354	1355	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Noted	Format is in agreement with Environmental Conservation style.
7912	3	4	1355	1357	Alcoa has aluminum smelter operating with amp <350ka and >350ka, we see difference in the AE duration and PFC emission when there is difference with the control system and alumina injection. For smelter having similar alumina injection and similar automatic control system, we have similar AE data (manual killed, frequency and duration) independly on the ka.	Christine Dubois	Noted	Separating Legacy from Modern based on amperage can be a bit arbitrary on the margins but the logic of separating the technology into two is driven primarily from the desire to add PFC emissions that are not associated with recorded anode effects into the emissions inventory. The "modern" cells typically have a larger number of anodes, and operate at higher amperage. These cells typically have a lower recorded anode effect frequency, one major factor being that voltage excursions that begin on one or two anodes don't always get propagated into a full anode effect with overall cell voltage exceeding 8V. These voltage excursions in a portion of the cell do, however, release PFC emissions. Therefore these "modern" high amperage cells have a different characteristic ratio of non-AE PFC emissions to AE emissions, that is, the high amperage modern cells typically have higher non-AE to AE emission ratios. Thus, a separate category is defined for those cells that characteristically have low AE emissions but high non-AE emissions. Alcoa has been active in making measurements of emissions to determine facility specific slope factors and this is the most accurate method for PFC accounting.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
7914	3	4	1356	1357	With GHG regulation, GHG emission calculation are regulated and inside the regulation we have the formula or information on calculation for GHG emission. For aluminium sector, information on calculation for GHG emission are based on IAI, GHG protocole and IPCC protocole. Updating PFC calculation will impact the national inventory and industry GHG reporting which is directly connect with the country reduction target.	Christine Dubois	Noted	Updated guidelines for Aluminium GHGs have been as per the IPCC mandate, which includes providing guidance on LVAE PFCs. Consdierations for GHG regulation are beyond the scope of these guidelines.
8666	3	4	1357	1357	There is today a very high uncertainty with the LVAE data. Backcasting it to earlier dates with todays emission factors seem unwise as it is impossible to know how these emission factors have varied over time. It is likely better to focus on improving the future with e.g. more measurements, different measurement techniques etc.	Henrik Åsheim	Accepted with modification	It is not suggested to backcast further than 2006. Major revisions to LVAE estimations were performed between the SOD and the FD in order to make sure that the methods with the lowest uncertainty remained. Finally, there is a suggestion added in the time-serie consistency to use actual smelters Tier 3 coefficient when backcasting instead of technology specific coefficient, which should also reduce the uncertainty.
2956	3	4	1364	1364	Lack comma in bibliographic citation	Poot-Delgado Carlos Antonio	Noted	Format is in agreement with Environmental Conservation style.
7916	3	4	1367	1369	Past inventory management must be clear and accurate. Carbon free allowance is given based on past benchmark or based on past year as 2007-2010 data for the WCI regulation. If we include LVAE for future, we need to adjust as much accurate we can past result. If there is a potential to overestimate the past inventory by backcasting PFC emission, there is also a risk to overestimate the actual PFC emission as the uncertainty is more +431 than -98.	Christine Dubois	Accepted with modification	Major revisions to LVAE estimations were performed between the SOD and the FD in order to make sure that the methods with the lowest uncertainty remained. Finally, there is a suggestion added in the time-serie consistency to use actual smelters Tier 3 coefficient when backcasting instead of technology specific coefficient, which should also reduce the uncertainty.
2958	3	4	1369	1369	Lack comma in bibliographic citation	Poot-Delgado Carlos Antonio	Noted	Format is in agreement with Environmental Conservation style.
4042	3	4	1419		Replace "that" with "than"	Andrea Tilche	Accepted	Changed in text
7532	3	4	1422	1422	Add at the end of the sentence : «no measurement protocol are actually available to improve consistency and alignment across the industry».	Nadia Morais	Accepted with modification	Included some wording to explain protocol is under development but not yet available
4044	3	4	1507		Replace "processis" with "process is"	Andrea Tilche	Accepted	
4046	3	4	1609		Replace "remove also some" with "also remove some" - just a suggestion. It's a question of taste.	Andrea Tilche	Accepted	
4048	3	4	1850		The sentence "Emission factors for alumina production are as follows" should be followed by some explanation.	Andrea Tilche	Accepted with modification	The appropriate text has been removed
4050	3	4	1882		Replace "consideration" with "considerations"	Andrea Tilche	Accepted	
4052	3	4	1908		"%" should be written in full	Andrea Tilche	Accepted	Replaced by word "percentage"
4054	3	4	2104		The word "terms" should be followed by "of"	Andrea Tilche	Accepted	Corrected in text
4056	3	4	2288		remove "s" after "fundamentals"	Andrea Tilche	Accepted	Corrected in text
2960	3	4	2297	2297	Verify bibliographic citation format in footnote	Poot-Delgado Carlos Antonio	Noted	Format is in agreement with Environmental Conservation style.
8576	3	4	2371	2372	There exist very limited information on quantifications of PFC emissions from RE metal production. The few recent pubications used here contains data with huge variations. As a first approach it is a good starting point, but the very different numbers for RE iron alloys is questionable as they are difficult to explain this from a theoretical perspective. Laboratory work published in Metallurgical and materials transactions B by Martinez et.al. have demonstrated RE-iron alloys to be produced in laboratory scale without any PFC at all, and in work that will be published soon on the same process have demonstrated it to operate at a 1000A pilot cell without PFC emissions.	Ole Kjos	Noted	Our understanding is that Dy-Fe and other high metal point (>1300 deg C) rare earth metals require alloying with iron for economic production; indications within the Chinese industry is that it also requires higher operational cell voltage than production of Nd and other RE metals/alloys, which may also increase the risk of PFC generation. Therefore the higher emission factors appear to be consistent with these process observations, at least in China. There were no industrial emission factors available prior to the Literature Cut off Date that has suggested otherwise. However, it is acknowledged that the industry is developing quickly, and other low PFC emisison technologies may soon be operating on industrial scale. Guidance has been added to highlight this. In the case of major technological developments and/or automation to reduce PFCs, it is good practice to employ Tier 3 facility specific emission factors.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
2962	3	4	2371	2372	Verify bibliographic citation format in footnote	Poot-Delgado Carlos Antonio	Noted	Format is in agreement with Environmental Conservation style.
2964	3	4	2377	2378	Verify bibliographic citation format in footnote	Poot-Delgado Carlos Antonio	Noted	Format is in agreement with Environmental Conservation style.
4058	3	4	2379		Replace "&" with "and"	Andrea Tilche	Accepted	
2966	3	4	2382	2383	Verify bibliographic citation format in footnote	Poot-Delgado Carlos Antonio	Noted	Format is in agreement with Environmental Conservation style.
2968	3	4	2432	2433	Lack comma in bibliographic citation	Poot-Delgado Carlos Antonio	Rejected	Format is in agreement with Environmental Conservation style.
4060	3	4	2442		replace "there" with "the"	Andrea Tilche	Accepted	
2970	3	4	2443	2444	Lack comma in bibliographic citation	Poot-Delgado Carlos Antonio	Rejected	Format is in agreement with Environmental Conservation style.
2972	3	4	2448	2448	Lack comma in bibliographic citation	Poot-Delgado Carlos Antonio	Rejected	Format is in agreement with Environmental Conservation style.
2728	3	4	Table 4.1		The relationships of the various pargraphs inside the Source column for coke production using by-product recovery technology, sinter production, iron production needs to be explained. (e.g. how does the USA example relate to the default 0.52 tCO2/t coke description at the top of the Source column for coke production using by-product recovery technology?)	Elsa Hatanaka	Accepted with modification	The "Source" column was modified and changes have made for the Table 4.1 to provide the proper explanation to the default EF.
8544	3	6	1	1262	For this charter, it shows how to calculate the consumption of Green house gas. But it does not consider scrubber's DRE%. The different type scrubber treats the waste gas that have different DRE% and produce byproduct.	Zhiping An	Noted	The collected data include all the abatment technologies and the table 6.7 include the suitable abatmente technologies for gas type.
8242	3	6	1	1626	References to annual time period should be made more general to enable calculations over diffferent time periods	Jeff Rudnik	Rejected	GHG inventories are reported by countries by year rather than by other time periods.
7994	3	6	7		I fully agree with the claims made in this chapter, however, GHG emissions from the electronic industry are much more dangerous than those of motor vehicles and anthropogenic. In the electronic industry, the toxicity of its gases is very high. In this sense, the non-existence of an effective and precise method to measure this type of GHG emission should be a cause for concern, and the treatment given by the chapter analyzed does not reflect this concern.	Alma Vargas	Rejected	IPCC Guidance on GHG Inventories is intended to focus on GHG emissions, not other types of emissions.
8272	3	6	156	160	Byproduct EF for CF4 should not be required or included if the abatement is certified that it is designed to abate byproducts. Data set to support EFs for CF4 reference is not cited in these sections and is not included in US EPA Subpart I	Jeff Rudnik	Rejected	Referencing CF4 as by-product from process not as a formation of abatement. Supplier certification included in flow diagram Figure 6.4 as well.
8174	3	6	156	160	Add to the byproduct comment	Jeff Rudnik	Rejected	See commnet #8272
8176	3	6	168	169	Did 2006 IPCC have 3 methods or four? (Tier 1, Tier 2a, Tier 2b, and Tier 3)	Jeff Rudnik	Accepted	Change made on final draft
8178	3	6	196	196	Change the word "brand" to "type"	Jeff Rudnik	Accepted	Change made on final draft
8180	3	6	210	210	Change the word "if" to "of"	Jeff Rudnik	Accepted	Change made on final draft
8182	3	6	219	220	Remove "as well as on the abatement efficiency of all input gases and byproducts" from the statement. Abatement efficiencies do not determine which Method to select.	Jeff Rudnik	Accepted	The sentence was removed.
8184	3	6	223	223	What does inter alia mean?	Jeff Rudnik	Accepted	among other things

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
8186	3	6	228	228	Unclear how Table 6.9 demonstrates a relative error > 100%. Perhaps you mean relative error across types of semiconductor manufacturing and if so, please specify.	Jeff Rudnik	Rejected	Out of Scope. It refers to 2006 guidelines
8188	3	6	233	235	Add comment that it is expected that all gas and FC usage will be tracked to the greatest extent possible.	Jeff Rudnik	Rejected	Out of Scope.
2974	3	6	252	253	check chemical formula	Poot-Delgado Carlos Antonio	Accepted	Change made on final draft
8190	3	6	322	322	The first process box asks if FC activity data is available? Please change to GHG as N2O and CO2 may be included. Change "Do reporting companies measure emission at the stack level" to "Do reporting companies measure GHG emissions at the stack level"?	Jeff Rudnik	Accepted	The changes addressed in final draft.
8192	3	6	350	350	Needs a back bracket within the equation	Jeff Rudnik	Accepted	Change made on final draft
8194	3	6	352	352	Change mass of gas I to kg of gas i.	Jeff Rudnik	Accepted with modification	Add Kg between parenthesis and changed kg to Kg all over the text.
8196	3	6	359	362	Should this be m2 rather than Gm2? It appears that the emission factors are in emissions per m2.	Jeff Rudnik	Rejected	it is in the 2006 guideline original text
2976	3	6	377	377	check chemical formula	Poot-Delgado Carlos Antonio	Accepted	Change made on final draft
8240	3	6	385	390	Strike last sentence "as if they were full" and replace with "using best information available."	Jeff Rudnik	Rejected	The remaining gas in a container is difficult to be measured in a consistent manner through different companies ans facilities. To ensure consistency they should be always regarded as been 100% full.
8198	3	6	442	448	This language should be refined to account for variations due to technology development and ramping of new technologies. By definition, these will have variations in their emissions that are more difficult to account for and model.	Jeff Rudnik	Accepted	A sentence was added "In the event of the introduction of new technologies and/or significant changes to wafer throughput this assessment should be repeated."
8278	3	6	442	448	Recommend providing option to exclude R&D or tool commissioning activities from 20% apportioning requirement (where possible) however need to ensure those purchases are kept in the emission calculations.	Jeff Rudnik	Accepted	see commnet #8198
4062	3	6	474		Replace "used" with "use"	Andrea Tilche	Accepted	Change made on final draft
8200	3	6	488	489	Remove the comment in brackets.	Jeff Rudnik	Accepted	Change made on final draft
2732	3	6	514	514	There should be a parenthesis '[' right before (1-hi) in Equation 6.6.	Elsa Hatanaka	Accepted	Change made on final draft
8202	3	6	516	516	Need a front bracket within the equation	Jeff Rudnik	Accepted	Change made on final draft
8538	3	6	523	524	Dk = overall reduction of gas k by-product emissions, fraction, calculated per Equation 6.7 (replacing i by k indexes). I confuse that if this reduce of gas , it includes the DER% of scrubber?	Zhiping An	Noted	Yes, Dk includes the DRE, fraction of gas used, and uptime for byproduct gas created from i.
8270	3	6	525	530	Byproduct EF for CF4 should not be required or included if the abatement is certified that it is designed to abate byproducts. Data set to support EFs for CF4 reference is not cited in these sections and is not included in US EPA Subpart I	Jeff Rudnik	Rejected	Referencing CF4 as by-product from process not as a formation of abatement. Supplier certification included in flow diagramFigure 6.4 as well.
2734	3	6	526	526	Should the ABF2, CF4 = Fraction of F2 explanation be more generalized to fit under the ABi, CF4 definition ? (since there is no seperate mentioning of ABF2, CF4 in Equation 6.6)	Elsa Hatanaka	Accepted	Rewrote paragraph to clarify by-product emission factors from combustion (525-530 and 633-638)
8204	3	6	555	556	This variable is unclear and I am unsure how this is calculated.	Jeff Rudnik	Noted	Addressed in the final draft.
8286	3	6	555	556	In order to get information to populate the gamma variable appears to require infomration similar to that required in Tier 2c for aip. Is there a more straightforward method to enable calculation of uncontrolled emissions. Is this defined at the process or tool level?	Jeff Rudnik	Noted	This is clarified in the final draft. An explanation of how the gamma factor is calculated was included.
8206	3	6	567	577	Update language to refer to time periods for which the inventory is taken and to not be annual only. Inventories may span multiple years.	Jeff Rudnik	Rejected	GHG inventories are reported by countries by year rather than by other time periods.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
8208	3	6	583	583	Change Table reference to Table 6.4	Jeff Rudnik	Accepted	Corrected in the text. All the "≥300mm" was changed with "300mm" all over the text
8210	3	6	599	599	Update Table references	Jeff Rudnik	Accepted	Change made on final draft
8212	3	6	604	604	Change "As for the Tier 2a and 2b methods, the Tier 3b total" to "As for the Tier 2a and 2b methods, the Tier 2c total"	Jeff Rudnik	Accepted	Change made on final draft
8288	3	6	615	616	COF2 listed as input gas but not a byproduct. Is this a PFC as it qualifies per current Table A-1 US EPA MRR	Jeff Rudnik	Rejected	The COF2 exists as byproduct but it have a very low impact and it have no official GWP (the best extimated value is 1).
8290	3	6	620	630	COF2 listed as input gas but not a byproduct	Jeff Rudnik	Rejected	The COF2 exists as byproduct but it have a very low impact and it have no official GWP (the best extimated value is 1).
8214	3	6	623	623	Add a back bracket to equation	Jeff Rudnik	Accepted	Change made on final draft
8268	3	6	633	638	Byproduct EF for CF4 should not be required or included if the abatement is certified that it is designed to abate byproducts. Data set to support EFs for CF4 reference is not cited in these sections and is not included in US EPA Subpart I	Jeff Rudnik	Rejected	Referencing CF4 as by-product from process not as a formation of abatement. Supplier certification included in flow diagramFigure 6.4 as well.
4064	3	6	638		Replace "&" with "and"	Andrea Tilche	Accepted	Change made on final draft
8216	3	6	647	652	Language is unclear. Please make this language easier to follow.	Jeff Rudnik	Noted	Change made on final draft
8218	3	6	685	694	Add substrate type.	Jeff Rudnik	Accepted	Change made on final draft
8266	3	6	695	700	Byproduct EF for CF4 should not be required or included if the abatement is certified that it is designed to abate byproducts.	Jeff Rudnik	Rejected	Referencing CF4 as by-product from process not as a formation of abatement. Supplier certification included in flow diagramFigure 6.4 as well.
8276	3	6	695	700	Data set to support EFs for CF4 reference is not cited in these sections and is not included in US EPA Subpart I	Jeff Rudnik	Rejected	More recent data exists (SESHA April 2018)
8220	3	6	704	706	Although country specific default emission factors are less desired, if utilizing country specific default emission factors the process should include a step to accumulate industry wide data so as to ensure accurate and up to date country specific emission factors. SHould document need for a mechanism to update the the specific emission factors.	Jeff Rudnik	Noted	Added a sentence to clarify that country-specific factors should include the full range of processes used in the country in the relevant process type, including both changed or new and pre-existing processes.
8222	3	6	728	728	Remove the extra back parenteses	Jeff Rudnik	Accepted	Change made on final draft
8224	3	6	733	733	Change input process gases to input process gas.	Jeff Rudnik	Accepted	Change made on final draft
8226	3	6	746	746	Specify what fab type means.	Jeff Rudnik	Accepted	Corrected in the text. Change to Industry type (Semiconductor, MEMs, PV, Display)
8228	3	6	748	748	Add examples	Jeff Rudnik	Accepted	Change made on final draft
8230	3	6	749	749	Add examples	Jeff Rudnik	Accepted	Change made on final draft
4066	3	6	764	766	The sentence is too long. Please revisit and make it shorter.	Andrea Tilche	Accepted	Change made on final draft
8232	3	6	771	771	Add language about phase in for measured emission factors from the body of the language. For the third diamond, is there a list of what has been characterizaed? How would a new inventory compiler know what was previously characterized? For the fourth diamond, specify that greenhouse gases refer to those defined in the IPCC.	Jeff Rudnik	Rejected	There is no formal "list" of equipment platform characterized. The authors believe that it is not necessary to specify within figure 6.2 which greenhouse gases are defined by the IPCC. The default EF tables specify the gases that are currently known to be used for chapter 6.
4068	3	6	802	806	The equation seems not to be referred to in the text	Andrea Tilche	Accepted	Change made on final draft
8234	3	6	809	809	Other equations are in kg of chemical. Convert this equation from metric tons CO2e to kg of chemical.	Jeff Rudnik	Rejected	This is preliminary estimate for purposes of assessing the magnitude of the CO2-equivalent emissions; needs to be in MTCO2e.
8236	3	6	820	821	Either remove CF from this equation or add it to all other equations	Jeff Rudnik	Rejected	This is just a preliminary estimate intended to establish priority of stack testing and is not meant for final inventory reporting.
8238	3	6	826	828	Either remove CF from this equation or add it to all other equations	Jeff Rudnik	Rejected	This is just a preliminary estimate intended to establish priority of stack testing and is not meant for final inventory reporting.
8298	3	6	864	864	For the definition of substantive changes, it includes a a decrease in tools with POUs, but not an increase. Suggest modifying "decrease" to "change".	Jeff Rudnik	Accepted	Change made on final draft

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
8300	3	6	882	885	States if expected byproduct or known used gas is not detected, use 1/2 the FDL. This could result in large emissions reporting due to large flow rates typical in fab exaust systems.	Jeff Rudnik	Rejected	This is a standard stack testing method
4070	3	6	945		Where are these tables?	Andrea Tilche	Accepted	Added tables in FOD
8248	3	6	1127	1130	Check Section reference numbers to ensure they still exist or are correct	Jeff Rudnik	Noted	
8250	3	6	1138	1138	Recommend changing word "gases" to "materials". It is confusing in section for liquid FCs	Jeff Rudnik	Accepted	
8252	3	6	1148	1148	Recommend change EFl to EFi in equation details	Jeff Rudnik	Accepted	
8246	3	6	1154	1154	Break out Tier 2 into Tier 2a-all chemical purchased and Tier 2b - Equation 6.25 methodology. There is not a footnote or documentation on GWP for all liquid FC-s note in the intro section.	Jeff Rudnik	Rejected	The method is not and should not be GWP-dependent.
8244	3	6	1154	1184	Should alternatives for calculation methodology be included which tracks usage without the complication of nameplate capacity or annual inventories?	Jeff Rudnik	Rejected	There is a Tier 1 alternative and the Tier 2 method is an inventory-based method requiring that a reliable inventory be kept.
4072	3	6	1186		I do not see where the figure is decribed.	Andrea Tilche	Accepted	Reference to Figure 6.3 corrected in SOD line 1129.
8254	3	6	1188	1188	In the decision tree what examples that lead companies to decide to use the Tier 1 method? The decision tree refers to the Electronics Industry as a whole?	Jeff Rudnik	Accepted	Text clarified in the introduction to section 6.2.1.2 and text in first diamond of decision tree (figure 6.3) will be changed to make it clear that the decision criteria is about the existence of an HTF inventory.
2978	3	6	1188	1189	The text of the flow diagram is not distinguished	Poot-Delgado Carlos Antonio	Rejected	Comment unclear.
8534	3	6	1198	1215	For the calculation of Tier 1 Method, in Table 6.2, why are there no N2O and C - C4F8 influence factor values in the semiconductor?	Zhiping An	Accepted	Factors updated with new data
8536	3	6	1216	1224	In Table 6.4 of Tier 2 B Method, the NF3 Remote Process IPCC believes that a large number of BY - Product: CF4 will be produced. However, in the actual manufacturing process, we have not found such a situation. Maybe this situation will be happen in after Burn type scrubber treat. Because Burn type scrubber use hydrocarbon fuel, but scrubber inlet (main tools exhaust) no this situation. If change scrubber type from burn to plasma also no this byproduct.	Zhiping An	Rejected	Post-process CF4 emissions from NF3 remote cleaning are related to the cleaning of carbon-containing films. Such CF4 emissions have been measured and quantified at the exhaust of process chambers in numerous instances and constitute a distinct source of CF4 emission than the formation of CF4 within combustion-based abatement systems. CF4 production within abatement systems are accounted for separately in new equation 6.6B (which will be renumbered as equation 6.7 in the final draft).
8280	3	6	1217	1217	Should the data table reference all sources or geographies associated with the underlying data	Jeff Rudnik	Noted	Addressed in FOD
8292	3	6	1217	1217	COF2 listed as input gas but not a byproduct	Jeff Rudnik	Noted	Decision was made not to include COF2 as a byproduct (see earlier comment).
2202	3	6	1217	1218	Table 6.3 : The source of "C2H5F, C3F8remote, COF2, F2, N2O TDF, N2O other " not listed in Table I-11 & Table I-12 of CFR part 98 Subpart I , is unknown.	Hiroshi Ito	Accepted	Placeholder; data will be recalcuated;sources will be updated.
2204	3	6	1217	1218	Table 6.3 :The values calculated from Table I - 11 and Table I - 12 are different from the values of "1 - Ui", "BCF 4" and "BC 2 F 6" of "CH 3 F"	Hiroshi Ito	Accepted	Placeholder; data will be recalcuated;sources will be updated.
2206	3	6	1217	1218	Table 6.3 :The value calculated from Table I-11 and Table I-12 are different from the values of "1-Ui" of "NF 3 Remote"	Hiroshi Ito	Accepted	Placeholder; data will be recalcuated;sources will be updated.
2208	3	6	1217	1218	Table 6.3 :The value calculated from Table I-11 and Table I-12 is different from the value of "BCH 3 F" of "NF 3"	Hiroshi Ito	Accepted	Placeholder; data will be recalcuated;sources will be updated.
2210	3	6	1217	1218	Table 6.3 :The value calculated from Table I-11 and Table I-12 is different from the value of "BCH 3 F" of "SF 6"	Hiroshi Ito	Accepted	Placeholder; data will be recalcuated;sources will be updated.
2212	3	6	1217	1218	Table 6.3 :The column of "C2HF5" calculated from Table I-11 and Table I-12 is missing from Table 6.3.	Hiroshi Ito	Accepted	Placeholder; data will be recalcuated;sources will be updated.
2214	3	6	1217	1218	Table 6.3 :Since there are many unknown points in the numerical value of the table, it is presumed that mutual confirmation of leadauthers has not been completed. The values agreed upon by the leadauthers should be stated.	Hiroshi Ito	Accepted	Placeholder; data will be recalcuated;sources will be updated.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
3410	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	Eunae Seo	Rejected	Duplicate
8282	3	6	1221	1221	Should the data table reference all sources or geographies associated with the underlying data	Jeff Rudnik	Noted	Addressed in FOD
8294	3	6	1221	1221	COF2 listed as input gas but not a byproduct	Jeff Rudnik	Noted	Decision was made not to include COF2 as a byproduct (see earlier comment).
8284	3	6	1222	1222	Should the data table reference all sources or geographies associated with the underlying data	Jeff Rudnik	Noted	Addressed in FOD
2216	3	6	1222	1223	Table 6.5 :The source of "C2H5F, N2O TDF, N2O other " not listed in Table I-3 of CFR part 98 Subpart I , is unknown.	Hiroshi Ito	Accepted	See answer to same question regrding Table6.3
2218	3	6	1223	1224	Table 6.6 :The source of "COF2, F2, N2O TDF, N2O other " not listed in Table I-4 of CFR part 98 Subpart I , is unknown.	Hiroshi Ito	Accepted	See answer to same question regrding Table6.3
8296	3	6	1223	1233	COF2 listed as input gas but not a byproduct	Jeff Rudnik	Noted	Decision was made not to include COF2 as a byproduct (see earlier comment).
2048	3	6	1233	1236	Cartridge (Media consumed) row in table 6.7 x at C4F8, CHF3, NF3 and SF6 is incorrect. The media in the cartridge is alkali substance such as Ca (OH)2, which doesn't react with these gases. x should be put at C3F6O (hexafluoroacetone) and COF2. These gases react with the alkali substance.	Tsutomu Tsukada	Rejected	Some cartridges contain adsorption media that are designed to abate PFCs
2050	3	6	1233	1236	x should be marked to all gases in the table6.7 except N2O. It is common knowledge that CF4 has the strongest C-F bond among the listed gases, and because that the decomposition performance depends on the C-F bond strength, all the listed PFC gases can be abated with same or higher efficiency under the condition that CF4 can be abated. Normally N2O is used with SiH4 for thin film deposition process and SiO2 is formed as a byproduct which damages the catalyst. This technology is not suitable for N2O abatement.	Tsutomu Tsukada	Rejected	X's in Table 6.7 are based on experimental evidence regarding the suitability of certain abatement technologies to abate certain GHGs. Table 6.7 will be updated for the final draft based on data collected.
2052	3	6	1233	1236	The temperature classification of Hot Wet in Table 6.7 is too rough. Since the decomposition performance of Hot Wet technology has clear temperature dependence, I propose the following temperature classification and each applicable gas list. < 800 ˚C COF2, C3F6O < 950 ˚C COF2, C3F6O, C2H5F, C4F6O, C4F8O, NF3 < 1200 ˚C COF2, C3F6O, C2H5F, C4F6O, C4F8O, NF3, C2F6, C4F6, C4F8, C3F8, CHF3, CH2F2, C4F6, C5F8, CH3F, C2F4, N2O < 1350 ˚C COF2, C3F6O, C2H5F, C4F6O, C4F8O, NF3, C2F6, C4F6, C4F8, C3F8, CHF3, CH2F2, C4F6, C5F8, CH3F, C2F4, N2O, SF6 > 1350 ˚C COF2, C3F6O, C2H5F, C4F6O, C4F8O, NF3, C2F6, C4F6, C4F8, C3F8, CHF3, CH2F2, C4F6, C5F8, CH3F, C2F4, N2O, SF6, CF4	Tsutomu Tsukada	Noted	Table 6.7 updated for the final draft based on data collected.
2570	3	6	1233	1236	The C4F8 decomposition by Cartrige(Media consumed) in Table.6.7 is X (= Stuitable to use defalut DRE). However, I think that it should be "Not applied" (blank). At least, in our acquisition data, C4F8's DRE by Cartrige(Media consumed) is > 99%.	Nobuhiro Natori	Rejected	Question is incoherent. Some cartridges are indeed capable of abating C4F8. Table 6.7 will be updated for the final draft based on data collected.
2572	3	6	1233	1236	The CF4 decomposition by Catalyst (Media not consumed) in Table.6.7 is X (= Stuitable to use defalut DRE). However, I think that it should be "Not applied" (blank). At least, in our acquisition data, CF4's DRE by Catalyst is > 99%.	Nobuhiro Natori	Rejected	Question is incoherent. Some cartridges are indeed capable of abating C4F8. Table 6.7 updated for the final draft based on data collected.
8260	3	6	1237	1237	Note 5 does not appear in the figure	Jeff Rudnik	Noted	Clarified in FOD

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
8542	3	6	1237	1262	According to the Figure 6.4 show, the table 6.8 is showed the DRE%, after install the scrubber. But as stated earlier, many gases will be generated by-product. Did you consider the emission of by-products when defining DRE? For example, C4F8 in tier 2b method calculates C4F8 0.13, b CF4: 0.11, and table 6.8 calculates C4F8 60 %. Does the generated CF4 count? If the calculation is included, then CF4: DRE 75 % is not reasonable.	Zhiping An	Rejected	Confusion between by-product from process vs by-product from POU.
2054	3	6	1241	1242	Table number is wrong. Table 6.6A should be table 6.7.	Tsutomu Tsukada	Noted	Table numbers updated as part of the final draft.
4074	3	6	1242		Replace "table" with "Table"	Andrea Tilche	Noted	FOD updated
8258	3	6	1243	1245	Question on if we need to change this to be more general	Jeff Rudnik	Noted	Addressed in FOD
8256	3	6	1246	1248	Recommendation to change from "all parameters" to "all parameters which affect DRE". There are operating parameters that are required to ensure no impact to fab tool that are not related to DRE.	Jeff Rudnik	Noted	Addressed in FOD
8262	3	6	1251	1251	Note 5 does not appear in the figure	Jeff Rudnik	Noted	Repeat of comment 8260
8264	3	6	1253	1257	Byproduct EF for CF4 should not be required or included if the abatement is certified that it is designed to abate byproducts.	Jeff Rudnik	Rejected	ABNF3,CF4 and ABF2,CF4 are emission factors reflecting the poential formation of CF4 within abatment systems.
8274	3	6	1253	1257	Data set to support EFs for CF4 reference is not cited in these sections and is not included in US EPA Subpart I	Jeff Rudnik	Rejected	Rejected based on new data.
8302	3	6	1261	1261	Table 6.8 states it lists USEPA GHG default factors, but list N2O PE/WC DREs at 60%, where Subpart I does not have a value here (only for CC). Also, would it be possible to use manufactured performance specs where available?	Jeff Rudnik	Accepted with modification	Table 6.8 updated in the final draft based on new data. The decision tree of Figure 6.4 allows for the use of site-specific measured DREs (but not performance specifications from the abatement OEM).
2056	3	6	1261	1262	All the gases in table 6.7 are not included in table 6.8. The gases in Table 6.7 and 6.8 must be consistent in the final version of the guideline.	Tsutomu Tsukada	Noted	Tables 6.7 and 6.8 updated for the final draft based on data collected.
2058	3	6	1261	1262	The DRE values of Tier 2a and 2b on the Table6.8 are against to the theory of decomposition of PFC gases on the catalyst, hot-wet, combustion and plasm technology. When you use these abatement technologies maintained and operated properly under tool suppliers' recommended condition, the PFC gas with lower C-F bond strength shows higher abatement efficiency. The example of abatement efficiency is as follows, Highest NF3 > C4F8, CH2F2, CH3F, C4F6 > C5F8 > C3F8, CHF3 > C2F6, N2O > SF6 > CF4 Lowest If the data of the DRE efficiency are in different order from shown above, that indicates something is wrong with the data. That data possibly contains data from fabs or tools with improper operation and/or maintenance condition. If the order of DRE value of Table 6.8 is different from the theory somehow, clear explanations are required. The highest DRE is NF3 and the lowest DRE is CF4, and the DRE of the other gas should be between the NF3 and CF4 DRE.	Tsutomu Tsukada	Noted	Tables 6.7 and 6.8 updated for the final draft based on data collected.
2060	3	6	1261	1262	If abatement tools are set appropriately and the tool conditions are maintained properly, DREs are independent from the condition of the process tools or wafer sizes. Therefore, the values of the DRE should be equal in all Tiers. If IPCC guideline doesn't assume that the abatement tools are set in proper operation condition which guarantee certified DREs, the data on the table 6.8 are meaningless.	Tsutomu Tsukada	Rejected	The statement is incorrect. DREs are not independent from the condition of the process tools or wafer sizes. A final decision to have different DRE values for different tiers will be made based on data. The IPCC guidelines clearly require that abatement tools are certified to abate exhaust gases in the worst case scenario if the default DREs are used.

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
8540	3	6	1261	1262	I don't quite understand the basis of DRE calculation in Table 6.8. What are the numerator and denominator of this processing performance? Is the ratio of main tools inlet and exhaust? Or the ratio of Scrubber inlet to exhaust? Or is it the ratio of main tools inlet to Scrubber exhaust?	Zhiping An	Rejected	The DRE calculation conforms to accepted standards.
2220	3	6	1261	1262	Table 6.8: The order of sizes of the listed DREs is not consistent with the ease of decomposition of each PFC gas. These values may have been developed based on the non-reproducible data measured by the abatement device under insufficient capacity or insufficient maintenance. It is necessary to reconsider the reliability of the numerical value. (Confirmation of reliability is also necessary for the unknown value commented above.)	Hiroshi Ito	Noted	Tables 6.7 and 6.8 updated for the final draft based on data collected.
7996	3	6	6.2.1.2		The document establishes that the leakage and evaporation of liquid fluorinated compounds during their use constitutes an important source of emissions of fluorinated gases; which is not debatable. However, in the estimation that takes into account the purchase / sale ratio, it does not value the leakage, which, when going to the atmosphere, increases the FEI that already exists, this could have an overestimation of the total volume of FEI in a given territory. .	Alma Vargas	Rejected	The estimation of leakage in baed on a standard inventory method which tracks the amount of HTF that is replenished during the reporting period.
2730	3	6	general		It would be useful to mention in Ch6 that there is guidance in Ch8 on waterproofing of electronic circuits.	Elsa Hatanaka	Accepted	This text has been added to the introduction.
4076	3	7	375		Replace "table" with "Table"	Andrea Tilche	Accepted	
4078	3	7	382		Replace "box" with "Box"	Andrea Tilche	Accepted	
4080	3	7	399		Replace "box" with "Box"	Andrea Tilche	Accepted	
4082	3	7	402		Replace "box" with "Box"	Andrea Tilche	Accepted	
4084	3	7	408		I do not understand the use of "for other"	Andrea Tilche	Accepted	
2982	3	7	448	449	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Noted	Verified
2984	3	7	457	457	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Noted	Verified
2986	3	7	461	461	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Noted	Verified
2988	3	7	468	468	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Noted	Verified
2740	3	7	505	506	Emission factors in the low end of the ranges should especially apply for those countries that have a mondatory or voluntary system...' should be modified to 'Emission factors in the low end of the ranges would only apply to those countries that have a mondatory or voluntary system...'	Elsa Hatanaka	Accepted with modification	The sentence was modified in order to be more clear: "For those countries that have a mandatory or voluntary system in place to limit emissions during equipment service, use, and disposal, emission factors in the low end of the ranges would typically apply."
2742	3	7	517	517	'All of these can reduce emission rates' is an unnecesary statement, since reductions will come naturally with mitigation.	Elsa Hatanaka	Accepted	
2980	3	7	531	532	Verify bibliographic citation format	Poot-Delgado Carlos Antonio	Accepted	
8304	3	7	541	542	Two of Table 7.9 column headers are difficult to understand - the meaning of "charge" and "lifetime" are not clear. Recommend adding additional text to Table 7.9 in order to clarify the table headings. A representation of the Table 7.9 column headers is shown in the supporting document, with the additional recommended text underlined and highlighted. Please see the supporting document uploaded into the system as a separate file. [-comments from Glenn Gallagher of the California Air Resources Board]	Y. Anny Huang	Accepted	

Comment ID	Volume	Chapter	From line	To line	Comment	Expert	Response	Authors notes
2738	3	7	Box 7.2B		To make the diagram more easily understandable, e.g. 'New equipment charge (Bank) Year 0' should be modified to 'New equipment charge (Bank) at Year 0' and 'Remaining Bank Year 0' should be modified to ' Remaining Bank from Year 0'. Also, the 'Lifetime emissions' on Y0 should be modified to 'Emissions in the first year of the lifetime,' since lifetime would imply the whole lifetime. It would also be useful to have indicated somewhere in the diagram that dotted lines are Emissions and solid lines are Charges.	Elsa Hatanaka	Accepted	
2736	3	7	Table 7.3B		The footnotes A and B in the Table title are reversed.	Elsa Hatanaka	Accepted	
8346	3	7			I am concerned by the reliance in this chapter on such an old IPCC/TEAP reference (2005) for the use pattern of alternatives; why not use the most up to date UNEP/TEAP report (2016)?	Pauline Midgley	Accepted with modification	We have used UNEP/TEAP 2016 to update information within the scop of the mandate. Other sections are left unrevised.
1832	3	8	18	18	Typo: Portugal	Urs Berger	Accepted	Change made on final draft
1834	3	8	75	75	Typo: PFCs with a small plural-s	Urs Berger	Accepted	Change made on final draft
1836	3	8	447	447	I am not aware that fluorine-based treatment was/is used to enhance hydrophilicity of surfaces	Urs Berger	Accepted	"or hydrophilicity" was eliminated.
1838	3	8	471	471	Typo: emisson factors	Urs Berger	Accepted	Verified
1840	3	8	481	481	Typo: emisson factors	Urs Berger	Accepted	Verified
2746	3	8	Table 8.11		The unit in the heading should be 'Emissions (g) /Circuit Board' instead of Emissions/Circuit Board (g).	Elsa Hatanaka	Accepted	Change made on final draft
1830	3	8			Please be clear and consistent in using accronyms for fluorinated chemicals. It is unclear what is meant with PFCs. Perfluorocarbons (i.e. fully fluorinated alkanes) or per- and polyfluorinated chemicals, which are abbreviated as PFASs in Appendix 1. Also, FC is defined twice, once as fluorochemicals (line 357), once as fluorinated compounds (line 455). What are FCs in relation to PFCs or PFASs? I suggest adhering to the terminology by Buck et al. (2011) Perfluoroalkyl and Polyfluoroalkyl Substances in the Environment: Terminology, Classification, and Origins, Integr. Environ. Assess. Manag. 7, 513-541	Urs Berger	Accepted	Acronyms harmonised + included suitable text to explain which terminology is followed.
2744	3	8			8.5: For clarity of guidance, it is necessary to remove the whole of 8.5 to the Appendix if default EFs cannot be provided in the next draft.	Elsa Hatanaka	Rejected	See answer to comment ID# 7584. The format for including this new source category to Chapter 8 was discussed and agreed to with the IPCC Task Force Bureau.
7862	3	Annex 4	18	26	There is a definition for LVAE as an anode effect (and emission of PFC gases) in cases where the cell voltage doesn't exceed the voltage threshold. As the emission of PFC is indicated, it can be add that there is no protocole of measurement for LVAE PFC emission at this moment.	Christine Dubois	Rejected	Information on the lack of a protocol for measurement has already been included in both Aluminium and Rare Earth chapters. This glossary is only relevant for defining HVAE and LVAE emissions.
7534	3	Annex 4	26	26	Add at the end of the sentence : «The LVEA is a concept relatively new and no measurement protocol are actually available to improve consistency and alignment across the industry».	Nadia Morais	Rejected	Information on the lack of a protocol for measurement has already been included in both Aluminium and Rare Earth chapters. This glossary is only relevant for defining HVAE and LVAE emissions.
1842	3	Appendix 1	61	61	Typo: 2,0000 should probably read 20,000	Urs Berger	Accepted	Change made on final draft
1844	3	Appendix 1	118	118	Typo: application techniques	Urs Berger	Accepted	Change made on final draft
1846	3	Appendix 1	220	220	Typo: that	Urs Berger	Accepted	Change made on final draft
1848	3	Appendix 1	495	495	Typo: or	Urs Berger	Accepted	Change made on final draft
1850	3	Appendix 1	691	691	Typo: process types	Urs Berger	Accepted	Change made on final draft
1852	3	Appendix 1	802	802	Unlogical numbering of header	Urs Berger	Accepted	Change made on final draft
1854	3	Appendix 1	806	806	Typo: emisson estimates	Urs Berger	Accepted	Change made on final draft