

ESPP response to JRC STRUBIAS Interim Report

This document presents the comments of ESPP (European Sustainable Phosphorus Platform www.phosphorusplatform.eu) on the EU Commission JRC Interim Draft Report “STRUBIAS”. This report is an impact assessment and “nutrient recovery rules” for struvite (widened to recovered phosphate salts), ash-based materials and biochars (proposed title “pyrolysis materials”), as proposed Component Material Categories (CMCs) for the revised EU Fertilisers Regulation. This report is available for consultation online at www.phosphorusplatform.eu/regulatory

The comments below present ESPP’s overall comments and questions, and a compilation of input received from ESPP members and stakeholder network.

A) ESPP main comments and questions	2
A.1. Overall approach and method	2
A.1.1. Choice by JRC of criteria as the basis of the STRUBIAS report.....	2
A.1.2. Finalisation to CMC format.....	3
A.2. Avoid multiplying unnecessary criteria and testing	3
A.2.1. Delete criteria which duplicate those in PFCs.....	3
A.2.2. Delete contaminant criteria which are not justified.....	3
A.2.3. Exempt testing where a contaminant should not be there.....	4
A.2.4. Specify testing methods and testing costs.....	5
A.3. Ash-as-a-process-ingredient and definition of “post-processing”	5
A.3.1. Sewage sludge incineration ash.....	5
A.3.2. JRC proposed approach for STRUBIAS criteria for “ash as a process ingredient”.....	5
A.3.3. JRC proposed “post-processing” wording.....	6
A.3.4. ESPP proposal for ash used as input for chemical reprocessing.....	7
A.3.5. Clarification of “post-processing” for all three STRUBIAS materials.....	8
A.4. Contaminant removal or dilution in ashes	8
A.4.1. Contaminant removal or dilution in ash-as-a-process-ingredient.....	8
A.4.2. Dilution of contaminants in direct use of ash after blending.....	10
A.5. Phosphorus solubility criteria	10
A.6. Comments on the proposed criteria for ash-based materials	10
A.6.1. The proposed oxides ratios.....	10
A.6.2. Widen input materials list for ashes.....	11
A.6.3. Adjust certain contaminant limits for ashes.....	11
A.7. Comments on the proposed criteria for phosphate salts	11
A.7.1. Phosphate salts which are chemically processed.....	11
A.7.2. Input materials for phosphate salts.....	12
A.7.3. Widening from struvite to “phosphate salts”.....	12
A.7.4. Carbon and contaminant limits for phosphate salts.....	12
A.7.5. P ₂ O ₅ requirement and drying methods.....	13
A.8. Comments on the proposed criteria for biochars	13
A.8.1. Call biochars ... biochars.....	13
A.8.2. Avoid fixing rigid time/temperature process criteria for biochars.....	14
A.8.3. Input materials for biochars.....	14
A.8.4. Contaminant limits for biochars.....	14
B) Conclusions of the ESPP stakeholder workshop	15
B.1.1. Ash.....	15
B.1.2. Biochars / pyrolysis products.....	16
B.1.3. Phosphate salts.....	17
C) Comments on liming ashes from OMYA/MEAC	18
D) Line by line comments on the Interim Report text	20
D.1. Comments on the main text body.....	20
D.2. Comments on lines 4018-4022 Nutrient Recovery Rules.....	30

A) ESPP main comments and questions

A.1. Overall approach and method

A.1.1. Choice by JRC of criteria as the basis of the STRUBIAS report

It is indicated lines 51-59 that:

“The JRC assesses STRUBIAS materials against following criteria ...”

- I. *The material shall provide plants with nutrients or improve their nutrition efficiency, either on its own or mixed with another material [following the definition of fertilising products in the proposal for the Revised EC Fertiliser Regulation];*
- II. *The use of the materials will not lead to overall adverse environmental or human health impacts;*
- III. *A demand exists for such a recovered fertiliser material, based on the current market and the projected future market conditions”*

ESPP has not found this wording in:

- the draft EU Fertilisers Regulation
- the mandate from DG GROW
- the STRUBIAS “Background Document” of 21/6/16
- the minutes of the STRUBIAS meeting 6-7 July 2016.

We note that the mandate from DG GROW specified: *“assess the suitability and feasibility of developing nutrient recovery rules for struvite, biochar and ash-based products from waste, biological materials or industrial by-products, and where deemed appropriate, will make technical proposals for such nutrient recovery rules.”*

We also note that Art. 42.1 of the proposed Fertiliser Regulation text reads:

*“The Commission shall be empowered to adopt delegated acts in accordance with Article 43 to amend Annexes I to IV for the purposes of adapting them to technical progress and facilitating internal market access and free movement for CE marked fertilising products
(a) which are likely to be subject of significant trade on the internal market, and
(b) for which there is scientific evidence that they do not present an unacceptable risk to human, animal or plant health, to safety or to the environment, and that they are sufficiently effective.”*

In particular, we have the following comments:

- The Fertiliser Regulation (Art. 42.1(a)) refers to **likely significant “trade”** whereas the JRC wording refers to “demand”. These are not the same. For example, it is unlikely that there will be “demand” for sewage sludge incineration ash, whereas it is certain that there will be significant trade (consequence of e.g. German legislation requiring phosphorus recovery from sewage). We note that the Waste Directive (2008/98), cited in the STRUBIAS meeting 6-7 July 2016 minutes (§4) refers to “a market or demand”. There will indeed be a market for sewage sludge incineration ash, albeit likely at a negative price.
- The criteria used by JRC (I) refers to the **definition of a “fertilising product”** in the draft Fertilisers Regulation (Art. 2(1)). This is used in the Regulation to refer to “CE marked fertiliser products”, that is to the finished product, not to the input materials (CMCs), as stated in Recital (6) *“CE marked fertilising products should therefore be divided into different product function categories, which should each be subject to specific safety and quality requirements”*. However, **STRUBIAS is not addressing product function categories (PFCs), but CMCs**. Many chemicals authorised as CMCs under CMC1 will not fit JRC’s first criterion (line 52-55).

We request an explanation of why the assessment criteria in lines 51-59 were chosen and defined as worded and indications as to what consequences result from this choice of wording.

A.1.2. Finalisation to CMC format

The recovery rules” proposed are not in the format appropriate for introduction into Annex II of the Fertilisers Regulation as CMC specifications.

The JRC discussion of the basis of these criteria would be clearer if this formulation to CMC wording was already carried out. Also, this would avoid possible duplication and contradictions in discussion when the current ‘Nutrient Recovery Rules’ are reformulated as a CMC text.

In particular, the interpretation (implementation) of the proposed Nutrient Recovery Rules depends strongly on a **clear definition of terms such as “additive” versus “input material”, and of “pre-treatment”, “core-process” and “post-treatment”, which are not defined in the Fertiliser Regulation**, and are not used in other CMCs (or are used more precisely, e.g. “composting additives”).

When and by whom will draft CMC criteria text be prepared and how will these ambiguities and questions be resolved?

A.2. Avoid multiplying unnecessary criteria and testing

A.2.1. Delete criteria which duplicate those in PFCs

As a general principle, and to ensure a level playing field between fertilisers produced from recycled materials and those from virgin materials (CMC1), **CMCs should not include limits and criteria additional to those in the PFCs**, unless there is specific reason to do this.

Also, in general and unless there are strong justifications for doing otherwise, **limits and criteria values should be harmonised between different CMCs and between CMCs and PFCs**.

A.2.2. Delete contaminant criteria which are not justified

In particular, unless there is a specific reason to expect to find a given contaminant in a given STRUBIAS product (e.g. dioxins in ash-based or pharmaceuticals in non-incinerated products recovered from municipal wastewater or manure), we consider that **“additional” contaminant limits should not be specified, that is the PFC contaminant limits should suffice** (as is the case for e.g. composts, digestates, food industry by-products CMCs).

For example:

- **Remove ‘additional’ heavy metal limits** proposed in the draft nutrient recovery rules, unless there is data to show that a specific heavy metal is likely to be found in the recovered material concerned and is not found in virgin materials and industrial byproducts (cf. IMCO amendment 281), and there is scientific evidence that the possible levels in the recovered material are susceptible to pose health or environmental risks.
- An exception may be **dioxins/furans and PAH which may be a specific possible pollutant in ashes or biochars** because potentially generated by the production process in some circumstances. However, for biochars measurement of dioxins/furans should only be required if the input material contains significant levels of chlorine. See comments line 3263.
- **Delete the <3% organic carbon criterion for “Class B” ashes**, because by definition (of input materials) they are coming from installations which are obliged to respect this <3% organic carbon limit.
- **Ba (barium) and B (boron)** are not, to our understanding, limited in any other legislation, so it is not appropriate to limit them for recycled fertiliser CMCs (ash, biochars).
- **Mo (molybdenum), Mn (manganese) and Co (cobalt)** are micro-nutrients, of value in some circumstances as crop fertilisers, so should not be subject to a limit but to a labelling threshold.
- **Remove phosphorus solubility criteria for phosphate salts and ashes** as this is ensured in PFC criteria, or simply refer to the PFC criteria

- **Remove the nutrient oxide ratio criteria for ashes**, which duplicates PFC1(C)1a nutrient content specifications for mineral fertilisers
- **The respirable particle criterion should be in labelling only** (<10% particles < 100µm) not as an exclusion parameter (as currently proposed for biochars and phosphate salts), in order to ensure treatment coherent with virgin materials and other CMCs
- **Remove process temperature/time criteria for biochars**, in that the H/C_{-org} is sufficient to guarantee removal of organic contaminants and pathogens
- **Delete O/C_{-org} for biochars**, in that the H/C_{-org} is sufficient
- Set the **PAH limit for biochars** to <6, in coherence with other CMCs
- **Remove the PAH limit for phosphate salts**: there is no reason to expect significant levels (above background) of PAH in these materials
- **PCBs in biochars** should only require measurement in biochars and phosphate salts if the input material is susceptible to contain them. See line 3263.
- **It should be discussed whether to maintain the macroscopic impurities criterion for phosphate salts or to add it for ashes and biochars**. Glass, metal and plastics will generally not be found in phosphate precipitates, but there may be organic macro-particles from the substrate (e.g. seeds) which may not be effectively limited by applicable (CMC or PFC) organic carbon limitations. Inorganic macro-particles may be found in ashes or biochars from substrates such as food waste if sorting / separative collection is not very performing. Although the market can self-regulate products with undesirable macro-particles (such products will not be accepted by farmers and fertiliser distributors) it may be preferable to include this criterion in the CMC, in the same way as for composts and digestates.

A.2.3. Exempt testing where a contaminant should not be there

It is not appropriate to penalize a fertiliser producer which uses a secondary material (e.g. ashes) by obliging additional product testing costs for a specific CMC contaminant (e.g. dioxins), if the processing of the CMC means that **the contaminant will inevitably no longer be present at relevant levels**.

For example (note: in all cases, PFC limits must in any case be met and monitored):

- If fertiliser is produced using ash for which dioxins were already tested at the output of the incinerator (e.g. as a requirement of the incinerator operating permit) then a company using this ash to manufacture a fertiliser product should not have to again measure dioxin in the finished product (subject to demonstrating that the process does not significantly concentrate dioxin)
- If a fertiliser is produced using ash for which a contaminant was already tested and shown to be less than 2 x the CMC limit, and in the production process a combination of 10% ash and 90% virgin materials is used, where the virgin materials do not contain significant levels of the contaminant, then testing of this contaminant in the final product should not be required (again subject to demonstrating that the process does not concentrate the contaminant)
- If a fertiliser producer can demonstrate that the processing of the secondary raw material will either remove or destroy a contaminant, then testing in the final product should not be required (e.g. if ash is reacted in acid or alkali at a concentration known to destroy dioxin molecules, then testing of dioxin in the final product should not be required)

In all cases, if a company can demonstrate that all the input materials they are using to produce the CMC are relatively clean (e.g. low heavy metals), then they should not have to test their product for concerned heavy metals. Also, if a company can demonstrate that their process does not result in or removes a given contaminant, then they should not be obliged to test for it. That is: **CMC contaminant testing requirements should be exempted or monitoring frequency significantly reduced if a company can justify that there is no reason that the contaminant should be there**.

In particular, if monitoring consistently shows low levels of dioxins (PCDD/F) in ash (or other materials) then frequency of testing should be minimalised, because analysis is relatively expensive, subject to there being no significant modification in parameters of input materials or incineration/treatment process.

A.2.4. Specify testing methods and testing costs

Throughout the STRUBIAS report, and for all three STRUBIAS materials, must be provided for all proposed contaminant and quality testing requirements:

- **Identification of standard test methods**
- **Definition of monitoring frequencies and methods**
- **Specification of tolerances**
- **Cost estimates for the recommended testing**

This information should be part of the impact assessment and of the feasibility analysis requested in the DG GROW mandate.

A.3. Ash-as-a-process-ingredient and definition of “post-processing”

A.3.1. Sewage sludge incineration ash

The new **German (and Swiss) legislation will render obligatory recovery of phosphorus from important volumes of sewage sludge incineration ash¹**. This immediately concerns phosphorus recovery from sewage sludge ash in these countries, but is likely also (by leading to large-scale implementation of technology, demonstration, new technologies, improved economics) to facilitate phosphorus recycling from sewage sludge ash and other ashes elsewhere. This will enable recycling of significant quantities of secondary phosphates in the Nutrient Circular Economy.

Sewage sludge incineration ash is readily transportable (dry, stable) so that international trade of this raw material is expectedⁱⁱ and a number of different processes are already being tested or constructed full-scale which can produce commercial fertiliser products from sewage sludge incineration ash, which should not be excluded from use in CE Fertilisers. It is therefore **important that processing of sewage sludge incineration ash to products conform to EU Fertiliser Regulation quality criteria should be enabled through STRUBIAS**.

A.3.2. JRC proposed approach for STRUBIAS criteria for “ash as a process ingredient”

We understand from JRC’s Q&A of 21/6/2017 (in response to ESPP’s email question of 9/6/2017) and from JRC’s further explanation at the ESPP stakeholder meeting, Brussels 5/9/2017, that it is proposed the STRUBIAS contaminant and nutrient content criteria (proposed “nutrient recovery rules” pages 111-114) should apply to the FINAL PRODUCT in the case of ash entering chemical processing, and not to the ash itself.

Such chemical processing can include, amongst others, as examples: (1) react ash with sulfuric acid to produce phosphoric acid, then purify the acid, then finally use the purified acid as in input material to manufacture a ‘standard’ fertiliser product such as TSP and its NPK derivatives (such as MAP and DAP); or (2) react ash with sulfuric acid (to produce TSP) or with phosphoric acid (to produce TSP) and then reprocess these into PK and NPK derivatives

It is our understanding that, in this case, the proposed “nutrient recovery rules” would then apply as follows, that is the contaminant and nutrient criteria are NOT applied (in this case) to the ash, nor to the intermediate material (green acid, purified acid, super phosphate).

Recovery rule	Page	Apply to the production of the ash (combustion process)	Apply to the final fertiliser product* (e.g. SSP, TSP or their NPK derivatives)
Product quality and labelling			
- Nutrients	111		X
- Contaminants	111 and 112		X
Input materials	113	X	
Process conditions			
- Core process	114	X	
- Additives	114	X	
- Post-processing	114		X

* the final fertiliser product must also and in addition respect the PFC criteria for the category in which it is sold

To our understanding, the proposed nutrient recovery rules would apply to any finished fertiliser product (such as SSP, TSP or their NPK derivatives) made almost entirely from virgin materials (inc. phosphate rock) if **even a very small amount (non zero) of ash-derived materials had been used at any stage in the production chain of the product** (e.g. phosphoric acid made partly from ash).

We therefore propose to change the name “ash-based materials” to “ash containing materials”

A.3.3. JRC proposed “post-processing” wording

In the proposed “Nutrient Recovery Rules (p114, STRUBIAS report), JRC proposed the following wording (note: this takes into account the modifications sent in the JRC “Q&A” of 21/6/17 published on the STRUBIAS working group closed website, clarifying their email response of 17/6/17 to ESPP’s email question of 9/6/17)

"Post-processing: Ashes as obtained from incineration can be chemically reacted with (1) virgin substances/mixtures registered pursuant to Regulation 1907/2006 (REACH) having a chemical safety report covering the use as a reactive agent in the manufacturing of fertilising products, and (2) on-site generated by-products that are REACH exempted on the basis of Annex V of Regulation 1907/2006 with the intention to improve plant nutrient availability and/or metal/metalloids removal. The post-processing of ashes must not lead to any overall adverse effect on human, animal or plant health, or on the environment, under reasonably foreseeable conditions of use in any CE marked fertiliser product containing this CMC."

Possible issues with the JRC wording

The following processing routes for ashes would appear to be excluded with this proposed wording (note: some of these are ‘hypothetical’ – the objective is not to indicate processes operational today, but to identify possible ‘cracks’ in the JRC wording:

- a) Industrial by-products: Example 1: Reaction of ash with sulfuric acid to produce phosphoric acid (which could then be processed to produce fertilizer products such as TSP, MAP or DAP). Sulfuric acid (as used in the phosphate industry) is not a virgin material, but a by-product of e.g. oil refining, metal cleaning or other industries, and in the example here is not an “on site” byproduct as per the JRC wording. Example 2: use of sodium sulfate in ash processing, where sodium sulfate is a byproduct of flue gas cleaning, so again is not an “on site” byproduct. Example 3: the ECOPHOS process for recovery of phosphate compounds from ashes uses hydrochloric acid, which might be a by-product from industries such potassium chemicals or isocyanates/polyurethane. Example 4: Ash is reacted with either sulfuric or phosphoric acid to produce SSP or TSP, which is then mixed with by product ammonium sulfate from caprolactam production and potash to produce and NPK. These examples concern industrial by-products which are excluded by the JRC wording “virgin substances/mixtures” and which are not covered by the JRC wording “on site”. This might not be resolved by the proposed industrial byproducts amendment.
- b) Bio-sourced materials: ash is converted to phosphoric acid, then reacted with e.g. agricultural by-product lignin to produce an organo-mineral fertilizer. Such biological materials may not be REACH registered as per the JRC wording. Additionally, such a final product will contain > 3% C_{-org} so will not meet this STRUBIAS ash criterion.
- c) Recovered minerals: ash is converted to phosphoric acid, then reacted with recovered calcium phosphate to produce TSP (where the calcium phosphate is recovered from e.g. a food industry liquor waste stream, and is a STRUBIAS “phosphate salt” CMC).
- d) Two different ashes: phosphoric acids produced (separately) from two different ashes (at two different ash processing sites) are purchased by a fertilizer manufacturer and used together in the same plant to produce a fertilizer such as SSP, TSP and their NPK derivatives.
- e) Phosphate rock: ash is reacted into a process using also virgin phosphate rock. This may be done because the ash is used in an existing fertiliser factory (e.g. for logistical or local circular economy reasons, or to reduce the cadmium content of the final fertiliser product), or because phosphate rock is added in an ash processing plant to adjust the P content of the final product

(P content in ash is variable). Mineral rock is exempted from REACH, so does not comply with the JRC wording.

- f) Organo-phosphorus products: ash is reacted (via phosphoric acid) with petro-chemical derived organic chemicals (virgin chemicals) to produce a phosphonate, for use as fertilizer. The final product would not respect the <3% C_{org} criterion.
- g) Upstream process reagents: ash is reacted to phosphoric acid, then chelatants are used to remove contaminants from the acid, before the (partly purified) acid is then used in manufacture of TSP, MAP or DAP. It is unlikely that the REACH dossier / CSR for such chelatants will include use in fertiliser manufacture. Further, it may not be appropriate to include use in fertilizer manufacture in the REACH dossier / CSR (or the Lead Registrant may refuse to do so) because the substance is not being used for fertilizer manufacture but for acid purification.
- h) Input to compost or digestate production process: ash is used as an input additive (e.g. liming reaction agent) in anaerobic digestion or composting. This would appear to be possible under CMC3 or CMC5 (if the ash is REACH registered and used at <5% of input). The resulting compost or digestate would appear to be authorized under CMC3 or CMC5 but excluded under the 'processed-ash' CMC which is confusing.
- i) Blending with compost or digestate: if ash is mixed with a finished compost or digestate, does this count as "blending" (PFC7), even if there is a chemical reaction? It should perhaps be clarified that in this case, the ash must itself respect the STRUBIAS ash criteria (in the same way as ash-used-directly) and not the final blended product

Proposals to adjust the JRC approach

- A) The term "Post-processing" seems to have caused confusion amongst stakeholders, because this vocabulary is generally used in industry to imply finishing steps (such as granulation, drying, sieving ...) and not to refer to chemical industry reaction / product production process (generating a new chemical substance). We suggest to replace by something clearer such as: *"Chemical/industry processes in which ash can be used to produce a fertilizer product"*
- B) The 3% C_{org} criteria should be applied to the ash production stage (to the initial ash) not to the ash after processing. This is logical in that the 3% C_{org} is relevant to the "core process" (it is a result of the combustion process parameters) and is not as such relevant to the final product (the C_{org} level of the final product will depend on its different component materials, and will define the PFC criteria it must respect)

However, we do not consider that such adjustment of the JRC approach will make it either comprehensible to industry, nor resolve flaws and gaps possibly resulting from processes, materials, intermediates, etc which have not been yet identified or which might appear with innovative recycling approaches.

A.3.4. ESPP proposal for ash used as input for chemical reprocessing

ESPP proposes to **treat ash exactly as are treated virgin materials (CMC1)* but subject to the final product (as placed on the market) respecting the specific additional STRUBIAS ash criteria** (input materials, combustion conditions, specific contaminant limits).

* and industrial by-products as authorized by the IMCO amendment

That is, ESPP proposes to remove all constraints for "post-processing" for ash (any form of chemical or other post-processing is authorized) – that is the ash would be subject to the same post-processing constraints as CMC1 materials (no constraints other than the general Fertiliser Regulation constraint that only CMC1 or other CMC materials can be used).

This ensures a level playing field between virgin and recycled (ash) materials, whilst ensuring the appropriate specific safety requirements.

This ESPP proposal would above would operate as follows:

Because ash is excluded from CMC1 because it is (or has formerly constituted) a waste, any CE fertilizer product containing ash(es) as an input material (in any quantity, at any stage of the upstream production chain) must fulfil the following,:

- **The ash(es) must respect** the proposed STRUBIAS criteria for “B - Input Materials” and “C – Process Conditions” – and $C_{-org} < 3\%$ (that is, the ashes at exit of combustion)
- **The final CE product as placed on the market** (in addition to respecting PFCxx criteria depending under which category it is sold) must respect the proposed STRUBIAS criteria for “A – Product Quality and Labelling” (except C_{-org} see above)

It can be questioned how to deal with the combustion-related contaminants (dioxins, PAH) in this proposal. If limits are applied at the final product stage, this effectively allows dilution of these contaminants, and so introduction of new contaminants into the environment. If limits are applied at the ash stage (exit of combustion) this prevents development of processes which remove these contaminants. Preferably, the final product would have to fulfill one of the following: (1) the ashes used must fulfill the dioxin and PAH criteria (at exit of combustion) OR must demonstrate that these have been removed during the reprocessing (from ash to final product).

A.3.5. Clarification of “post-processing” for all three STRUBIAS materials

A clear and detailed explanation of what is authorized as “post processing” (we suggest to change this misleading terminology) should be developed for all three STRUBIAS materials:

- for biochars and phosphate salts, this line of the proposed nutrient recovery rules is currently empty, so it is not clear whether processes are authorized such as drying, granulation, polymer-coating or blending with other materials (the latter is maybe covered by PFC7)
- we suggest to modify the currently misleading use of the terminology “post-processing” and replace by either “finishing” to cover processes without chemical reaction, or “chemical re-processing” to cover further processing involving chemical reactions
- the currently proposed text for ash needs reconsideration (see comments below on wording)
- we suggest to clearly specify that finishing is authorized for biochars, and chemical re-processing for ashes and phosphate salts
- this question, and the vocabulary used, needs clarifying throughout the report (e.g. where it currently refers unclearly to “normal industrial practice”).

See our detailed comments under line 44.

A.4. Contaminant removal or dilution in ashes

A.4.1. Contaminant removal or dilution in ash-as-a-process-ingredient

It needs to be resolved whether contaminants present in ash used as a process ingredient (e.g. heavy metals such as mercury or lead) must be removed in the processing (to a waste stream for disposal or to a permanent sink such as cement production) or whether these contaminants can acceptably be diluted.

Full scale processes are today tested or under construction involving removal of contaminants from ash (e.g. Ecophos, Zurich process) or dilution by mixing or co-reaction in the process (e.g. combining ash with phosphate rock in existing fertiliser production factories) or a combination (some removal and some dilution, e.g. where some phosphate rock is added to a process to adjust final product levels to compensate variations in ash input material).

This raises questions of political acceptability and of legality.

Legality of contaminant dilution

It is our understanding that the EU Waste Framework Directive 2008/98ⁱⁱⁱ art. 18.1^{iv} and art. 7.4^v forbid the mixing of waste to dilute contaminants ONLY for “hazardous” wastes. In some cases, ashes (some or most sewage sludge incineration ash) or intermediate materials produced from them (such as phosphoric acid) will be classified as “hazardous” wastes.

However, derogation from art. 18.1 is foreseen in art. 18.2 subject to the operator having an appropriate waste permit, adverse environment and health impact is not increased (art. 13^{vi}) and BAT is respected. It is our understanding that such derogations are normal practice in place for other recycling industries.

To our understanding, there is no legal restriction or exclusion to diluting contaminants in “non hazardous” wastes.

It thus appears that there is no legal obstacle to dilution of contaminants in processing of ash under EU legislation, subject to:

- Ensuring environmental and health protection in the final product (c.f. art. 6^{vii} of the Waste Framework Directive), which is by definition “recognised” if the product is an EU Fertiliser
- For “hazardous” ash or processing intermediates, subject to the conditions of art. 18.2 of the Waste Framework Directive.

Political acceptability of contaminant dilution

In terms of level playing field, it should be noted that it is not required to remove cadmium or other contaminants from phosphate rock to achieve (not yet decided) Fertiliser Regulation limits. A company could achieve these limits by mixing high and low contaminant-level rock inputs, and indeed it is expected that in many cases this is what industry will do. If such ‘dilution’ of contaminants is not authorised for processing of ash to fertilisers, then the principle of a level playing field for recycling is not respected.

Mixing of different ashes into existing fertiliser industry processes is a significant potential route for phosphorus recovery from ashes, and in particular from sewage sludge (see comments above on the importance of P-recovery from sewage sludge given the new German and Swiss legislation). This route offers advantages of cost, use of existing infrastructure (both for processing and for logistics/marketing of the finished product), products adapted to farmers habits and needs. Not allowing dilution by mixing would reduce considerably the potential phosphorus recycling of sewage sludge ashes and of replacement of imported virgin phosphate rock or acid by secondary materials. One company indicates that currently proposed CMC and PFC contaminant limits would, in this case, limit replacement of virgin materials in their production to around only 10%

It can be suggested that “removal” of contaminants may be preferable in terms of reducing contaminant input to the environment and the food chain but this will depend on the LCA (environmental costs) of the removal technologies and on the final destination of the “removed” contaminants (landfill ? other ?)

It should be taken into account that contaminants in ash are not a net addition to contamination of the food chain: they result in many cases from concentration in sewage, then further concentration in ash, of elements which were disseminated in the environment, such as lead or copper from drinking water, or heavy metals entering the food chain and so sewage from soils. In this case, the return of such “recycled” contaminants to the environment (under conditions which ensure health and environmental safety as guaranteed by the CMC and PFC contaminant limits of the Fertiliser Regulation) should be compared to the introduction of new contaminants into the environment in phosphate rock. Dilution of contaminants in recycled materials can be considered to go alongside the use of recovered fertilisers to reduce heavy metal input to the environment / food system from phosphate rock.

Maybe one constructive solution to this would be to replace the “dilution / concentration” concept by a “total acceptable amount” concept. As an example: If a piece of wood bark contains a certain amount of cadmium, then the cadmium concentration will increase through incineration whereas total amount remains the same. Contaminant limitation should maybe be regulated by thresholds of total amounts recycled or applied to fields, rather than by concentrations, which would resolve the “dilution” question.

A.4.2. Dilution of contaminants in direct use of ash after blending

If ash is not further chemically processed, but is used directly on a field after e.g. granulation or mixing, then the final product is the ash. However, clarification is needed concerning blending. **Is dilution by blending to achieve the proposed contaminant limits or nutrient availability criteria accepted?**, e.g. if ash (containing PK) is blended with DAP and magnesium sulfate to adjust N, Mg and S crop needs, are the nutrient and contaminant criteria tested on the ash or on the blend?

A.5. Phosphorus solubility criteria

We suggest that **the phosphorus solubility criteria should be deleted for phosphate salts and ash-materials, because these materials will be placed on the market as PFC “mineral” fertilisers**, or for phosphate salts only possibly as “low carbon” fertilisers (IMCO amendment 132), for which phosphorus solubility is already specified in PFC criteria (this is not the case for biochars which will be sold under other PFCs). Including CMC phosphorus solubility for these two categories is therefore unnecessary and susceptible to cause confusion with the PFC phosphorus solubility criteria (but see our footnote question)^{viii}.

The citric acid solubility should preferably be deleted and replaced by reference to NAC OR water solubility OR formic acid. This is coherent with the specifications and limit values in the draft Fertilisers Regulation (PFC1(C) with the IMCO voted “OR” amendment: IMCO n°133). If reference to only one solubility test is retained, this should be to NAC (neutral ammonium citrate), which is most representative test of plant phosphorus availability (reference: P-REX results).

If the inappropriate reference ONLY to 2% citric acid solubility is retained, then the limit value should be reduced.

The option should be included to demonstrate plant availability of phosphorus by other methods (soil incubation tests, pot or field trials, bio-assays, Olsen P 0.5 M NaHCO₃ extraction, Bray P for acid soils ...) for materials where the solubility tests may not accurately represent in vivo plant nutrient availability.

A.6. Comments on the proposed criteria for ash-based materials

In addition to the fundamental issues discussed above regarding the definition of “post-processing” (ash used as an ingredient for chemical manufacturing of other fertiliser products) and dilution of contaminants, the following comments concern the proposed “nutrient recovery rules” for ash-based materials, both where ash is used directly as a fertiliser (applied to fields after e.g. blending or granulation) and where ash is chemically processed to generate fertiliser products.

A.6.1. The proposed oxides ratios

The proposed minimum nutrient oxides ratio $(K_2O + P_2O_5 + SO_3)$ /(various oxides) ratio of >0.3 (30%) poses a number of issues, which we propose to address as follows:

- a) **The proposed limit of >0.3 is too high.** Bonemeal ashes widely marketed today are between 0.25 and 0.3. Also, products from thermal processes such as AshDec have a ratio around 0.25. **We propose to reduce the required limit to 0.2**
- b) **Widen to include magnesium and calcium**, as is already proposed for biochars, in order to ensure coherence between the proposed CMCs: $(P_2O_5 + K_2O + CaO + MgO + SO_3)$ /(all oxides)
- c) **Calculate over total dry mass.** The calculation of the bottom line of this ratio $(SiO_2 + Al_2O_3 + Fe_2O_3 + Na_2O + TiO_2 + CaO + MgO + MnO + K_2O + P_2O_5 + SO_3 + Cl_2O)$ is unnecessarily complex and potentially expensive. It is not standard procedure to test titanium concentrations for example. We do not see the interest of this complex list of oxides: if an ash contains a significant level of some other metal this will reduce its fertiliser value, but not appear in this calculation. We suggest to replace by $(K_2O + P_2O_5 + SO_3)$ /(dry mass). The result is likely to be very similar, as ashes will not contain water, carbon or nitrogen. In reality most companies will probably make this calculation anyway then if the ratio is above the limit (based on total dry

mass) then they know they do not need to do the analysis of the 12 elements. Changing the bottom line of the ratio to “dry mass” would make the proposal much more legible to users.

NOTE: it is probably similarly appropriate to change the bottom line of the first ratio (CaO + MgO + MnO)/(...) also to total dry mass, but this concerns liming materials not nutrient products and is outside ESPP’s competence, but see comments from OMYA included in this submission.

- d) **Preferably, however, we propose to delete this (K₂O + P₂O₅ + SO₃) criterion** and to replace it by the requirement to fulfil either the first proposed ratio (see comments on this ratio below) or the requirements of PFC1(C)a-I straight solid mineral macronutrient fertiliser or PFC1(C)a-ii compound solid mineral macronutrient fertiliser. Setting criteria for fertiliser products which include ash as one of their upstream process components different from fertiliser products made only from virgin materials will cause market confusion and is not a level playing field.

Concerning the liming oxides ratio (CaO + MgO + MnO)/(various oxides) > 0.3 (30%) is not ESPP’s competence, however we refer to the detailed comments received from OMYA/MEAC’s expert in the French AFNOR BN Ferti Group and convenor of ISO/TC 134/WG 4 Mineral soil amendments. We include these below and suggest that JRC take them into due consideration in consultation with other experts from concerned industries and stakeholders.

A.6.2. Widen input materials list for ashes

The input materials list should be extended for ashes to allow industrial wastes, e.g. aqueous, used to adjust processing, where these do not pose risks or compromise ash quality and properties. Reference to EWC waste codes should be used where useful. See further detail in comments to line 4022. See also alternative IED incineration conditions (for Class B ashes) in comments to line 4022.

Cat. 1 ABP should be authorised as input materials for ashes, subject to incineration conform to the relevant ABP End Point, as is the case at present in certain Member States where this material is already used in fertiliser in significant quantities. This is an important potential source of P and K. To our understanding this is legal under ABP Regulation and poses no safety questions (subject to relevant incineration conditions being respected, as per the ABP End Point)

A.6.3. Adjust certain contaminant limits for ashes

The **Sb (antimony)** and **Mo (molybdenum)** limits for ash (used directly) are unjustified and too low. We would suggest to increase both of these to the same level as As (arsenic) in PFCs.

Ba (barium) and **B (boron)** are not, to our understanding, limited in any other legislation, so it is not appropriate to limit them for recycled fertiliser CMCs (ash, biochars).

B (boron), Mo (molybdenum), Mn (manganese) and **Co (cobalt)** are micro-nutrients, of value in some circumstances as crop fertilisers, so should not be subject to a limit but to a labelling threshold.

A.7. Comments on the proposed criteria for phosphate salts

A.7.1. Phosphate salts which are chemically processed

The term “normal industry practice” (line 44) is not a useful description and this point needs to be clarified. ESPP proposes that the JRC proposal for defining “post-processing” of ashes (dealing with ash which is chemically processed to other fertiliser chemicals) should also be applied to phosphate salts.

Struvite has been extensively demonstrated to be a quality fertiliser, so that in general it will be used directly as such (after e.g. blending with nitrogen and potassium compounds to balance nutrients, granulation, polymer coating or other finishing) but not chemically reprocessed.

We note that the question above for ashes concerning **dilution of contaminants and modification of nutrient solubility ratios during blending** applies equally to phosphate salts.

However, other phosphate salts, such as some calcium phosphates or other metal phosphates, may be chemically processed to improve plant nutrient availability or other properties.

We therefore propose that, as for ashes, the “Nutrient Recovery Rules” for phosphate salts be applied after “post processing”, where this is defined exactly as for ashes (see discussion above on this definition).

It would not be coherent to effectively “allow” post-processing for ashes but not for phosphate salts, and this would generate a non level playing field between different treatment/recovery routes for waste streams and so potentially favour incineration or organic waste streams.

A.7.2. Input materials for phosphate salts

The list of input materials for phosphate salts should be extended to add

- fertiliser industry waste/byproduct streams
- some streams from sites handling animal by products (e.g. meat, dairy and food processing), the latter subject to ABP End Points / CMC11 (DG SANTE)
- not only potato treatment with sodium acid pyrophosphates and food processing with “no chemical substances and additives” (under “specific” food processing industries), but also any food industry using only “food additive” authorised chemicals. Why exclude food processing where vinegar or alcohol or salt have been used
- a number of vegetable processing and other materials are specified in other CMCs: we propose to authorise struvite recovery from other CMCs (e.g. any CE-labelled digestate). This ensures coherence.

A.7.3. Widening from struvite to “phosphate salts”

ESPP supports the widening to “Recovered P-salts” (not only “struvite”) as this corresponds to potential processes (e.g. K-struvite, brushite), to the fact that in some situations the precipitated phosphate will be a mixture of calcium and magnesium phosphates, and possibly to the widening to other metal phosphate salts where their fertiliser value is demonstrated. This is not a problem provided that the farmer is informed of the different nutrient content and that the phosphorus plant availability respects the PFC “mineral” or “low-carbon” fertiliser criteria.

The (Ca+Mg)/P > 0.8 molar ratio criterion is too narrow. Mono- and di- potassium phosphate salts are for example excluded whereas these would be valuable fertiliser materials potentially recoverable from waste streams, either nearly pure (e.g. by dosing potassium salts to a P-rich stream) or mixed with other phosphates (recovery from potassium rich streams such as calf manure). The standard fertiliser products MAP and DAP are also excluded. We suggest to delete this ratio to allow other phosphate salts.

A.7.4. Carbon and contaminant limits for phosphate salts

The **PAH limit for struvite** / recovered phosphate salts is not justified.

We suggest to delete the proposed <3% organic carbon (C_{org}) limit for phosphorus salts. An amendment is currently under discussion in European Parliament (supported by both the mineral and the organic fertiliser industries, and adopted by IMCO n°132) to define within PFC1: mineral fertiliser for C_{org} < 1% and “low carbon” fertiliser for 1% < C_{org} < 15% (the level for organo-mineral fertiliser). Adding a new, different cut-off limit for P-salts will cause unnecessary confusion, whereas the organic carbon can be of interest to the farmer (given that its quality is ensured by the list of accepted input materials, contaminant limits are respected, and the level is clearly labelled). We note that the information in line 962 onds. Indicates that the C_{org} limit is not justified for safety reasons. Quality and safety are ensured by the PFC specifications for the relevant categories (mineral and “low carbon” fertilisers) and the C_{org} < 3% is not therefore justified and should be replaced with the requirement that the final product respects criteria for either “mineral” or “low carbon” fertiliser PFC.

It should be discussed whether or not to remove the macroscopic impurities criterion for phosphate salts. See above.

A.7.5. P₂O₅ requirement and drying methods

The P₂O₅ minimum of 35% for phosphate salts is too high. This level is only applicable to struvite, in the in appropriate hypothesis that struvite is dried at 105°C so destroying it by driving off both the water of crystallisation and part of the ammonium (the material remaining is no longer struvite). Thus, fixing this limit requires use of a drying technique which is not applicable to struvite, and should not be used, and so will cause market misunderstanding (the actual % P₂O₅ even in pure struvite is << 35%, so farmers are not in fact getting 35% ...). If implemented as in line 1192, the 105°C proposal will effectively result in having two different drying temperatures, one for testing P₂O₅ and a different one for testing contaminants – this will cause confusion and complication and additional costs. Also, if the 105°C will generally incite industry or other stakeholders to use a drying method which should be avoided.

Furthermore, some calcium phosphates placed on the market as fertilisers today do not respect the 35% limit. A limit of maybe 20% would have to be fixed to cover both struvite (dried appropriately) and calcium phosphates.

However, we do not understand the logic of fixing a minimum phosphate requirement for recovered phosphate salts, other than that already defined in the draft Fertiliser Regulation for straight solid inorganic macronutrient fertilisers PFC1(C)(I)(a)(i) or for compound solid inorganic macronutrient fertilisers PFC1(C)(I)(a)(ii), page 8-9 of Annex II. If struvite or other phosphate salts are placed on the market as inorganic fertilisers, whether manufactured from virgin chemicals (CMC1) or recovered, they will have to respect these minimum P₂O₅ levels (12% P₂O₅ for a phosphate fertiliser): why should recovered phosphate salts have to also respect a different and higher P₂O₅ minimum. This is not a level playing field and will cause market confusion.

We therefore recommend to remove the minimum % level of P₂O₅ and to refer only to the PFC requirements.

All references to dry matter content or drying phosphate salts should be replaced with drying at temperatures which do not destroy struvite molecules or similar compounds – this includes to not drive off the water of crystallisation (see possible appropriate method standards in our comments on line 4019).

The “**dry matter content >90%**” criterion must also be based on a drying method must not modify the phosphate salt molecule and must not drive off water of crystallisation.

Also, the proposed 40% solubility in citric acid is too high for phosphate salts, and is not appropriate as the only P-availability test. We suggest in any case to not specify solubility in this CMC but to refer to PFC1 phosphorus availability requirements (with the proposed European Parliament amendment, this will specify citric acid, water “OR” NAC). If a specific criterion is maintained for phosphate salts CMC, then Neutral Ammonium Citrate (NAC) is the best indicator of plant phosphorus availability or preferably the criterion should specify water solubility in citric acid, water OR NAC.

A.8. Comments on the proposed criteria for biochars

A.8.1. Call biochars ... biochars

The term “pyrolysis materials” as title of this CMC is technically correct, but not comprehensible to farmers and the market. We propose to modify to “*Char materials including biochars*” or “*Hydrochars and biochars*”

A.8.2. Avoid fixing rigid time/temperature process criteria for biochars

ESPP suggests that the requirements for ensuring sanitation (animal by products) and degradation of organic contaminants such as pharmaceuticals, **should be ensured by appropriate testing of indicative substances in the final product (H/C_{org}), not by fixing temperature/time profiles for the pyrolysis process.**

Experience with composting and anaerobic digestion shows that results can be achieved with different processes (depending not only on temperature and time, but also particle size, pH, oxygen conditions ...) and that fixing one “profile” in regulation blocks innovation without improving security (some Member States then accept alternative profiles, leading to market confusion).

We also underline that the proposal for >500°C >20 minutes is based in effect on only one study which shows only that 300°C was inadequate and 500°C adequate, but says nothing about whether 400°C or 450°C are adequate. See on the other hand the extensive full-scale operating data from Hitachi Zosen (HITZ) which we understand have been transmitted to JRC.

A.8.3. Input materials for biochars

Sewage sludges should be accepted as input materials for biochars. There is no justification for excluding such an important nutrient recycling input resource, if sewage source control and biosolids selection combined with pyrolysis processes can achieve the STRUBIAS contaminant and safety criteria.

A.8.4. Contaminant limits for biochars

For coherence with the Fertilisers Regulation and to ensure a level playing field, the PAH limit for biochars should be the same as limits in the draft Fertiliser Regulation revision for composts, organic fertilisers and organic soil improvers, and the same as proposed in STRUBIAS for ashes and phosphate salts: **PAH₁₆ < 6 [not 4] mg/kgDM.**

The H/C_{org} criterion of < 0.7 should be maintained as proposed. This is a valid indicator of effective removal of organic contaminants and pathogens. Also, the O/C-org ratio poses analysis difficulties because some chars are modified during production (e.g. quenching with water to stop the process) or to create surface functional groups^{ix}. During this process char surfaces may be oxidized so modifying the O/C-org ratio. Thus, **the O/C-org criterion should be removed** as this does not provide useful additional information and is not reliable.

H/C_{org} must be tested on dry, ash free material, at least for materials with <50% carbon.

B) Conclusions of the ESPP stakeholder workshop

ESPP organised a workshop in Brussels, 5th September, with over 100 participants from a wide range of industries, farming organisations, environmental NGOs, national and EU regulators, including the European Commission (JRC, DG GROW, DG ENVI, DG SANTE).

This workshop included breakout sessions addressing the three STRUBIAS materials (phosphate salts, ashes, biochars) which were reported to and discussed in the workshop plenary. The conclusions of this workshop for these three materials are presented here:

B.1.1. Ash

rapporteur & moderator = Kristy Blakeborough-Wesson, Secanim/SARIA & Kees Langeveld, ICL Fertilisers

General approach

- As a general principle, quality criteria (nutrient content/solubility, contaminants ...) should not be “duplicated” in CMCs when already fixed in PFCs
- The modified JRC wording of “post-processing” to cover chemical reaction of ash to produce different chemicals requires further assessment, both as regards workability and the wording currently proposed

Contaminants:

- Molybdenum, manganese and cobalt are micro-nutrients. They can have added value. Therefore they should not be subject to an exclusion limit, but to a labelling obligation above the specified threshold.
- OK for the proposed limits on PAH, PCB and dioxins. It is appropriate to specify limits for all three (as proposed) because levels can be independent in ash
- Macroscopic impurities should not be limited (they are not in the JRC proposal for ashes) because the market will take care of this: farmers will not accept products containing e.g. lumps of glass
- Mixing / dilution of contaminants should be subject to the same rules as are applicable to virgin materials

Category 1 animal by-products (ABPs)

- Cat. 1 ABPs which are appropriately incinerated reach an ABP end-point, and the use of this ash as fertiliser is therefore legal. Indeed, this is widely practised in the UK (and elsewhere ??? examples of companies in other Member States ???). Cat. 1 ABPs also include materials such as Netherlands eggs, chicken manure or carcasses contaminated with Fipronil, where there is no safety question after incineration. Dialogue with DG SANTE would be useful to confirm the legality of use of Cat. 1 ash as fertiliser. Cat 1 ABP ash is rich in K and P, and is safe once incinerated under appropriately controlled conditions (as required by the ABP Regulations) and should not be excluded from use in ash based products.

Other comments

- Input material additives (additives added in the combustion process): the limit of 25% is appropriate, but the definition of accepted additives is too restrictive. In particular, additives may not be REACH registered, e.g. wastes or natural materials (such as silica, clay). Why should such limitations be applied for production of ash when not in processing of virgin materials (CMC1). At the same time, confusion between “feedstocks” and “additives” must be avoided.

Nutrient content

- The proposed limit of >0.3 for the ratio (phosphate + potassium + sulphate)/(total minerals) is too high, and would exclude both ashes which are today sold and recognised as fertilisers, and also standard manufactured fertiliser chemicals. ESP suggests > 0.2 as a limit.

B.1.2. Biochars / pyrolysis products

rapporteur & moderator = Mike Parr, Hitachi Zosen & Jürgen Kern, Leibnitz Inst. & Biochar COST

Sewage sludge should not be excluded as an input material for biochar production:

- Sewage sludge has the potential to be an important input material for biochar, recycling nutrients and organic carbon. There should be no exclusion of sewage sludge.
- If sewage sludge biochar can meet contaminant limits then there is no reason to exclude it.

Ensuring elimination of organic contaminants

- The best and safest way to identify the presence and levels of organic micro-pollutants in biochar is to measure the H to organic carbon ratio (H/C_{-org}). Page 112 of the JRC report places an upper limit of 0.7 on this ratio which is acceptable.
- It is not appropriate to set minimum process temperatures/times as proposed: the JRC report recommends a process temperature of 500°C and a duration of 20 minutes as process limits that will eliminate organic micro-pollutants which could range from antibiotics through to prions. The problem with this approach is that 500°C will reduce biochar yield. Furthermore, this temperature is not required to ensure that, for example, biochar derived from pig slurry feedstock has minimal micro-pollutants. The JRC report cites the paper by Ross et al. (2016) as justification for its 500C/20 minute process parameters. However, Ross et al. (2016) showed that there is no change in the amount of micro-pollutants above a process temperature of 300°C. The justification for 500°C is thus absent. In addition, Ross et al. (2016) clearly showed that 5 minutes residence time at 300 °C (or presumably even shorter at higher process temperature) is enough to eliminate organic pollutants.
- Furthermore, if the process parameter route is chosen as the way to ensure minimal micro-pollutants in biochar, for the reasons given above, different feedstock would need different process parameters. For example, animal bone may well need a 500°C/20 minutes process parameters to eliminate prions. However, since there are no prions present in pig slurry and since Ross et al (2016) showed that 300°C is adequate to eliminate residues such as antibiotics then a set of different process parameters could be specified for pig slurry or indeed a wide range of animal slurries. This raises issues of MRV (monitoring, verification and reporting).
- By contrast, using the H/C_{-org} ratio applied to any and all biochar, regardless of feedstock, focuses on results (does the end product meet contamination limits) and not processes. It also simplifies MRV - which can be implemented by a simple and regular test.
- The H/C_{-org} ratio must be tested on dry and ash-free biochar, in particular for the materials termed "Pyrogenic Carbonaceous Materials" (<50% carbon) in the report. If the biochar sample that is being measured is not ash-free, this will bias the resulting ratio i.e. it will give a false result.

The O/C_{-org} ratio should be deleted

- The O/C_{-org} ratio is proposed in the nutrient recovery rules and mentioned on page 112 of the JRC report. However, this fulfils a similar criteria to that of H/C_{-org} . There is no need to measure two such ratios given that a single ratio (H/C_{-org}) is sufficient to identify (or not) micro pollutants.

PAH limit for biochar should be raised from <4 to <6

- This would enable harmonize limit values with similar compounds (struvite, ash). There is no reason why biochar should be regarded more strictly than other fertilizer products.

B.1.3. Phosphate salts

rapporteur & moderator = Christian Kabbe, KWB Berlin & Pierre Jaouen, TIMAC

- Positive welcome to the widening of the definition to “phosphate salts” as proposed (not only struvite). However, this is contradictory to the proposed $(Ca+Mg)/P > 0.8$
- Need for more precise definition of post-processing (“normal industry practice” is not a useful description)
- Quality criteria are defined by PFCs and so should not be specified additionally for CMCs: organic carbon content, phosphate content, phosphate solubility, Mg/P ratio.
- CMCs should only define safety criteria
- However, a limit on organic carbon may be justified if it is demonstrated that this is a meaningful indicator of safety (organic contaminants, pathogens)
- Drying of struvite must not be at a temperature above that at which the molecule is modified (for determination of dry matter)
- More generally, analytical methods for testing all defined parameters should be specified, along with tolerances
- Add to authorised input streams:
 - fertiliser industry discharge
 - some streams from sites handling animal by-products (to be defined in CMC11 ?)
- It would be preferable that the Fertiliser Regulation ensure End-of-Waste status for phosphate salts at the material stage (CMC before post-processing) and not only for the finished fertiliser product (after post-processing at PFC stage. This would merit clarification.
- Alternative methods of assessing plant availability should be accepted (in addition to the P solubility criteria), e.g. Hedley method^x

C) Comments on liming ashes from OMYA/MEAC

Comments from François-Xavier Gaumont, francoisxavier.gaumont@meac.fr of Groupe MEAC, France (subsidiary of OMYA, the biggest company in the world dealing with calcium carbonate of natural origin for agriculture and industry), expert in AFNOR BN Ferti for fertilizers and liming material, France representative in CEN/TC 260/WG3 Liming materials and convenor of ISO/TC 134/WG 4 Mineral soil amendments.

Presently, ashes are listed in the French NF U 42-001-1 (Mineral fertilizers) that is mandatory and they may be put on the market through this standard. The minimum levels in this standard (respectively 2 % PO₅ and 5 % K₂O for ashes of vegetal origin) are quite high, and many ashes may not be put on the market because of these values.

In the same time, there is a new agronomic and legal intelligence of liming all over Europe and world : soil pH control is coming from bases (carbonates : CO₃⁻⁻, oxides : O⁻⁻, hydroxides HO⁻ and silicates SiO₃⁻⁻), not from calcium and magnesium. Consequently, we tend to consider now as liming materials (PFC 2) all the products containing bases, whatever their calcium or magnesium content. Ashes, with their high pH and significant Neutralizing Value have now been recognized having such a function.

The relevant indicator in products for this property [H+ (protons)neutralization in soils] is the Neutralizing Value (NV) which is standardized at EU level (EN 12945).

As a consequence of the above consideration, it was agreed at French and EU level (standardization and regulations as well) to progressively modify the old unit for NV, presently expressed as CaO, which is very confusing with calcium content, into a new universal unit : HO⁻.

In the same way, a new ISO standard 20978 has been prepared, agreed, and is presently reaching the DIS stage with a ring test also including ashes.

The EU Neutralization value standard EN 12945 has been modified accordingly, allowing this new unit, and the new HO⁻ unit has been introduced in the EN 14069 Denominations and specifications EU standard. The situation has been explained to the EU Commission, and in the drafts of the future new harmonized regulation for fertilizing products, the minimum NV requirements for PFC2 (Liming materials) are also expressed as HO⁻.

At the French level, we (BN Ferti) are preparing the introduction of [wood or agro/food industry] ashes in our NF U 44-203 mandatory standard as a mixt product by constitution, having both fertilizer (P, K, Mg, Ca, Mg as nutrients) and liming (NV) properties. A dossier is being prepared for France BN Ferti containing :

- Technical aspects : origins, ways of obtention, materials to be incinerated, necessary industrial treatments and practices before being considered as a fertilizing product , physical presentation, ...
- Efficiency aspects : claimed properties, physical and chemical composition, total and "available" or "soluble" nutrients (P, K, Ca, Mg), NV (chemical and by incubation), ...
- Innocuousness : trace elements, dioxins, ...

This dossier will be forwarded to JRC when completed, probably within 1-2 months from now.

I have got all the necessary information to prepare this dossier through different approaches, including a data base from different ashes providers and from industrial trial experiences (mixtures, granulation, forest liming, etc ...).

Already, the following comments on the STRUBIAS report can be made:

- 1) as Neutralising Value is the main property of [wood = C type] ashes that have much higher NV than nutrient content, NV of ash-based product should be labelled, whatever their proportion (1321), at least for "C-type ashes (1675).
- 2) as C-type ashes have both nutrient (PFC1) and neutralizing properties (PFC 2), in which PFC would you put it ? Mixt PFC by constitution ?
- 3) The 4 to 13 range of pH value seems to be much too large, at least for C-ashes alone(CMC) : All of fresh ashes have a pH higher than 12, tending to 8-9 after possible recarbonation, not lower.
- 4) Due to wood unburnt material in C-ashes, a maximum value of 3 % organic carbon (ie ~ 6 % organic matter) will be somewhat restrictive, except if ashes are strongly screened.

- 5) When speaking about Ca, Mg, K, Na, do not speak about “basic cations” (1297). It is non sense. Ca, Mg, K, Na are not basic (= cannot neutralize H⁺). Only oxides, hydroxides, carbonates and silicates can bring basic properties. Please speak of cations associated with basic anions. In combustion, “basic cations are not transformed into oxides”. There is no transmutation of Ca into O, HO or CO₃ !
- 6) In line 1310, it is true that the neutralizing value (=total potential neutralizing capacity, measured at extremely low level in HCl, see EN 12945) of ashes is lower than in Burnt lime. The 3 to 1 ratio mentioned for NV in ashes(1312), in our data base is much larger : burnt lime NV : ~90 as CaO equiv., where between 20 to 60 NV as CaO equiv. for C-ashes (till 1 to 4.5).
- 7) Additionally , we checked their effective NV by incubation (EN 14984). Their effective NV by incubation ranges from 100 % to 50 % of their chemically (HCl reaction) measured NV.
- 8) We also see significant differences between flying ashes and bottom ashes regarding trace elements (also mentioned in 2142), but from a practical point of view, in most existing existing units of C ashes, a part of the flying ashes are recycled in the bottom ashes (bottom ashes containing fine particles from multi-cyclones).
- 9) We experienced industrial addition of dolomite and granulation of ashes by compaction (2404), after preliminary : de-ironing, screening (5 mm), and limitation of water content for agronomic trials with ONF(Office National des Forêts), in order to compare the influence of different fertilizing practices on forest soil fertility when wood uptake is increasing more and more for energy purpose. In that way, fineness before agglomeration and after break down of the granule is a major criteria for efficiency towards pH increase because ashes are not a water soluble product.
- 10) In 1683, an easier criteria for C ashes type would be a minimum Neutralizing Value of 20 (as CaO) : CaO and MgO content are measured through Ca and Mg measurement, then conventionally converted into “CaO” and “MgO” but the calcium and Magnesium content is absolutely not connected to neutralizing properties : Gypsum has 36 % CaO (from Ca measurement) but 0 NV (from HCL reaction measurement) !
- 11) We confirm, in line 1705 that total phosphorus content is sometimes very far from available phosphorus (as soluble in ...). Many C ashes have a P citric acid/ total P lower than 40 % in our data base. In the same way, total K is not equal to water soluble K.

D) Line by line comments on the Interim Report text

D.1. Comments on the main text body

Line no	Comments
15	<p>'STRUBIAS materials can be used as component materials for the different Product Function Categories (PFCs)'. It is unclear if this wording means struvite would undergo further processing (chemical reactions) in order to be considered a PFC.</p> <p>1) Recovered struvite is often applied as a straight fertiliser or after finishing steps (e.g. blending with other nutrient products or coating with polymers to ensure controlled release or better handling). This text should be clarified to make clear that this is recognised and taken into account.</p> <p>2) The document should also make clear that the proposed criteria cover both direct use of struvite/phosphate salts as fertiliser (as above), but also use as input to further chemical reaction processing to manufacture other fertiliser products (e.g. chemical reaction with other nutrients source chemicals).</p>
44	<p>The paragraph 44-49 needs completely rewriting following JRC's Q&A of 21/6/2017 and the clarification that "post-processing" of ash can include chemical reaction. The unclear reference to "normal industrial practice" should either be removed or clarified by specifying in detail what sort of processes are covered or not covered by this term..</p> <p>It is essential for understanding of the STRUBIAS report and proposed Nutrient Recovery Rules to distinguish between:</p> <p>1) Finishing and conditioning steps where the product is prepared for use as fertiliser without chemical modification. To facilitate understanding, a wide list of such finishing steps should be included, but specifying that this is not complete and is for illustration only:</p> <ul style="list-style-type: none"> - filtration - grinding - sieving - granulation, including addition of bonding materials - wetting - drying, at temperatures which do not modify the chemical nature of the material - blending with other fertiliser materials - coating with polymers to improve release or handling, or other conditioning - ... <p>We would suggest to call this "finishing"</p> <p>2) Chemical processing, modifying the chemical nature of the material, to produce new or modified fertiliser chemicals - see above discussion of the definition / limitations to this chemical processing (comments on the text included in the proposed nutrient recovery rules for ashes "<i>ashes as obtained after incineration can be ...</i>") We suggest to call this "chemical re-processing"</p> <p>It is also important to clarify and throughout the report text, as in JRC's Q&A of 21/6/17, that "<i>the proposed material quality criteria will be evaluated after completion of the full production process chain</i>" – that is contaminant limits and nutrient content/solubility requirements will be evaluated AFTER (2) chemical processing, that is on the final fertiliser product (for example TSP or DAP manufactured by chemically processing a mixture of ash and phosphate rock).</p> <p>It is then also necessary to distinguish for which of the three STRUBIAS materials in the report (2) above (chemical re-processing) is authorised and for which only (1) finishing/conditioning is authorised. At present the "post-processing" line of the Nutrient Recovery Rules page 114 (is empty for phosphate salts and biochars).</p>
51	<p>Why are the assessment criteria I-II specified in lines 51-59 different from the mandate to JRC from DG GROW and from the criteria in Art. 42.1 of the draft Fertilisers Regulation ?</p>

	What other consequences (in addition to the exclusion of processed ash) result from this choice of wording ?
169	It should be added that End-of-Waste status to the CMC (prior to obtaining the CE label through a PFC) and to intermediates (e.g. phosphoric acid produced from ash, which will then be used in a fertiliser production process) can be granted by national regulators, self-declaration or other appropriate routes – independently of the Fertiliser Regulation
311	See comments below concerning agronomic and market value of struvite
352	See comments in introduction on phosphorus solubility.
378	Clarify what is meant by “ <i>end materials</i> ” – that is the EU label fertiliser, after chemical reprocessing if relevant
425	ESPP supports the widening to cover other phosphate salts
428	It should be noted here that there are now over 50 published tests of struvite, in pot and field trials, with a range of crops and at both acid and neutral soil pH, confirming that it is an effective fertiliser with plant availability comparable to commercial phosphate fertilisers (see update to mid 2016 www.phosphorusplatform.eu/scope121 not including further more recent data)
428	<p>Sustainable Arable LINK Project LK09136 undertaken in the UK by the Agriculture and Horticulture Development Board concluded that struvite outperformed triple super phosphate (TSP) and other P sources: ‘The best way of enhancing recovery of fertiliser P was to use struvite (a slightly soluble P compound recovered from wastewater) instead of TSP and place it close to the seed, but best recoveries were still <10%. Placement of struvite proved significantly better than placement of TSP at just one of the ten sites (with potatoes)’ – see page 16. The report is attached for information.</p> <p>See document:</p>  <p>UK LINK Project LK09136 final report I</p>
428	<p>Ostara has invested significantly into Crystal Green (recovered struvite) market development, including extensive research into the mode of action and plant response rates. To date over 175 trials across 13 crops have been undertaken, which has resulted in an initial application focus on crops that show a particularly strong response to phosphorus, such as potatoes and sugar beets.</p> <p>This development effort has allowed Ostara to position Crystal Green as a premium priced alternative to chemical phosphorus fertilisers due to the superior performance, including proven increase in crop yields.</p> <p>The Ostara Pearl technology is currently installed in 14 locations throughout North America and Europe with a combined production capacity of 20,000 tonnes per annum of Crystal Green. Due to the production development effort, some product inventory has been built up since production commenced in 2009, however, Ostara forecasts that their global annual fertiliser sales will exceed their annual production (which is forecast to more than double in the same period) by 2019/2020. In Europe, Ostara are already constrained by supply and have imported Crystal Green from their North American inventory to fulfil sales orders. Ostara’s North American market analysis has identified demand for around 45,000 tonnes of Crystal Green fertiliser per annum in potatoes and sugar beets alone and potential for over one million tonnes per annum based upon the crop trials conducted thus far. Equivalent market analysis is currently underway for the European market.</p>
326	Agreed - important
352	See comments in introductory section on phosphorus solubility
357	See comments in introductory section on phosphorus solubility
394	Also K-struvite (potassium ammonium phosphate) can be recovered. REACH registration may have not yet been done because to date the expense is not accessible to R&D or start-up pilots.
454	It is stated that “ <i>there may be a potential for P-recovery from sludges containing Al-P and Fe-P complexes as input materials for the production of recovered phosphate salt fertilisers</i> ”. That is, the ash would be used not as a fertiliser product itself, but as an input material to fertiliser production by chemical processing. Why is this possibility then ignored by proposing criteria only for ash used directly on the field, and not for ash as a chemical process ingredient?

457	It is stated that no recovery plant has been operated recovering iron or aluminium phosphates. This is incorrect. The INCOPA comments include details of the KREPRO full scale plant, Sweden, recovering iron phosphate from sewage sludge, which operated 1996-2000. This should be presented in the document and the references provided by INCOPA included.
461	The text appears to suggest that recovered iron phosphates inherently have high organic carbon content. This is not true. Low carbon iron phosphates can be recovered (cf. INCOPA comments). The section of text should be deleted.
466	As written, the report appears to exclude Fe and Al phosphates because of their high organic carbon content. This is incorrect, because these salts can be recovered with / or processed to low organic carbon content. This section of text should therefore either be deleted or rewritten.
474	ESPP supports the widening to “phosphate salts”
474	The current text is not clear. On the one hand it seems to suggest a limitation to Mg and Ca salts, on the other hand it suggests that other phosphate salts could somehow be “included ... at a later stage ... by delegated acts”. A later delegated act could modify the title of the new (STRUBIAS / delegated act) “phosphate salts”, could modify its criteria, or could add a new category for some other mineral salt. It should be clarified whether the objective is to include ‘all’ phosphate salts now or only Ca and Mg salts.
489	The $(Ca + Mg)/P > 0.8$ requirement makes no sense. This should be removed. This ratio seems to contradict examples in the paragraph 492-504
513	Ostara Crystal Green is applied directly as a fertiliser without further processing as an NP fertiliser type B.2.1 under the current regulation (EC) No 2003/2003.
753	The future completion of CMC11 (ABPs) does not prevent that it is logical to deal specifically with ABPs in each of these three STRUBIAS materials
775	Ostara successfully demonstrated the techno-economic feasibility of phosphorus recovery from fertiliser production (phosphogypsum) process water. Analysis of nutrient and heavy metals concentrations in Crystal Green produced from this source is consistent with analysis from municipal wastewater sources. We consider that this input material should be added. More data available on request.
908	See comments in the introductory section concerning the <3% organic carbon limit for phosphate-salts
916	“metals and metalloids” are independent of organic C – so should be removed here, or the paragraph rewritten
919	For phosphate salts, PCDD/F, PCB, PAH are not principally dependent on organic C content. Rather, they depend on contamination of input/substrate flows.
1284	This states that the name “ash based materials” is proposed to cover both raw ashes obtained from the incineration process as well as ashes that have been processed in the aim to partly remove metals etc. This should be clarified and the name changed to “ash containing materials” see our comments in introduction.
1087	The proposal to fix a limit for PAH the same as for digestates and composts (line 1087) is not justified: a possible limit for struvite should logically be considerably higher than for e.g. composts or digestates or biochar, given the higher nutrient content of struvite and consequently lower expected application rates. In any case, the evidence suggests that significantly higher levels are not expected. Overall, there is no reason to expect struvite (as specified in line 587), which does not come from a thermal process, to contain significant levels of PAH. The levels noted in some samples by STOWA (line 898) at 9 mg/kg or others (line 1021) even lower can be considered not significant. We propose to delete this criterion for phosphate salts.
1192	The proposal to have two drying temperatures, one for testing P_2O_5 content, one for testing contaminant content, will result in confusion for industry and for farmers.
1285	Line 1285 states: “whenever the fertilising materials are partly manufactured from ashes, all criteria of CMC “ash-based materials” should be met”. Please refer to our comments in introductory section concerning clarification of this.
1292	Ashes from poultry manure and meat and bone meal are also widely used already today as fertiliser
1304	These ashes are not used as a “component” of fertiliser, but directly as such after in some cases finishing processes such as making into pellets for easier handling or spreading
1413	This is incorrect as written and should be modified: ABP rules currently allow the use of ash

	from Category 1 ABP incineration to be used as fertiliser. Ref: ABP Implementing Regs 25 Feb 2011 - Section 9 in intro – allows use of residues in P fertiliser and the 181 regs are repealed
1424	Phosphorus recycling will often concern ash from fluidised bed incineration, therefore fly ashes are also significant and should be mentioned here.
1432	And throughout the document. Replace the term waste by residues to avoid discussion concerning end of waste criteria, unless it is specifically intended to imply a material having waste status and not a by-product or a material having perhaps obtained end-of-waste status through national or self-declaration procedures.
1454	The organic carbon limit is not necessary if installations are operating to the Industrial Emissions Directive requirements (850°C, 2s)
1457	ESPP supports the reference to IED and ABP combustion conditions and also the proposed more lenient conditions for the listed biomass and biowaste input materials, in order to cover installations operating with energy production objectives rather than waste disposal objectives.
1496	Various industrial wastes/by-products can also be used as additives to improve ash production (combustion process), e.g. aqueous wastes. These are likely to not be REACH registered and so be excluded by the current wording. These should be authorised, beyond the limitative list here, on condition that the final product meets the quality requirements (STRUBIAS, PFC). The list of accepted wastes could either be limitative (using EWC codes for waste materials) or be open subject to the final product respecting quality criteria.
1509	25% max additive is OK, but see comments in conclusions of 5/9/17 stakeholder meeting included above
1529	Here should be clarified, that the limits for “ash based materials” do not apply to the input-ashes in the processes in which components (like metals) are removed, nor to intermediates generated by such processes, but only to the final end product where these materials are processed into a CE Fertiliser (PFC). See comments in introduction
1539	The phrase “ <i>Based on the information from the STRUBIAS sub-group, thermal post-processing steps are only economically viable if they take place as an integral part of the combustion process for which reason any added materials during the thermochemical approach can be considered as input materials and additives to the combustion process (see requirements stipulated above)</i> ”. Concerning the economic viability, we would suggest that the STRUBIAS expert group probably does not have the necessary data to make this statement (it does not include operators/experts in such thermal processes. We would suggest that this statement is not true, and will become irrelevant with the regulatory obligations to recover phosphorus from sewage / sewage sludge incineration ash in Germany and Switzerland. The economic viability of the P-recovery processes from sewage sludge incineration ash depend on various parameters (regulatory obligations and context, capacity, P-concentration in the ash, available energy sources for pre-heating, available by-products as reagents, separation of different input materials into incinerators, design and operation of incinerators, etc.). Also, the statement concerning additives in this phrase is incorrect: in some thermal processes 40% or more of nutrient containing materials are added during the thermal process which have nothing to do with the combustion process, e.g. to improve final product nutrient balance or solubility (for example 40% Na ₂ SO ₄ in the AshDec process). This phrase should be removed.
1539	Alkaline additives are used in P-recovery from ash for some chemical processes to evoke the required chemical reactions and cannot be considered as belonging to the additives facilitating the incineration and gas cleaning process. Limits in feeding Na ₂ SO ₄ or K ₂ SO ₄ to such processes are not justified nor appropriate: they could be compared to limits in feeding H ₂ SO ₄ to phosphate rock for producing phosphoric acid.
1583	There are processes other than and additional to the thermal and wet-acid routes cited. For instance, EasyMining Sweden has developed two processes: One is a wet acid process: <u>Ash2Phos</u> with which P-containing ashes can be used as input raw materials producing clean well known phosphorus fertilizer, mono-ammonium phosphate of technical grade, with a very low content of metals, <1 mg Cd/kg P. It is as wet chemical process where the ash is dissolved in an acid and thereafter chemical methods are used to remove the dissolved elements. Unwanted metals are separated for disposal.

	The other <u>Ash2Salt</u> uses fly ash, air pollution control residues, with high chlorine content as raw material which is treated with water and the chlorine dissolved in a solution from which we recover clean commercial salts, one of the salts is potassium chloride which is a fertilizer or fertilizer ingredient. Here the purpose is to wash the ash to be able to dispose the rest without leaking of chlorines and the potassium chloride is one of the salts produced.
1596	Line 1596 and table summary page 114 line 4022: “post processing” defined as simply “mixing” with virgin chemicals or on-site by-products is inadequate. This should be rewritten and clarified. See detailed comments in introduction.
1632	Must include Category 1 ABP material. ABP1 ashes are already authorised and marketed as fertilisers. See comments in introduction.
1682	See detailed comments in introduction concerning the $K_2O+P_2O_5+SO_3$ ratio.
1682	The $K_2O+P_2O_5+SO_3$ minimum fraction will exclude generally sewage sludge incineration ash
1705	The statement that “ <i>plant availability of P in ash-based materials should be regulated for raw ashes that are directly applied on land as well as for ash-based materials that have been produced from the post-processing of raw ashes (see also section 2.3)</i> ” should be clarified - see detailed comments in introduction concerning definition of “post-processing”.
1720	Practical on-farm experience with Kalfos ash-based fertilisers in the UK over the last 5 years has shown that a material with a ratio below the ratio proposed is proven to be effective.
1724	See comments on phosphorus solubility in introduction
2038	Ash fertilisers are currently applied up to 1 tonne/ha based on its phosphorus content. The proposed AR of 5 t/ha is therefore exaggerating the accumulation risk by nearly an order of magnitude
2132	Comparing the proposed limits in table 7 to the JRC annexes page 25/38, these limits will make the direct application as fertiliser of ashes from waste water treatment sludge impossible. E.g. in table 7 maximum metal concentration for Mo=20 and Sb=6 are mentioned. Page 25 of Annexes shows Sb concentrations varying from 6.9-160mg/kg. Similarly for Mo in our experience the concentration in the ashes are even higher than the maximum concentration of 45mg/kg as mentioned on page 25.
2133	Table7: antimony level of 6 mg/kg seems unrealistically low. This is much lower than for arsenic and is not justified.
2187	We agree that specific limits for <u>leachable</u> fraction of ash products are not appropriate.
2264	It should be specified that the limits apply to the ash itself if used as fertiliser after finishing/conditioning or to the final fertiliser product if ash is used in chemical reprocessing.
2371	For ashes which are used directly as a product on fields, the respirable silica criterion should be included as a labelling obligation for user safety reasons (or the product contains respirable silicon it should be further conditioned or processed to resolve this and/or ensure safety in handling)
2383	It is not coherent to fix a respirable particle limit (labelling) for phosphate salts but not for ashes or for PFCs manufactured from virgin materials. We propose to include this limitation in labelling not as a material obligation.
2399	pH limit range is currently proposed is OK, but must not be reduced
2419	The title “Pyrolysis materials” should be questioned. If hydrochars are included in this chapter it must be made clear that hydrothermal carbonisation is a process completely different from pyrolysis. For suggested titles, see introduction.
2429	European Biochar Certificate (EBC) requires a minimum organic carbon content of 50%
2436	It can also be interesting to use nutrient-rich materials for co-composting with nutrient-poor but carbon-rich biochar (cf. Birk and Glaser 2012 or Glaser 2015)
2458	Nitrogen loss is mainly determined by N content of feedstock
2461	Most nitrogen is volatilized as NO _x or N ₂ during thermochemical conversion
2481	There are many studies showing different and results, sometimes positive and sometimes negative and sometimes “no effect” from biochar application. The different results in many cases probably relate to very different types of biochar material: nutrient content or not, physico-chemical properties as well as context of application / use ... The following recent study should be referenced. This shows that low-rate application of biochars can enhance yield through nutrient – root interaction, see Schmidt et al., Land Degradation & Development, attached

	 Schmidt Land Degradation & Develk
2491	Use the term “physico-chemical” instead of “physical”
2494	Include a new review article “Kern et al. 2017”: Kern J, Tammeorg P, Shanskiy M, Sakrabani R, Knicker H, Kammann C, Tuhkanen EM, Smidt G, Prasad M, Tiilikkala K, Sohi S, Gascó G, Steiner C, Glaser B (2017). Synergistic use of peat and charred material in growing media – an option to reduce the pressure on peatlands? <i>Journal of Environmental Engineering and Landscape Management</i> 25 (2): 160-174. doi.org/10.3846/16486897.2017.1284665 .
2535	We would prefer for a number of parameters that the IBI standards are used – see comments below
2551	If chars are only used for energetic purposes, product quality plays a minor role
2578	Avoid the term wet pyrolysis and speak only about hydrothermal carbonisation
2607	this makes the point of no limitations on the pre-treatment of pyrolysis feedstock. Given that in the case of animal slurry - extensive de-watering is need - this is a very useful point. The EUFR needs to reflect this: i.e. no wording which covers pre-treatment.
2609	If “any thermal pretreatment is authorised”, this would include pyrolysis, which seems to make little sense ?
2615	“Slow pyrolysis” is defined by reaction time rather than by temperature
2621	Not clear enough, what the product quality criteria are (EBC?)
2621	This directly contradicts what is in the EUFR: Recital 55 “Promising technical progress is being made in the field of recycling of waste, such as phosphorus recycling from sewage sludge, and fertilising product production from animal by-products, such as biochar. It should be possible for products containing or consisting of such materials to access the internal market without unnecessary delay when the manufacturing processes have been scientifically analysed and process requirements have been established at Union level. For that purpose, the power to adopt acts in accordance with Article 290 of the Treaty on the Functioning of the European Union should be delegated to the Commission in respect of defining larger or additional categories of CE marked fertilising products or component materials eligible for use in the production of such products. For animal by-products, component material categories should be expanded or added only to the extent an end point in the manufacturing chain has been determined in accordance with the procedures laid down in Regulation (EC) No 1069/2009, since animal by-products for which no such end point has been determined are in any event excluded from the scope of this Regulation.”
2625	“... it is not possible to predict ...” – this is not accurate as written, see Schimmelpfennig and Glaser (2012).
2625	Change “Therefore, it does not appear suitable to set strict criteria for production conditions with the aim of making a pyrolysis material with a demonstrated agronomic value.” → “Therefore, it does not appear suitable to set strict criteria for production conditions provided the pyrolysis material has a demonstrable agronomic value”. Explanation: the responsibility for demonstrating agronomic value lies with biochar producers and their customers i.e. commercial aspects - does the product work, or not. An alternative approach is to leave out all wording after "conditions" since it is self-evident that end users of "pyrolysis materials" will neither buy nor use them if they have no agronomic value. As an alternative, the report could observe that pyrolysis materials will have no market unless they can show agronomic value.
2632	It is stated that organic pollutants and pathogens are “concentrated” in pyrolysis materials. This should be modified. These substances will be mostly degraded, not concentrated. Even PAH and dioxins/furans which might possibly be “generated” are not “concentrated”.
2632	This section opens with observations about organic micropollutants in two types of feedstock (manures & animal carcasses). It further (2636 – 2639) notes that the removal of organic micropollutants is a function of the temperature profile and states Lines 2640 – 2648 indicate that “based on research (Weiner et al., 2013; Ross et al., 2016; vom Eyser et al., 2016)” it is claimed that process temperatures of <500C are unable to remove micropollutants that were originally present in contaminated feedstocks. Line 2656 proposes a process temp of >500C & residence time of +20 minutes.

Hitz Response & Proposal

The Hitz proposal is for a minimum temperature when treating livestock manure (or wastewater sludge) using pyrolysis of 400 degree Celsius in an oxygen-free atmosphere and no minimum residence time.

Pyrolysis & Biochar Test Parameters

The above proposal is based on an investigation of biochar production using an indirectly heated kiln with a feedstock of pig manure (having 40% water content) and a process temperature of 450 degree Celsius under oxygen-free condition. Multiple samples of biochar were collected during one-week of continuous operation using this feedstock and process temperature.

Outline of Pyrolysis System

The indirect heating kiln consists of double cylinders. The diameter of the internal cylinder is 560 mm and the length is 4.5 m. Raw material is fed into the internal cylinder and hot gas flows through the area between internal and external cylinder. The gas flows against the raw material, i.e. the gas flows from the downstream side of the material to the upstream side. The internal cylinder is heated by the hot gas which comes from the combustion of the gas produced by the pig manure. Temperatures of over 850 degree Celsius are reached in the combustion chamber. The gas from the combustion chamber has a temperature of 700 degree Celsius when it reaches the downstream side of the pyrolysis system. By the time the gas reaches the upstream end of the process it has a temperature of 300 degree Celsius.

Organic Micropollutants

Six common antibiotics, such as tetracycline(TC), chlortetracycline(CTC), oxytetracycline (OTC), doxycycline(DOX), tylosin(TYL) and tilmicosin (CHM) were investigated as target micro organic pollutants because of their abundances in pig manure. Pig manure and biochar of pig manure were analyzed by liquid-liquid extraction or accelerated solvent extraction (ASE), followed by solid phase extraction and quantification by high-performance liquid chromatography mass spectrometry (HPLC-MS/MS). In this study, five organic solvents, citric acid solution, methanol, acetonitrile, toluene and dichloromethane were used for extraction.

Results of tests for Organic Micropollutants.

Concentrations of each pollutant in pig manure were 27 ng/g-TC, 430 ng/g-CTC, 840 ng/g-DOX and 36 ng/g-TYL. By contrast, the concentration of all pollutants were below quantifiable levels for biochar derived from pig manure and processed as above. Specifically: 5 ng/g for TC, CTC and DOX and 10 ng/g for TYL). Oxytetracycline(OTC) and tilmicosin(CHM) was also below quantification levels in all materials analyzed (5 ng/g for OTC and 10 ng/g for CHM).

Hitz Comments & Observations concerning the sources mentioned in the draft Strubias report.

1. Toluene is a more powerful extraction solvent than methanol (used by Ross et al (2016)).
2. The paper by von Eyser 2016 considers the presence of micropollutants with process temperatures in the range 90-210 C (& not surprisingly finds them)
The paper by Weiner et al 2013 considers the presence of micropollutants with process temperatures in the range 200/255 C (& not surprisingly finds them)
The paper by Ross et al 2016, considers temperatures of 22, 100, 200, 300, 400, 500, 600 C. The paper finds that micro-pollutants remains at 400 C, but not 500 C. Ross et al do not show any data for micro-pollutants in biochar pyrolyzed in the range 400-500 C

Conclusion

The results obtained in the Hitz study strongly suggest that biochar derived from livestock manure can have organic micropollutants removed through oxygen-free pyrolysis at a maximum temperature of 450 degree Celsius.

A pyrolysis pilot plant was used to produce samples for the Hitz tests. The pilot plant has a

	multi-tonne weekly output of biochar and can be considered representative of a full-scale pyrolysis production system both in terms of its operation and the product that it produces.
2664	Use the term “residue” not “waste”
2666	Limit to bio-origin fibres (e.g. cotton, wool) not synthetic fibres
2698	2.6.3.4 Post-processing - this is a good section & needs to be reflected in the EUFR - i.e. what happens post-pyrolysis is largely a matter for those using the material.
2703	The reference “Schulze et al. 2016” regarding the stability of chars after washing can be included to point b) Schulze M, Mumme J, Funke A, Kern J (2016) Effects of selected process conditions on the stability of hydrochar in low-carbon sandy soil. <i>Geoderma</i> 257: 137-145. http://dx.doi.org/10.1016/j.geoderma.2015.12.018
2711	Replace “decomposition” by “conversion”
2742	“Based on the precautionary principle, a positive input material list is therefore appropriate to control adverse environmental or human health impacts.” - who will generate this list (of input materials)?
2753	“In this respect, it is interesting that the upper limit for the scale of individual pyrolysis reactors will likely remain smaller than that of biomass combustion technologies (Boateng et al. This means that pyrolysis may provide an alternative compared to current business-as-usual treatment scenarios from animal by-products (e.g. manure) that show a high degree of geographical dispersion.” This is not scientifically justified and adds nothing to the overall aim of the report: to provide a science-based basis and criteria for including biochar in the EUFR. It also misses an important point: pyrolysis systems are scalable in the sense that one or more rotary kilns can be placed in a location depending on feedstock availability. Also if there is a high degree of dispersion (of manure generating farms) - there is usually not a disposal problem. This should be removed.
2769	Limit to bio-origin fibres (e.g. cotton, wool) not synthetic fibres
2775	Animal by-product ABP end-point: line 2775 indicates “Please note that the pyrolysis process can only start once the end product of Regulation (EC) No 1069/2009 has been reached”. However, in some cases the pyrolysis process can itself achieve the ABP end-point. Therefore this phrase should be deleted.
2866	Effects of char materials on GHG emissions are complex and results are somewhat inconsistent. Depends on the type of char, the scale, the nutrient supply etc. Hydrochar for example may reduce N ₂ O emissions as often shown in lab experiments. Just now the message is that GHG emissions increase after biochar with low C stability are applied. Remove the bold style (2867-2868) and to note considerable uncertainties, which are reviewed in the article of Kammann et al. (2017): Kammann C, Borchard N, Cayuela M, Hagemann N, Ippolito J, Jeffery S, Kern J, Rasse D, Sanna S, Schmidt H-P, Spokas K, Wrage-Mönnig N (2017). Biochar as a novel tool to reduce the agricultural greenhouse-gas burden – knowns, unknowns and future perspectives. <i>Journal of Environmental Engineering and Landscape Management</i> 25(2): 114-139.
2889	Remove the criterion: O/C-org as this depends on on finishing and is not useful if H/C-org is specified. Most HTC chars have higher O/C ratios (cf. Schimmelpfennig and Glaser 2012)
2889	The O/C-org ratio (paragraph 2.6.5.1) should not be fixed as a standard or limit. This is based on the following rationale: - line 2428 - 2429 of the report notes that “The carbon content of pyrolysed chars significantly varies from 5 % to 95 % of the dry mass” - the report goes on to note (Line 2436 - 2438) that there are two broad types of pyrolysis material, C-rich and Nutrient-rich. - nutrient-rich pyrolysis material contains carbon with lower concentration than C-rich one. Thus O/C-org ratio of Nutrient-rich one gets much higher than those of C-rich one. The content depends on the feedstock (=raw material) and process temperature, paragraph 2.6.1 (line 2428) of the report. Given the above, setting a O/C-org ratio of 0.7 could lead to the exclusion of biochars derived from animal manures such as pig-slurry which are rich in phosphorous (and have O/C-org ratios higher than 0.7). One of the points of the revision of the Fertiliser Regulation is to recycle phosphorous from sources such as animal slurry. It would thus be unfortunate if the use of a low O/C-org ratio excluded animal slurries as a feedstock for biochar.
2902	Refer also to Schimmelpfennig and Glaser 2012

2909	Requirement to declare particle density, specific surface area and volatile matter. This is just an additional cost as farmers/growers would not need this detail of information for soil applied biochars. It is not a requirement of IBI for example
2939	Also most N s volatilized as NO _x or N ₂ causing high C:N ratios of chars
3201	Regarding metal limits for Ba, Co, Sb and V. In order to avoid unnecessary monitoring costs, monitoring of these elements should be waived if it can be justified that the input materials do not contain significant levels (e.g. non chemically treated biomass)
3050	<p>One assertion (cause) and an impact (effect) is claimed in line 3050 and 3051 - extract: "high production costs (as communicated by the STRUBIAS subgroup) for pyrolysis materials have severely restricted pyrolysis applications in real-world agroecosystems."</p> <p>- dealing first with "cause" - high production costs - the Hitz process has one main cost - that of capital. Whilst you can argue that this is a production cost, once the Hitz pyrolysis process is running - there are very few "production costs". One of the reasons that biochars have seen limited use in the EU is because they are not in the EUFR/ This argument is thus circular and non justified</p> <p>Discussions with fertiliser companies indicate an interest in testing biochars to address the knowledge gap (see Line 3052). Furthermore, fertiliser companies (at least the ones spoken to by Hitz) already tacitly acknowledge the need for fertilisers blended to suit a given location. One company offered 300 different formulae. There is no doubt that biochar would thus be tested in the field by fertiliser companies to see where it works well & makes a difference (& thus the end user will pay to have it) and where it does not.</p>
3070	When biochar / pyrolytic materials fulfil all given requirements, they will all pass an earthworm avoidance test (contrary to most chemical fertilizers). However, such bio-asset tests are expensive and take a lot of time prolongating the obtainment of certification results. The earthworm avoidance tests are not available in most professional laboratories, they are mainly used in universities. We therefore suggest to remove this criterion for biochars.
3152	Just make 1 category of pyrolysis materials, not 2, what about overlaps ?
3215	"contaminants such as hormones, veterinary products and their metabolites" – specify that these are more likely to be degraded than concentrated
3244	PAH maximum level. This is proposed as < 4 mg/kg dry matter. We note that, e.g. IBI standards have < 6 mg/kg and for recovered P salts and ash materials STRUBIAS proposes < 6 mg/kg. Analysis of PAH's is at the absolute limit for many laboratories, analysis of many of Carbon Gold's biochars indicate that total PAH's < 4 mg/kg may not always be achievable. For consistency, we propose a figure of < 6 mg/kg. In addition biochars are sites for microbes that break down PAH's to non-toxic compounds. Biochars are not applied on an annual basis so accumulation of PAH's is not an issue here.
3263	<p>The REFERTIL project (E. Someus) has suggested for biochars to specify that PCDD/F need only be measured if PCB > 0.07 mg/kg, because measurement is expensive and because the PCB limit is expected (for these materials) to provide a reliable surrogate indication of PCDD/F. The REFERTIL project www.refertil.info and the WESSLING Group laboratory investigated seven different biochar series from five EU countries. Even in low end technology performance cases PCDD/F limits were significantly below the targeted < 20 ng/kg (I-TEQ OMS) limit. Therefore, REFERTIL recommends:</p> <ol style="list-style-type: none"> PCBs: <0.2 mg/kg DM (PCB7 sum of PCBs 28, 52, 101, 118, 138, 153 and 180. Indicator for PCDD/F). TEST: EN 16167:2013 PCDD/F: <20 ng/kg (I-TEQ OMS) (mandatory measurement only if PCB >0.07 mg/kg). TEST: CEN/TS 16190:2012 <p>Some publications do show that dioxin and PCB levels are correlated in biota or humans (Mori 2008, Babut 2009, papers supplied to JRC) but this cannot necessarily be transposed to biochars, as indicated below.</p> <p>Recent exchanges with biochar experts have concluded that:</p> <ul style="list-style-type: none"> PCB and dioxin levels in biochars are independent and not correlated PCBs are not generated by the pyrolysis process, but come from contamination in the input feedstock (e.g. chemically treated biomass) Dioxins are only potentially generated if the input material contains significant chlorine levels (e.g. salted food waste, some straws) Dioxins in biochars analysed are generally very low

	<p>Evidence that PCB and PCDD levels are low in biochars comes from the Fertiplus project, analysis carried out by an accredited laboratory for the European Compost Network, contacts fryda@ecm.nl and A.B.Ross@leeds.ac.uk</p> <p>Further data on dioxins and other contaminants has been provided to JRC as follows. This is not included here for reasons of confidentiality:</p> <ul style="list-style-type: none"> - HITZ data 2016 - Eurofins data 2014, 2015, 2017 (Carbon Gold) - NRM data 2017 (Carbon Gold) - Wiedner et al. 2013 <p>Additionally, it is underlined that In any case, PCBs and PCDD/Fs and PAHs are all so tightly bound in biochars that they are scarcely bioavailable. This low bioavailability of PCDD/Fs means that passive samplers and not total contents should be used to assess the actual risk they pose, see http://www.biochar-international.org/node/6734</p> <p>An extensive review of contamination in biochars has been published recently by Hilber et al. 2017 (below) and this should be taken into account:</p> <p> Hilber Biochar contamination review</p> <p>We recommend to see also Schimmelpfennig and Glaser 2012 for biochars properties</p> <p> Schimmelpfennig Glaser Biochar quality</p> <p>Also analysis in ashes (Austria EPA, attached below) showed very low levels of PCDD/F showed very low levels in ash (FWW in the document)., and showed that additionally, these were further reduced by the Ashdec process (AGES in the document)</p> <p> UBA_Wien_Pb 0511_209_PCDD-F.ppt</p>
3388	'The framework of the proposal for the Revised Fertiliser Regulation indicates that STRUBIAS materials are CMCs, and are not yet products, since product status only applies to PFC materials. Therefore, STRUBIAS materials maintain the legal status of the materials they have been derived from.' Lack of clarity regarding struvite categorisation as a PFC; contradicts 3495-3497.
3467	Must also include ashes derived from Category 1. These are already today classed as exempt from ABP legislation ie they have ceased to become ABP materials
3495	'STRUBIAS materials will likely become products when used as substances on their own or in mixtures with other CMCs when compliant with all requirements laid down for the corresponding PFC...' Implied that struvite can be a PFC; contradicts 3388-3391.
3698	See information and scientific references provided by INCOPA
3686	See INCOPA comments. Add ferrous Fe(II). Calcium is not widely used for chemical removal in wastewater treatment.
3702	In discussion of biological waste water treatment plants, it may be useful to indicate the advantages of this route for complete or partial phosphorus removal (maybe completed by chemical P removal for finishing): reduced sewage sludge generation, lower chemical purchase cost, compatibility with future developments towards N removal/recovery and increased biogas production such as ANAMMOX
3847	Please correct text as follows: "Saria (UK) processes around 45 kt of MBM to produce ~ 2kt

	P yr-1 as the P-fertiliser product “Kalfos” (mainly calcium phosphate mineral fertiliser ~21% P ₂ O ₅ plus potassium, sulphur)”
3937	PYREG mainly sell plants, not operate, therefore the production volume quoted is not relevant and should be removed or replaced by the annual production volume from the plants that they have sold and which (others are now) operating
4100	See comments concerning market potential of recovered struvite under line 311

D.2. Comments on lines 4018-4022 Nutrient Recovery Rules

4018	The recovery rules” proposed are not in the format appropriate for introduction into Annex II of the Fertilisers Regulation as CMC specifications. When and by whom will draft CMC criteria text be prepared?
4018	For ash-based materials. It will not be possible for many ash based fertilisers to meet the draft nutrient specification. The K ₂ O+P ₂ O ₅ +SO ₃ minimum fraction should be reduced to 0.2 or lower to ensure that a fertiliser material has valuable nutrients but does not exclude materials which are proven to be effective fertilisers. The ratio for bonemeal ashes today sold and used as effective fertilisers is between 0.25 and 0.3. See comments on oxide ratios in introduction.
4018	Nutrient Recovery Rules - A Product and Labelling – The K ₂ O+P ₂ O ₅ +SO ₃ minimum fraction will exclude sewage sludge incineration ash. See comments on oxide ratios in introduction.
4018	For ash-based materials. The required ratio for citric solubility should be reduced to 0.2. A product at this level can still provide valuable nutrients to plants; customers wanting higher phosphate solubility will merely choose another product based on commercial and technical realities. The ratio for bonemeal ashes today sold and used as effective fertilisers is between 0.2 and 0.27 for the citric acid solubility test and between 0.23 and 0.32 for the neutral ammonium citrate solubility test. See comments on phosphorus solubility in introduction.
4018	For ash based materials, the (K ₂ O+P ₂ O ₅ +SO ₃)/(all oxides) ratio could be replaced by (P ₂ O ₅ +K ₂ O+CaO+MgO+SO ₃)/(all oxides), to cover all nutrients, as is already proposed for pyrolysis materials, and the limit reduced from 0.3 to 0.2. See comments on phosphorus solubility in introduction.
4018	For phosphate salts: for the criterion “Dry matter content (%)” this must be evaluated WITHOUT driving off the water of crystallisation, that is using a drying method which does not modify the phosphate salt molecule (e.g. does not drive off the 6H ₂ O water of crystallisation from struvite). See comments on drying temperature and proposed drying method for struvite under line 4019.
4018	Stakeholders also suggest that these mineral oxide ratios proposed will be costly to analyse, due to the need to analyse 13 different elements, without providing information on fertiliser value which is useful or comprehensible to users and farmers.
4018	For pyrolysis materials, the (P ₂ O ₅ +K ₂ O+CaO+MgO+SO ₃)/(all oxides) ratio should be set at < 0.1 rather than <0.15 as currently proposed, in order to not exclude biochars with higher organic carbon value and lower mineral nutrient content.
4018	If citric acid solubility is not deleted, then for all three STRUBIAS categories, the required ratio for citric acid solubility should be reduced. See comments on phosphorus solubility in introduction.
4018	For all three STRUBIAS categories, replace the 2% citric acid (phosphorus) / total P by NAC (neutral ammonium citrate) phosphorus solubility test, or by NAC or water or citric acid (as in PFCs) or simply refer to the criteria in the PFCs. See comments on phosphorus solubility in introduction.
4018	Ash based products – the organic carbon (3%) limit is not necessary for class B ashes, as these are coming – BY DEFINITION 4022 “Core Process” - from IED installations which require <3% C-org (as explained at 1405). Therefore, delete this requirement for Class B ashes (add under “Core Process” that this is an IED requirement).
4018	See comments in the introductory section concerning the <3% organic carbon limit for phosphate-salts
4018	The (Ca + Mg)/P > 0.8 requirement should be modified, see comments in introduction. As defined, this ratio only takes into account Mg struvite or calcium phosphates, not K struvite or K-based phosphate salt fertilisers.

4019	<p>Drying of struvite at 105°C is not possible: loss of water of crystallisation and loss of ammonium (destruction of the struvite molecules). Suggest to refer to the following two standards</p> <ul style="list-style-type: none"> - Association of Fertilizer and Phosphate Chemists AFPC, Methods of analysis for phosphoric acid, superphosphate, triple superphosphate and ammonium phosphates, No 2 Free Water, B. Vacuum desiccator method - under development: ISO/AWI 19745, Determination of Crude (Free) water content of Ammoniated Phosphate products -- DAP, MAP -- by gravimetric vacuum oven at 50 °C http://www.iso.org/iso/home/store/catalogue_tc/catalogue_detail.htm?csnumber=66222&commid=52376
4019	Nutrient recovery rules- ash-based materials and biochars: increase Sb and Mo limits to same levels as for arsenic in PFC1C (60 mg/kg), or at least to the level for Mo in UK Poultry Litter Ash end-of-waste protocol (45 mg/kg). See comments on contaminants in introduction.
4019	Ashes: Mn limit – avoid reference to bioassay test – ambiguous (which test, what results?) and expensive
4019	Regarding metal limits for Ba, Co, Sb and V. In order to avoid unnecessary monitoring costs, monitoring of these elements should be waived if it can be justified that the input materials do not contain significant levels (e.g. non chemically treated biomass). See comments on contaminants in introduction
4019	It can also be suggested that certain heavy metal limits for ashes used directly on fields should be possibly lower than limits set in PFCs for mineral fertilisers, because ashes may be used at larger application rates. This could possibly be addressed by relating contaminant levels to nutrient contents.
4019	Total carbon content – biochars: should be modified to “organic carbon”. Content of inorganic carbon (e.g. in carbonate) is not relevant to biochar properties.
4020	PCB, PAH, micropollutants, ... : why not the same thresholds for all those materials covered by STRUBIAS for which these are pertinent (ash, biochars). PCB and PAH are not relevant for struvite/phosphate salts. See comments on contaminants in introduction
4020	For biochars, apply the same limits as in the draft Fertiliser Regulation revision for composts, organic fertilisers and organic soil improvers: PAH ₁₆ < 6 mg/kgDM
4020	For PAHs, for biochars: extraction with toluene should be specified because PAHs can be strongly adsorbed to the biochar matrix, so that PAH analysis methods adapted for soils may not accurately detect PAH present in biochars. Proposed text method: DIN EN 15527: 2008-09 (with toluene extraction); DIN ISO 13877:1995-06 – Principle B with GC-MS
4020	The particle size (respirable dust) criterion should be a labelling requirement (not an obligation), and set at the same level for all STRUBIAS materials and for fertiliser products from virgin materials.
4020	For ashes which are used directly as a product on fields, the respirable silica criterion should be included as a labelling obligation for user safety reasons. See line 2371.
4020	“Macroscopic impurities (organics, glass, metal and plastics > 2mm)” are currently left blank for ash and for pyrolysis materials. See comments on contaminants in introduction.
4020	E. coli are eliminated by the temperature/time profile of biochar production, therefore the reference to PFC should be removed.
4020	For biochars – measurement of PCDD/F and PCB should only be required where justified. See line 3263 and introduction.
4020	For H/C _{org} for biochars, specify Test: DIN 51732:2014-07 Testing of solid mineral fuels - Determination of total carbon, hydrogen and nitrogen - Instrumental methods
4020	When biochar / pyrolytic materials fulfil all given requirements, they will all pass an earthworm avoidance test (contrary to most chemical fertilizers). However, such bio-assay tests are expensive and take a lot of time prolongating the obtainment of certification results. The earthworm avoidance tests are not available in most professional laboratories, they are mainly used in universities. We therefore suggest to remove this criterion for biochars.
4020	It is important that an estimation of the analytical cost be proposed for the proposed Nutrient Recovery Rules. The EBC analysis for biochars already cost currently 710 Euro. With the proposed rules in this Interim Report, stakeholders estimate that these costs will rise to more than 2000 Euro (per sample). Especially the PCDD/F and PCB analyses are very expensive (> 1000 Euro) and not yet standardized for biochar materials. Moreover, most of the suggested analyses can currently only done by one professional laboratory it should therefore really be investigated how realistic some of the analytical exigencies are.

4021	Ash-based materials, class B: remove the exclusion of ABP Cat.1, these are currently authorised as inputs and are no longer classified as ABP after incineration under IED conditions (as specified here for class B ashes)
4021	Phosphate salts: Input materials – see introduction
4021	See comment on line 775
4021	Pyrolysis materials: sewage sludges should not be excluded. There is no justification for excluding such an important nutrient recycling input resource, if sewage source control and biosolids selection combined with pyrolysis processes can achieve the STRUBIAS contaminant and safety criteria.
4021	Phosphate salts – Pre-Treatment - Additives - Municipal waste water treatment plants (and other water treatment installations) use additives which are not “food additive” authorised. This may contradict the current wording. See comments on the definition of terms such as “additive” and “pre-treatment” in introduction.
4022	Phosphate salts – Pre-Treatment - Additives - polymers and other flocculants may be used in either recovery of precipitated salts from solution or in granulation. These are accepted in the current proposal if from “virgin materials”. Propose to add also polymers as authorised by the EU Fertilisers Regulation CMC 10.
4022	Ash-based materials - “post processing” defined as simply “mixing” with virgin chemicals or on-site by-products is inadequate - in the cases cited 1529-1570 there is a chemical reaction, plus in some cases thermal treatment, not simply “mixing” - in many cases, non-virgin chemicals may be used, for example sulphuric acid for the acid process is a by-product e.g. of oil refineries (not an on-site by product as specified) - biobased polymers or similar should be authorised for granulation, if these are conform to the Fertilisers Regulation polymers criteria
4022	For ash-based materials under post-processing, the limitation to “on-site by-products” should be deleted. Easymining’s Ash2Phos process (see line 1583) produces intermediate products that can be produced in a smaller plant and the upgraded to final products at a site where also the finalization of the products are made. This solution enables plants with smaller capacities to be built and still economical viable.
4022	Specify also for phosphate salts that chemical reaction re-processing is acceptable under the “post processing” line (same as for ash materials)
4022	Biochars: Pyrolysis temperature and time conditions are proposed in the Nutrient Recovery Rules. This contradicts - line 2621 states “ <i>With product quality of primordial importance, it is proposed not to impose any constraints on the pyrolysis process, as long as the output material meets the product quality criteria</i> ” - line 2614 - lists various pyrolysis processes (& typical temperatures) ends with the statement: “ <i>no process constraints provided output material meets product quality criteria</i> ” - line 2625 - notes that molecular structures and agronomic properties are NOT predictable based on temperature profiles, and ends with the statement “ <i>Therefore, it does not appear suitable to set strict criteria for production conditions with the aim of making a pyrolysis material with a demonstrated agronomic value.</i> ”
4022	Ash based materials – B Input Materials. This list needs expanding and defining in terms of EWC codes for waste materials. The principle should be to allow wastes such as compost and AD plant liquors (19 . . . codes), aqueous wastes from for example detergent and pharmaceutical manufacturers (07 . . .) provided the product meets the specification agreed in the Nutrient Recovery Rules Part A. Aqueous wastes are very important for some production processes as a means of controlling combustion and emissions. The effect of an aqueous waste on the product is minimal or insignificant and is easily and effectively controlled by input material sampling and analysis. For example, the full list of input materials for the Kalfos UK production plant under the Environment Agency End of Waste requirements is available on request.
4022	Ash-based products – Core process – the ABP regulation allows (in addition to the IED incineration requirements) possibility to respect 0.2 seconds at 1100°C. This should be added for Class B ashes.
4022	Nutrient Recovery Rules – ash-based materials – additives (max 25%). Specify that this is “as wet weight” and as % of input into combustion process.

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- i The German regulation is expected to require at least 80% recovery of phosphorus from some 300 000 tonnes/year of sewage sludge incineration ash
 - ii Ecophos has already announced the processing in Dunkerque, France, of 60 000 t/y of sewage sludge incineration ash from the Netherlands www.phosphorusplatform.eu/scope111
 - iii <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0098>
 - iv Waste Framework Directive art. 18.1 “Ban on the mixing of hazardous waste: Member States shall take the necessary measures to ensure that hazardous waste is not mixed, either with other categories of hazardous waste or with other waste, substances or materials. Mixing shall include the dilution of hazardous substances.”
 - v Waste Framework Directive art. 7.4 “The reclassification of hazardous waste as non-hazardous waste may not be achieved by diluting or mixing the waste with the aim of lowering the initial concentrations of hazardous substances to a level below the thresholds for defining waste as hazardous.”
 - vi Waste Framework Directive art. 13 “Member States shall take the necessary measures to ensure that waste management is carried out without endangering human health, without harming the environment ...” and Commission Guidance (June 2012) states that this should be interpreted as follows: “For example, diluting hazardous substances in recycled products (for example diluting pesticides in recycled plastics products) would increase adverse environmental impacts.”
 - vii Waste Framework Directive art. 6 “the use of the substance or object will not lead to overall adverse environmental or human health impacts”
 - viii The following question should however be verified: it should not be possible to place on the market as “mineral” phosphate fertiliser (PFC1(C)(a)(i)) a blend of a recovered phosphate salt with low phosphate solubility mixed with a virgin fertiliser with high phosphorus solubility, to “just” achieve the PFC solubility limit. If this is an issue, then the CMC phosphate salts should simply require conformity to the PFC phosphorus solubility criterion, and avoid specifying other specific/different phosphorus solubility limits.
 - ix see Schlimmelfennig and Glaser 2012, Wiedner 2015, Glaser 2015 as provided to JRC by Bruno Glaser 11/9/2017
 - x See “Changes in Inorganic and Organic Soil Phosphorus Fractions Induced by Cultivation Practices and by Laboratory Incubations”, J. Hedley et al., 1982, SSSAJ Vol. 46 No. 5, p. 970-976 <http://dx.doi.org/10.2136/sssaj1982.03615995004600050017x>